IMPLICATION OF CHANGING CONSUMPTION PATTERN ON FOOD SECURITY AND WATER RESOURCES IN BANGLADESH

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ABSTRACT

Bangladesh is expecting an additional population burden of more than 58 million by 2050 with respect to the present time (year 2010). National statistics (BBS, 2001) showing the composition of dietary energy composition for the Bangladeshis revealed that around 80% of the total food energy is contributed from major carbohydrate sources. With the increase in the population burden, food demand will increase and at the same time consumptive water use (CWU) by crop will also increase. But change in the consumption pattern, like shifting from grain dependency may reduce the net water use to some extent (as grain crops consume more water than that of the non-grain foods. This research develop a portfolio of balanced diatery intake for the bangladeshis and thereby enumerate the total food demand till 2050. Results shows that total food demand for rice in 2050 may rise by 56% from the base case and other dominant cereals like maize and wheat may be increased by more than twice in 2050. At the same time it assess the impact of water demand in terms of CWU for major crops.

Keywords: *Food security, water demand, CWU, agriculture, consumption pattern*

1. INTRODUCTION

Increasing income and urbanization are triggering a rapid change in food consumption patterns in Bangladesh. Food grains dominate in the total dietary consumption of the Bangladeshi people. Historical data (FAO, 2005a[1]) on consumption profile shows that, on an average, around 82.5% of the total food energy is contributed from major carbohydrate sources followed by 10% from protein, 5% from fat, 2% from mineral and only 1% from fibrous food. In addition to this, rice is the main food grain all over Bangladesh, which comprises around 88% of the total grain consumption. The non-grain food crops and animal products provided 8% and 4%, respectively, of the remaining calorie supply. WHO proposed that there must be 55-65% of carbohydrate, 10-20% protein, 15-25% of Fat and 5% of mineral sources for maintaining a balanced composition between different energy sources. Historical trend is showing a decrease on the dependency on grain or carbohydrate consumption, but no such study has ever been initiated in Bangladesh which estimated the net amount of food requirement in future that also matches with the balance in dietary requirement.

[1] FAO, 2005. FAOSTAT database

Although rich people generally have more capacity to buy healthy foods, but in Bangladesh the variation of energy consumption for different income groups is also very less in terms of different dietary composition. In a word, Bangladeshis indifferent to income profile, principally dependent on grains or more specifically on rice. In other words, it can be clearly affirmed that the Bangladeshis indifferent to the income group, has been suffering from malnutrition due to imbalance in dietary intake due to excessive carbohydrate intake. But what should be the overall ideal requirement of grains and other foods for the Bangladeshis, at present and in future, has never been estimated.

In Bangladesh, poverty is measured in terms of calorific intake per person per day. According to the Poverty Reduction Strategy Paper (PRSP) for Bangladesh, the food poverty line is estimated by costing a fixed-bundle of food items corresponding to the age-sex adjusted normative calorie requirement of 2,122 kcal per day per person. A comparative statistics of average daily calorie intake of the average person in 20 countries shows that it is found maximum of 3,410 kcal for Ireland and minimum 1,710 kcal for Upper Volta (Source: http://www.trivia-library.com/). Few years ago, the Government's mandate was to ensure "Rice with Fish" for every Bangladeshis and at present Government is campaigning for "Rice with Pulse". But in most of the cases, a big portion of Bangladeshis either could not afford or became habituated suffering from malnutrition due to the absence in protein, vitamins, minerals and proper amount of fibre on their daily intake. In this regard, an initiative has been undertaken in this study to quantify the net requirement of food for the Bangladeshis in 20501, maintaining the standard balance in dietary composition.

Water demand is positively correlated to the food production, i.e., if food production increases then the water demand will also increase. On the other hand, food demand is also going to increase as the population increases. By 2050, more that 56 million new people is anticipated to be added to share the total available food[2]. But not necessarily the demand of water will also increase linearly. Change in the productivity of different crops and technological advancement may contribute to a non-linear change in the relation between water demand and food consumptive demand. But change in the consumption pattern, like shifting from grain dependency may reduce the net water use to some extent (as grain crops consume more water than that of the non-grain foods). At the same time if the growth in water productivity stagnates, the CWU demand exceeds the potentially utilizable water resources. Now the question of how Bangladesh should manage its water resources to meet food grain security for the increasing population is a paramount concern for the policymakers. In this regard, under the current study an attempt has been made to assess the food and water demand for Bangladesh for the base case (Year 2001) and thereby to project the consumptive demand up to 2050 at 10 yr. interval.

2. OBJECTIVE

The main objective of the research paper is to construct the balanced portfolio of dietary composition that will guide the policy makers to make a step towards achieving food security. In addition to this, the paper also aims to assess the change in the water demand for maintaining the above stated balance in dietary requirement. To achieve the above-mentioned main objectives, following are the instrumental objectives:

- To check whether any trend or shift exists in the global, regional and local dietary pattern
- To iterate and propose an alternative and a balanced portfolio of dietary composition for eradicating the malnutrition by year 2050
- To assess consumptive water demand for the proposed change in the dietary composition

[2] Population projection made by United Nations Population Division considering medium fertility as variant

3. METHODOLOGY, DATA AND ASSUMPTIONS

This study assesses the demand for four major categories of food and under these categories a total of 15 general crop categories have been considered.

The cereal or grain crops category includes rice and wheat (milled equivalent), rice and wheat flour, other cereals (such as barley, millet, sorghum etc.); mutton, beef, chicken, ducks and birds, eggs fall under the meat and poultry category; fish means the consumption of sweet fish, saline fish and dry fish and other types, oil crops which can be treated as the non-grain crops mainly includes vegetable oils as oil crop equivalent and other non-grain crops are potato and other starchy roots, vegetables, fruits and sugar. The food balance sheets from the FAOSTAT database show that these crops accounted for 99% of the nutritional supply in the daily diets from 1991 to 2001, directly through food and indirectly through feed for the livestock (FAO 2005a). Hence, these are selected for the projection of food demand in this study.

Figure 1 show the overall methodological framework for the food demand projection, which has been adopted from a relevant study on changing consumption pattern published by the International Water Management Institute (Amarasinghe et al., 2007).

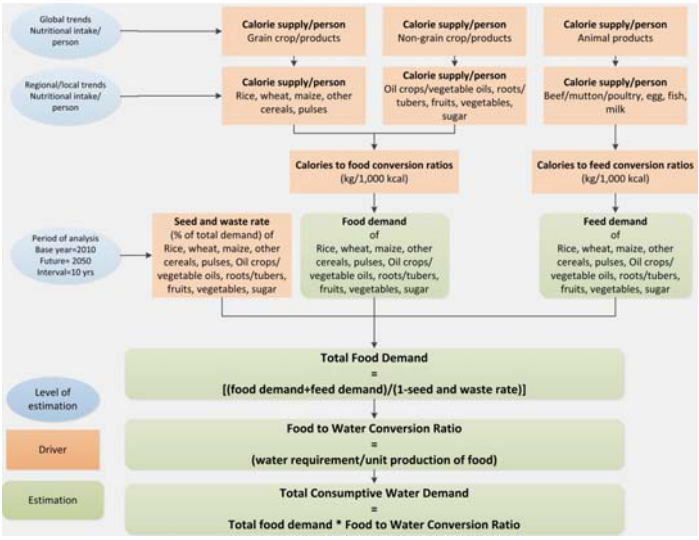

Figure 1: Analytical framework for food demand computation (Source, modified and adopted from Amarasinghe et al., 2007)

3.1 Total Food demand calculation for the base year

- First, we compute quantity of food demanded from the national statistics for each of the grain, non-grain and other food categories and then covert the quantity demanded into calorie intake by dividing the quantity demanded by the food conversion factors. The food conversion factor is the quantity (kg) of food required to generate 1,000 kilocalories (kcal) of calorie supply.
- Second, we assess the level of consumption of animal products in the name of feed demand. The feed conversion ratio is defined as the quantity (kg) of a crop used for generating 1,000 kcal of animal products in the diet.
- Third, we keep an allocation for seeds and waste for the total demand computation as a percentage of total demand.
- The total demand for each crop is estimated as:

  Total demand = (food demand + feed demand) / (1 - seeds and waste as a percentage of total demand) (1)

3.2 Food demand projection up to Year 2050

- National and international (developed, developing and other neighbouring country) trends of energy intake of different food categories with respect to the changes in different income groups have been computed
- For different crops and income groups, in most cases, annual growth rate has been computed on the basis of historical trend of per capita intake.
- Same methodology of total food demand calculation (as stated above) has been adopted for individual year demand calculation

3.3 Consumptive water demand calculation

- Consumptive water use (CWU) is assessed here as water demand following the methodology described by FAO (2005). Theoretically, it is the quantity of water transpired by the crops and evaporated by the surface on which the crop grows during the crop growth period - as a means of assessing the implications of increasing food demand on water demand.
- We use the mean monthly rainfall and the ETp at hydrological region level[3], the crop coefficients (the ratio of potential to actual ET) at different periods of crop growth (initial, development, middle and late), and the crop calendar of different crops for four different regions to estimate the CWU (FAO 2005b).
- This study uses a 75% exceedence probability of monthly rainfall for estimating the effective rainfall (Amarasinghe et al. 2005). The CWU for each of the crop is estimated as:

$$CWU = \sum_{k\,seasons} CRA_{lk} \sum_{j\,months} \sum_{i\,growth\,periods} kc_{ki}^{l} \times ETp_j \times \frac{d_{ij}}{n_j} \qquad (2)$$

where CRA is the crop area, respectively, of the crop in the kth season; l represents 8 crops (T Aus, T Aman, Boro, Wheat, Potato, Oilseeds, Spices and Vegetables), iε four growth periods (initial, development, middle and late), d_{ij}= number of days of jth months in the ith crop growth period, and n_j= number of days of jth month; kc_{ki}^{l} is the crop coefficient of the crop in the ith growth period in the kth season.

4. RESULTS AND DISCUSSION

4.1 Food demand for the base year

National consumption figures for the year 2001 are projected from the available time series data acquired from the Household Income Expenditure Survey (HIES) of the Bangladesh Bureau of Statistics (BBS,2004). It is found that people from the low income group category consumes 2062 kcal per day of which 83% is covered by the grain crops. On the other hand medium and high income groups consumes 2324 kcal and 2527 kcal of which 80% and 74% respectively comes from the grains.

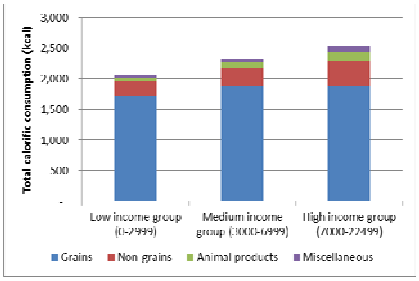

Figure 2: Consumption of different major category of food items disaggregated by different income groups

[3] There exist eight hydrological regions in the country: North East, North Central, North West, South East, South Central, South West, River and Estuary and Eastern Hill

Composition of grains, non-grains, animal products and miscellaneous other products in the daily calorific intake is shown in figure 2. Here it is found that the peoples from the higher income category are consuming relatively more non-grains and animal products.
Food conversion factors for Bangladesh is given in Table 1, where it is evident that vegetables are the largest calorie value crops and on the other hand rice and other cereals are contributing the lowest value in respect to their individual physical mass .
Crops like Barley, Maize, Sorghum, Pulses, Milk and Pelagic Fish are the main sources for animal feed in Bangladesh and the respective feed conversion factors is given in Table 2. It is quite interesting to note that a large proportion of feed demand in Bangladesh is met up by the milk for the purpose of calf feeding.

Table 1: Food conversion factor for Bangladesh disaggregated by crops

Crops	**Food conversion Factor**	**Crops**	**Food conversion Factor**
Rice (Milled Equivalent)	0.2750	Vegetables	3.8919
Wheat	0.3209	Fruits - Excluding Wine	2.0112
Maize	0.2791	Sugar & Sweeteners	0.2987
Cereals, Other	0.1207	Meat and poultry	0.6275
Pulses	0.2914	Eggs	0.6683
Oil crops	0.2498	Fish	1.5387
Potatoes	1.4285	Milk	1.5910
Starchy Roots	1.3029	Misc	0.100

Table 2: Feed conversion factor for Bangladesh disaggregated by crops

Crops	**Feed Conversion Ratio**	**Crops**	**Feed Conversion Ratio**
Barley	0.0018	Pulses, others	0.0020
Maize	0.0074	Milk	0.5377
Sorghum	0.0007	Pelagic Fish	0.0166

Seed and waste consumption percentage is given in Table 3 and it has been showing that oil crops and starchy roots generate the maximum demand for seed keeping and wastage.
Finally, total food consumption for the base year has been enumerated using the Equation 1 as stated in the methodology section (Table 4). Food and feed conversion factors are multiplied with the calorific demand to enumerate the gross consumption demand. This per capita consumption demand is multiplied with the average number of members within individual household income range and this household demand has been converted to the national demand using the total number of national households.

Table 3: % of seed and wastage demand for Bangladesh disaggregated by crops

Crops	**% of seed and wastage demand**	**Crops**	**% of seed and wastage demand**
Rice	0.0896	Oil crops	0.4278
Wheat	0.0644	Starchy Roots	0.2082
Maize	0.0881	Vegetables	0.1016
Sorghum	0.0796	Fruits	0.1059
Pulses	0.0679	Sugar crops	0.1678

Table 4: Base year (2001) consumption demand for Bangladesh disaggregated by crops

Crops	**Total Consumption (Million MT)**	**Crops**	**Total Consumption (Million MT)**
Rice	2454	Vegetables	1197
Wheat	101	Fruits	235
Maize	33	Sugar and sweeteners	45
Other cereals	5	Meat and poultry	48
Pulses	85	Eggs	29
Oil crop	246	Fish	290
Potato	374	Milk	262
Other roots	194	Miscellaneous	29

4.2 Food Demand Projection up to 2050

Global statistics shows that around half of the total calorie supplies is obtained from grains. On the other hand, Bangladesh consumes more than 80% of the energy from grains (FAO, 2005a). As shown in Figure 3, consumption pattern for different food items indicate that, historically rice consumption pattern has been decreasing, whereas the other main grain food wheat consumption is slightly increasing over the time period. On the other hand, potato and fish demand has been increasing and overall vegetable demand decreasing quite sharply over the decades. So it is obvious that the dietary habit irrespective to the income pattern has been changing for the Bangladeshi people. Another paradigm of the increasing food demand is mainly accounted for the emerging trends of increasing animal products, which can be evident from the net increase of animal feed consumption by six times over a 8-yr period (2500 Ton during 1996 to 17,500 M Ton during 2003).

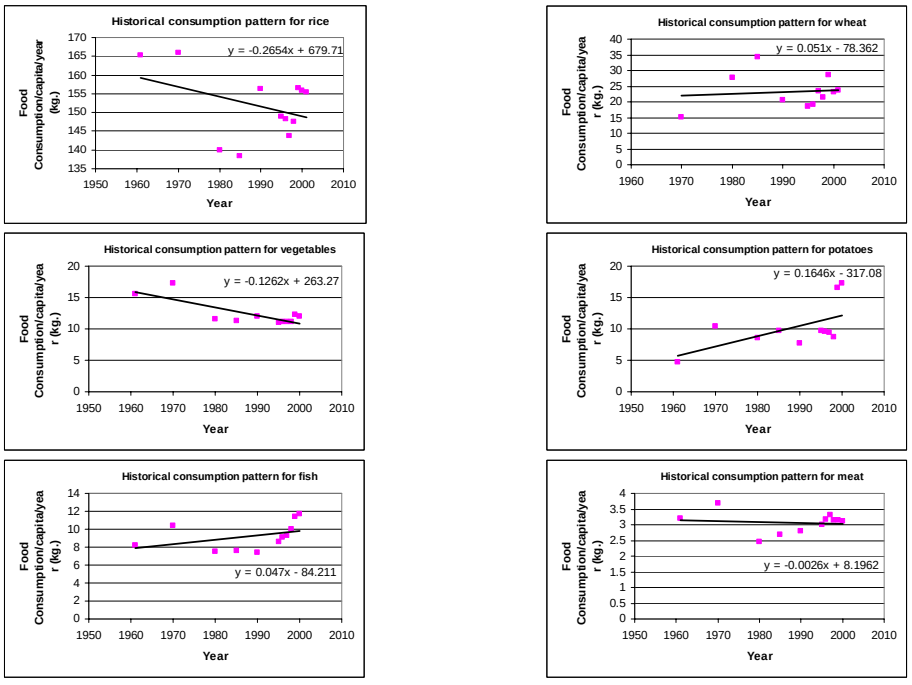

Figure 3: Historical consumption trend for different food items

Annual growth rate for individual crops has been determined from the projection of historical consumption data obtained from the FAOSTAT database of FAO (FAO, 2005b). In some cases, judgement is applied for fixing the annual growth rate. For example, the historical meat consumption rate in Bangladesh is decreasing, but comparing with the other developed and developing country the future consumption rate for meat has been revised to reach the level of standard healthy dietary practice. Similarly, some other differences have been made mainly due to reducing the consumption burden on grains and subsequently to shift the proportion on non-grain and animal products.

Using the same methodology for converting the calorific demand to the gross mass demand, consumption demand has been projected up to 2050 at 10 yr. interval. Total food demand for the nation derived from the sum of food demand, feed demand and demand for seed conservation and wastes is shown in figure 4. Total food demand for rice in 2050 will rise by 56% from the base case and other dominant cereals like maize and wheat will be increased by more than 10 times and twice in 2050. Fish and meet demand will increase almost by the same percentage of around 150%. Non grain crops like Potato which can be expected to act as a substitute of rice will be increased by more than 200% and other animal products like milk and egg will be increased by more than 500% and 200% respectively.

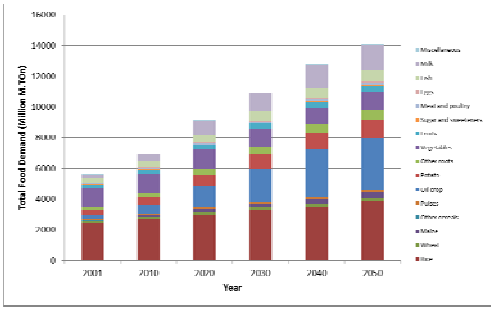

Figure 4: Total food demand up to year 2050

4.3 Consumptive water use

The implications of increasing food demand on water demand are assessed through the consumptive water use (CWU). The CWU is the actual evapotranspiration (ETa)—the evaporation from the field and the transpiration from the crops—during the cropping period.

The estimates of CWU are only for broad category of rice, wheat, oil crop, potato and vegetables. In 2001, the estimated net CWU (Gross CWU-effective rainfall) of the examined crops was 11,888 billion cubic meter (BCM) which might increase up to 26,322 BCM in 2050 due to increase in the food demand and also due to the change in the consumption pattern. Decadal change in the CWU disaggregated by different broad crop category is shown in figure 5. Gross CWU for the rice crops may increase from 10,855 BCM to 16,951 BCM, whereas the change in water demand from the oil crops is significant which may increase from 615 BCM to 8546 BCM.

In a nutshell, by 2050, population in Bangladesh will be increased by 58% and consequently total food demand will be increased by 200% (Rice demand may be increased by 56%, wheat demand may increase by 138%, meat and poultry demand may increase by 143% and milk demand by 527%). On the other hand, consumptive water use or water demand may increase by 57% with respect to the base case (Year 2001). Gradual shift in the consumption pattern, like shifting from grain crops to animal products, are the main reason behind the fact.

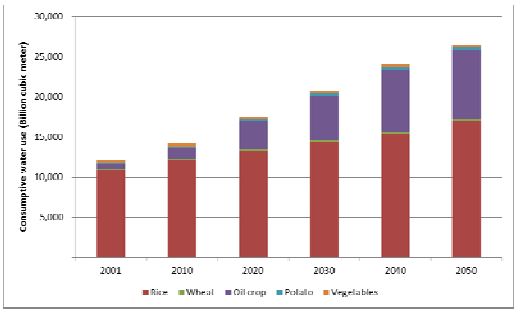

Figure 5: Consumptive water use for major crop category up to year 2050

5. CONCLUSION

This report started assessing the recent shifts in food consumption patterns in Bangladesh and their implications on total crop demand. The recent trends clearly show changing patterns of consumption. While direct grain consumption is decreasing, non-grain product consumption in the daily diet is increasing. This study projects that, with increasing income and urbanization, the non-grain crops and the animal products (dairy and poultry) would dominate the consumption basket by 2050. The contribution of grain products to the total calorie supply is projected to decrease from 79 percent in 2001 to 59 and 55 percent by 2030 and 2050, respectively. However, the average total calorie supply is projected to increase to about 3106 and 3274 kcal/person/ day by 2030 and 2050, respectively. This level of average calorie supply is sufficient for providing adequate nutritional security to people even in the lowest income percentiles.

A major implication of the changing consumption patterns is the increasing feed demand. The total feed demand will increase from 0.12 million Metric Ton (MMT) in 2001 to 0.23 and 0.29 MMT by 2030 and 2050, respectively. Another implication of the changing consumption patterns is the high level of consumption of non-grain crops. The demand for oil crops (including edible oil), vegetables and fruits increase several times from the present level. The study also assessed the implications of the changing food consumption patterns on CWU. Total CWU will increase from 10,981 Billion Cubic Meter (BCM) to 14,645 and 17,251 BCM respectively. But how the government shall cope with this increasing food and water demand is the intimidating task and it should be studied thoroughly on a national and regional basis.

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