

Economic Impact of Adopting healthy Diet in Canada

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Abstract

The WHO recognizes obesity as a global health issue with one billion adults worldwide identified as overweight and an additional 300 million as obese. Obesity has come to be recognized as both a Canadian “epidemic” and a global “pandemic”. These facts indicate that the costs of chronic diseases are increasing at a rapid rate and have negative implications for the well-being of the Canadian economy. Lifestyle plays an important role in determining the prevalence of chronic diseases. Among several initiatives, the provision of healthy diet is recommended as one of the important measures to address the problem of chronic disease.

In this background, the study estimates the macro economic impact of healthy diet guideline announced by the Public Health Canada using Input-output framework. The study outlines a gap between actual and targeted consumption of Healthy diet in Canada for the year 2004. Results shows that Canadian diet is influenced by more meat and less vegetables, fruits, milk and whole grains than the targeted one. A number of strategies implemented in household consumption expenditure combining different food. An increase in GDP and employment is expected, if Canadian diet applies more Vegetables and fruits, while more than double reduction in employment and GDP estimated for reduction in meat consumption. The combined strategy will generates some space for job as well as GDP. Overall it is apparent that Canadian economy is more meat based compared to fruits, vegetables and others. Finally the study suggests some policy options to overcome the economic losses keeping healthy guidelines constant.

1. Introduction

Chronic diseases were responsible for 50% of the disease burden in 23 high-burden developing countries in 2005 (Nugent, 2008). Currently, 2.5 million Canadians suffer from diabetes compared to 1.3 million a decade ago. It is estimated that 3.7 million Canadians will be affected by diabetes by 2020 (the Globe and Mail, 2009). The WHO recognizes obesity as a global health issue with one billion adults worldwide identified as overweight and an additional 300 million as obese. It has been projected that by 2050, 60% of the UK population (a 2.5- fold increase from current levels) could be obese if current trends persist (Government Office for Science, 2007). Obesity has come to be recognized as both a Canadian “epidemic” and a global “pandemic” (Katzmarzyk, 2002). As in other countries the prevalence of overweight and obese youth is rising in Canada. The 2004 CCHS identified that 23% of Canadians aged 18 or older were considered obese, while an additional 36% were classified as overweight (Janssen et al., 2004). Obesity rates in the U.S.A are among the highest in the world with 64% of adults being overweight and 26% being obese (North American Association for the Study of Obesity, 2006). Estimates of the number of obese American adults have been steadily expanding, from 19.4% in 1997, 24.5% in 2004 (CDC, NCHS 2005) to 26.6% in 2007 (CDC, NCHS, 2007). Should current trends continue, 75% of adults in the United States are projected to be overweight and 41% obese by 2015 (Wang and Beydoun, 2007).

The ‘nutrition-transition’ behind these increases in obesity and nutrition-related chronic disease has been facilitated since the 1980s by economic growth, modernization, urbanization and globalization of agri-food systems. Market-led agricultural policies, trade liberalization and foreign direct investment by large transnational food companies in particular have altered the global food system through changes in food production and distribution. This has facilitated the shift in food culture, dietary consumption patterns and nutritional status (Lock et al., 2010). Lifestyle plays an important role in determining the prevalence of chronic diseases. In the past few decades there has been an increase in the consumption of fast foods, pre-prepared meals, soft drinks, and candy, while at the same time there has been a shift towards less physically

demanding work (WHO, 2003). A transition to diets high in saturated fat (mainly from meat and dairy products) and sugar, and low in cereals, fruits and vegetables, is occurring in a majority of countries worldwide. Household income has a major impact on food expenditures and consumption. This transition is causing a global public health concern because the pattern of food consumption is a major modifiable risk factor for the most common global non communicable chronic diseases (Lock et al., 2010).

Non-communicable chronic diseases have large individual costs, both in terms of monetary expenditures and well-being, as well as large social costs. In Canada, it was estimated that heart disease affected 1.4 million people, diabetes 1.2 million, cancer 0.8 million, and strokes 0.4 million people in 2003 (Dube et al. 2009). The number of Canadians with these diseases is increasing which is having negative consequences on individual well-being, the cost of health services, and lost productivity in the economy. The cost of six chronic diseases (hypertension, stroke, respiratory diseases, cancer, cardiovascular disease and muscu-skeletal disease) were estimated to have a direct cost to the health care system of \$26.43 billion and an indirect cost of lost productivity through absenteeism of \$47.91 billion in 2005 (Dube et al. 2009). The Canadian Diabetes Association (2009) reported that the direct cost of diabetes has increased from \$5.9 billion in 2000 to an estimated \$12.2 billion in 2010 and in 2009 the direct cost of diabetes represented 3.5% of the public health care funding in Canada. They also predict that these costs are expected to increase to \$16.9 billion by 2020 (the Globe and Mail, 2009). Thus, this disease has the potential of causing a financial crisis for the health care system. These facts indicate that the costs of chronic diseases are increasing at a rapid rate and have negative implications for the well-being of Canadians and the Canadian economy.

Healthy diet guidelines around the world

What to do is a central challenge to policy makers worldwide. Healthy eating, following the WHO guidelines, is one approach for addressing this challenge faced by world community. Promotion and adoption of “healthier diets” in Canada would decrease the prevalence of chronic disease. There are several examples of a “healthier diet” and the health gains

associated with adopting them. This has an impact on the well-being of individuals and households, would decrease the financial burden on society for these types of health related problems, and increase productivity through increased labour efficiency. These changes in the demand for food and other commodities will have a macroeconomic impact on the economy. As individuals and households diets change, the demand for agriculture and food products also changes, which has a direct and indirect impact on the Canadian economy. Changes to a “healthier diet” would have an impact on agriculture production, food processing, trade and policies that affect these sectors.

Among several initiatives taken by the different governments, the provision of healthy diet is recommended as one of important measures to address the problem of chronic disease. A healthy diet is one that helps maintain or improve health. It is important for the prevention of many chronic health risks such as: obesity, heart disease, diabetes, and cancer (WHO 2004; Mozaffarian, 2010). Already several organisations have prepared guidelines of healthy diet. Healthy diet normally consists of nutrient-dense foods such as fruits, vegetables, legumes, whole grains, lean meats and low-fat dairy products (WHO, 2003). It needs to have a balance of macronutrients / energy (fats, proteins, and carbohydrates) and micronutrients to meet the needs for human nutrition without inducing toxicity from excessive amounts.

The World Health Organization (WHO) makes the following 5 recommendations with respect to both populations and individuals (WHO, 2004a): a) Achieve an energy balance and a healthy weight; b) Limit energy intake from total fats and shift fat consumption away from saturated fats to unsaturated fats and towards the elimination of trans-fatty acids; c) Increase consumption of fruits and vegetables, legumes, whole grains and nuts; d) Limit the intake of simple sugar; Limit salt / sodium consumption from all sources and ensure that salt is iodized.

A systematic review of dietary recommendations defined by expert panels for the prevention of nutritional deficiencies, infectious and chronic diseases, identified a broad consensus across 94 reports. The reports recommended diets high in cereals, vegetables, fruits and pulses, and low in red and processed meats, which would result in high dietary intake of dietary fibre and

micronutrients, and low dietary intake of fats, saturated fatty acids, added sugars and salt. In addition to ensuring energy balance and maintaining a healthy weight, a 'healthy diet' to provide adequate population nutrition and reduce chronic disease risk has the following characteristics: 15-35% of total energy as fat, of which saturated fat should be under 10% and trans fatty acids under 1%; 55-75% of total energy as total carbohydrate, of which free sugars should be under 10%; 10-15% of total energy as protein using mainly plant sources; and more than 400g/day of fruits and vegetables(Lock et al.,2010).

Apart from that several countries have their own guidelines. For example, the American Heart Association recommends a diet rich in fruits, vegetables, and healthful fatty acids and that limit saturated fat (USDA, 2005). The food guides in Canada, USA, Japan, UK and Australia reflects similarities and differences in dietary guidance. Different graphic images were chosen for each country: a spinning top for Japan, pyramid for the USA, rainbow for Canada, Eat Well plate for U.K. and enjoy variety of foods for Australia. However there are striking similarities in the basic food group categories which include grains, vegetables, fruits, milk products, and meat/alternates. In Canada, vegetables and fruits are a single category. Japan, UK, USA and Australia have separate categories for these food groups. These food guides all target both adults and children with a minimum age of two years for the US and Canada, and one year for U.K. and Australia and 6 years for Japan. The dairy recommendations differ significantly across countries with lower recommended intake in Japan and higher in Australia (Murphy and Barr, 2007). The most important difference is in food reference level between US and other countries guideline. USA followed the 2000 calorie-per day reference level as healthy guideline and food consumption has been allocated accordingly, while rest of the countries healthy guideline followed the serving basis.

The approach in developing Canada's food guide extended the approach used by the US and Japan. These food plan distribution is quiet similar to Australia (except Extra food). Almost all people following the food intake pattern in Canada's food guide should have a high probability of meeting their nutrients requirements and a low probability of nutrients excess. It implies

that Canada's food guide could be used as a target for the intakes of population group as well as for individuals.

The current study is an attempt to estimate the macro economic impact of adopting healthy diet in Canada using Input-output table of Canada, 2003. It estimates the required consumption of fruits vegetables, whole grains, milk and dairy products and meat using healthy guidelines announced by the Public Health Canada, 2007. The study outlines a gap between actual and required consumption of those in Canadian diet. A number of strategies combining different food habits have been implemented in household consumption expenditure to calculate the impact on GDP, Output and employment.

Rest of the paper is organised as follows: Section 2 calibrates the model. Data and aggregation scheme of the input-output table is described in Section 3. Section 4 deals with different estimates to calculate the actual and required consumption of fruit and vegetables, meat, dairy products and grains in Canada. The analysis of results presented in Section 5. Section 6 concludes the paper with few policy options.

2. Model

The primary objective of the study is carried out with the help of 2003 transaction matrix for Canada which basically describes the flow of commodities from one sector to another. The rectangular input-output model of Canada has been taken for consideration. The rectangular model is based on the following accounting equations.

$$q = Bg + e \text{ -----(1)}$$

where,

q = $m \times 1$ vector of the values of total commodity output,

B = $m \times n$ matrix of industry technology coefficients (value of commodity inputs per \$1 of industry output),

g = $n \times 1$ vector of the value of total sectoral (industry) outputs,

e = $m \times 1$ vector of final demand (less imports),

m = number of commodities,

n = number of industries.

Equation (1) requires that total output equals the sum of intermediate and final demand. The difference is that B relates output levels of industries to intermediate demands for commodities.

Commodity output levels are further related by the market shares equation,

$$g = Dq \text{ -----(2)}$$

where,

$D = n \times m$ matrix of market share coefficients. The matrix D relates the output levels of industries to the sum of its share of each commodity.

Substituting equation (2) into equation (1) gives

$$q = BDq + e \text{ ----- (3) which has the solution}$$

$$q = (I - BD)^{-1} e \text{ ----- (4)}$$

$$\text{Alternatively, } g = (DB)g + De \text{ -----(5)}$$

To estimate the impact one could substitute equation (1) into equation (2) and solve for the level of industry output, as shown by equation (6).

$$g = (I - DB)^{-1} De \text{ ----- (6)}$$

For the current study we consider equation (6).

The impact matrix is defined by $(I - DB)^{-1} D$ and will estimate the direct and indirect effects of a change in final demand for commodities in the economy. Eq. 5 can be modified to take into account leakages out of the economy that result from imports, withdrawals from inventories or changes in government production. It is assumed that the leakages are in fixed proportion to domestic commodity demand (for details see [Thomassin and Baker, 1992]).

Eq. 6 integrates this assumption into the model:

$$g = (I - D (I - \hat{u} - \hat{\eta} - \hat{\alpha}) B)^{-1} D [(I - \hat{u} - \hat{\eta} - \hat{\alpha}) f + (I - \hat{u}) E + (I - \hat{\eta} - \hat{\alpha}) X] \text{----- (6)}$$

$$g = (I - D (\mu) B)^{-1} D [(\mu) f + (I - \hat{u}) E + (\mu + \hat{u}) X] \text{----- (6a)}$$

Where $\mu = (I - \hat{u} - \hat{\eta} - \hat{\alpha})$

\hat{u} = a diagonal matrix of imports to commodity use

$\hat{\eta}$ = a diagonal matrix of inventory withdrawals to commodity use

$\hat{\alpha}$ = a diagonal matrix of government production to commodity use

E = a vector of re-exports

f = a vector of final demand excluding exports, re-exports, imports, government production and withdrawals from inventory

X = a vector of commodity exports.

From Eq. 6a, the $m \times m$ matrix, $(I - D (\mu) B)^{-1}$ is called the inverse matrix and is equivalent to the $(I - A)^{-1}$ matrix in the simple Leontief model, except with secondary production.

For the simulation exercises, we disaggregate the component 'f' as 'C_i' (consumption vector) and I_i(Investment vector). Where $i = 1, 2, 3, \dots, 125$. We carry out several simulation exercises to estimate the whole economy impact of adopting healthy diet in Canada.

3. Data and Aggregation scheme

We have used Worksheet level make and use Input-Output table of Canada for the year 2003 prepared by Statistics Canada, 2007 and modified by AAFC (Agriculture and Agri-Food Canada) with disaggregated agricultural sector at basic price for the year 2003.

Aggregation scheme

Originally the modified table consists of 697 commodities, 16 primary input, 286 industries, and 168 final demand categories. For our convenience we have aggregated 697 commodities into 125 including 25 detail agricultural commodities according to modified worksheet level. The

rest of the commodities have been aggregated according to the medium level aggregation of Canadian I-O table. 16 primary inputs have been aggregated to 11.

Like commodities, the scheme of detailed agricultural sector has also been applied to industry aggregation. Finally, industries are aggregated to 84 from 286, and final demand to 7 categories from 168 including private consumption, investment, change in stock, govt. expenditure, export, re-export and import.

Thus Use matrix consists of 125 commodities and 84 industries, 11 primary inputs and 7 final demand categories; and Make matrix consists of 84 industries, 125 commodities.

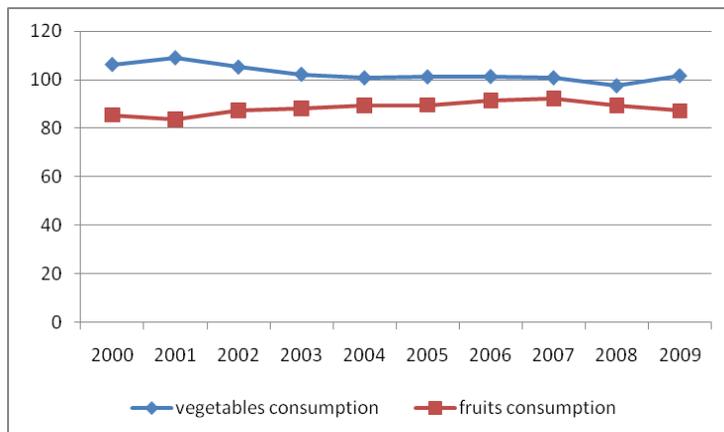
4. Estimation of Actual consumption and Requirements of Healthy Diet

This section provides estimates of actual fruits and vegetables, meat, grain and milk and milk products consumption in Canada for the year 2004 using Stat Canada data. It also estimates the required consumption of those foods following different guidelines towards healthy diet. Finally we computed the gap between actual and required consumption.

4.1 Actual consumption of Fruits and Vegetables in Canada

To estimate the actual consumption of fruits and vegetables, we considered data from Stat Canada (2010). According to Stat Canada estimates total available fruit -- fresh as well as processed -- adjusted for losses is 89.35 kg in 2004. Canadians ate 100.82 kg of vegetables -- fresh as well as processed -- per person in 2004 (figure 1). Using this information, the consumption figure arrives at 6075228 tonne for the year 2004.

Figure 1 Fruits and Vegetables Consumption per person in Canada (2000-2009) in kg



4.2 Estimation of the required fruits and vegetable consumption for healthy diet

Canada's Food Guide (2007) recommends number of food guide servings per day for different age group. The content of each serving is also mentioned in the food guide. For example, fresh frozen or canned vegetable 125ml (115 gm); leafy vegetables cooked 125ml (raw 250 ml or 230 gm); fresh frozen or canned fruits 125 ml (115 gm) and juice 125 ml (115gm). Considering the number of servings we have calculated total gram of fruits and vegetable consumption for per person per day. Using the information on servings and population (age and sex), the required amount of vegetables and fruits arrives at 12196127 tonne. The required amount of vegetables and fruits for adult population (12+) is 10913385 tonne.

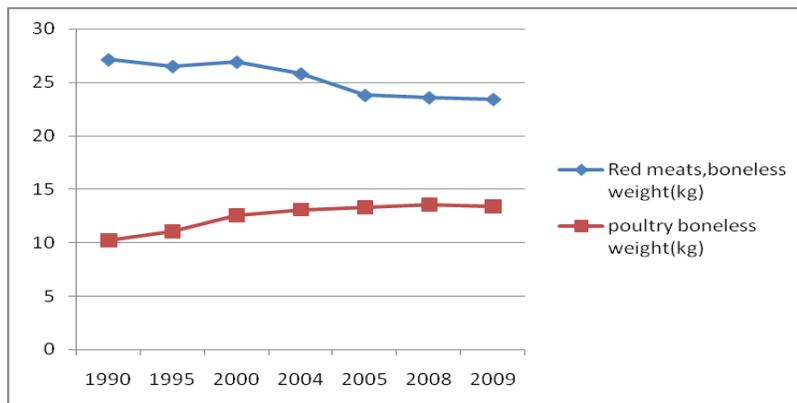
Appendix 1 summarizes the gap between actual and required consumption of fruits and vegetables in Canada for the year 2004. It is evident that Canadians are yet to achieve the required level of fruits and vegetables consumption according to Canada's Food Guide, 2007. It records that Canadians are weigh below the required consumption of fruits and vegetables (Canada's food guide) i.e. they are short off 50.18% from the recommended consumption of Canada's food guide. In this connection it should be noted that the recommended consumption of fruits and vegetables as per international guidelines may vary as it depends on the average BMI of the country.

Like fruits and vegetables, here also we calculate the actual and required consumption of meat in the next section. The Stat Canada data is reasonable for this purpose.

4.3 Actual consumption of Meat in Canada

The actual consumption of meat is estimated on the basis of Food Statistics data. According to Food Statistics, 2009 (Statistics Canada, 2010) the boneless red meats and poultry consumption in Canada is 25.82 kg and 13.08 kg per person respectively for the year 2004 (figure 2). So the total meat consumption is 38.9 kg per person which is estimated on the basis of food available adjusted for retail, household, cooking and plate loss. Applying this information on population data of Canada (Census of Canada, 2006), we calculate the total meat consumption (1242712 tonne) in Canada for the year 2004.

Figure 2 Actual Meat Consumption per person in Canada (kg)



4.4 Estimation of the required meat consumption for healthy diet

The required consumption of meat has been estimated as per guideline of Health Canada, 2007. Canada's Food Guide (2007) recommends number of food guide servings per day for meat and meat alternatives (detail in Appendix 2). Here meat and meat alternatives suggested by Canada's Food Guide include lean meat, tofu, eggs, peanut butter, shelled nuts and seeds. For the current estimate we consider only meat and down size the servings accordingly (detail in Appendix 2).

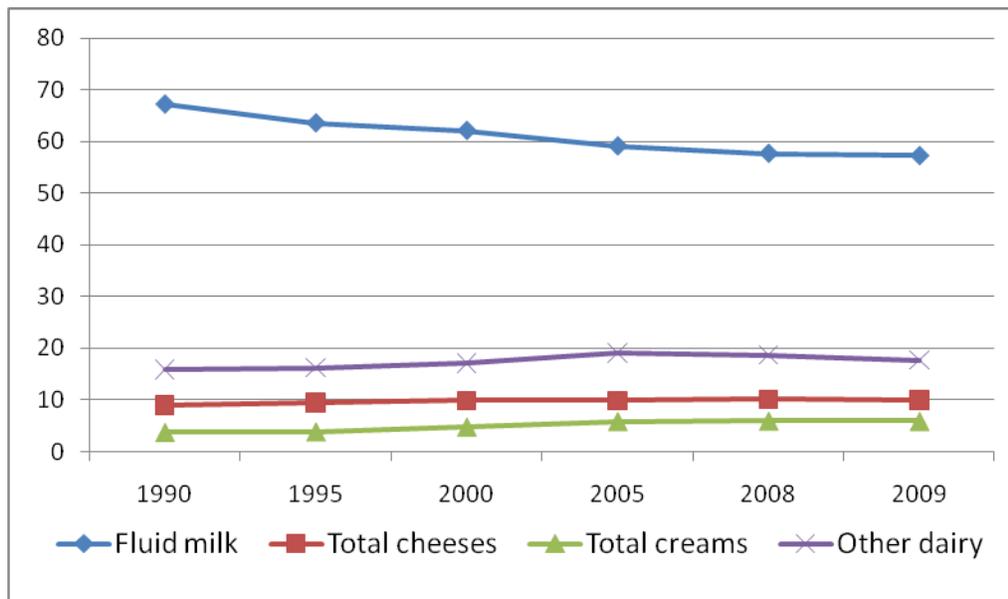
On the basis of servings across age groups and sex, we have calculated three scenarios of recommended meat consumption according to healthy guide of Canada, 2007.

Appendix 2 summarizes the estimates of actual and required consumption of meat in Canada for the year 2004. It reveals from all different estimates that actual consumption of meat in Canada is higher than the required consumption set by the healthy food guideline by Health Canada, 2007. Among all cases, third scenario is reasonable, which indicates that Canadian meat consumption was 20% higher than the required meat consumption according to Healthy Guideline of Canada, 2007.

4.5 Actual consumption of Milk and Dairy products in Canada

The actual milk and dairy products has been estimated on the basis of Stat Canada data. According to Food Statistics, 2009 (Statistics Canada, 2010) the milk and dairy products (Yogurt, cheese and other dairy products) consumption per person is 59.11 kg(60.26kg in 2004) and 34.9 kg(34.34kg in 2004) respectively for the year 2005 (figure 3).

Figure 3 Actual Milk and Dairy products consumption per person in Canada (kg)



The total milk and dairy products consumption is estimated on the basis of food available adjusted for retail, household, cooking and plate loss. Using this information, we calculate the total milk consumption (1925085.55 tonne) and dairy products (1097036.804 tonne) in Canada for the year 2004. Another estimate has been done considering only less fat milk (skimmed milk, butter milk, 1% and 2%). The consumption figure arrives at 1510171.15 tonne.

4.6 Estimation of the required milk and dairy products consumption for healthy diet

The recommended consumption of milk and dairy products has been done as per guideline by Health Canada, 2007. Canada's Food Guide (2007) recommends number of food guide servings per day for milk and milk alternatives (details in Appendix). Here the recommended number of food servings combines Milk and milk alternatives. For the sake of convenience, we consider 2 milk servings for the population under age group of 2-3 years and 1 serving for rest of each age group of population (detail in appendix).

The content under milk and milk alternatives suggested by Canada's Food Guide includes Milk, Canned Milk, Yogurt, Kefir, and Cheese etc. Considering the number of servings we have calculated the required amount of milk and dairy products consumption for per person per day (detail in appendix 3).

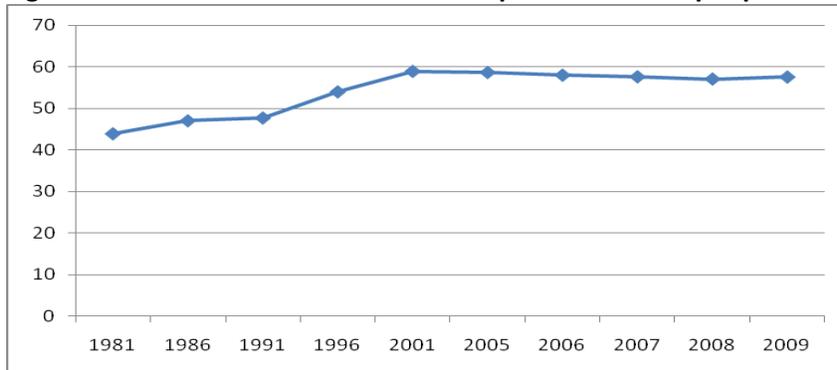
According to Canada Health Guide, 2007 the required amount of milk and dairy product consumption is estimated at 2915273.41 and 2212551.94 tonne respectively for the year 2004 (appendix 3).

Appendix 3 shows that actual consumption of Milk and dairy products in Canadian diet falls short off estimated consumption according to Healthy Guideline of Canada, 2007. It conveys that Canadian diet needs 33.96 % and 50.41% more milk and dairy products respectively to meet the Healthy Guideline of Canada, 2007. More specifically, the diet needs 48.2% more less fat milk.

4.7 Actual Grains Consumption in Canada

Since 1989, per capita cereal in the Canadian diet has grown by 8.9 kg per person. Total consumption of cereal products recovered in 2009, increasing 0.8% over 2008, following declines in the past four years (figure 4). Canadians increased the amount of rice and wheat flour intake in their diets. Rice availability for consumption has more than doubled (+108.8%) over the past 20 years.

Figure 4 Actual Cereal and Grain Consumption in Canada per person (kg)



According to Food Statistics, 2009 (Statistics Canada, 2010) the grains products consumption per person is 58.56 kg per person for the year 2004. The total grains consumption in Canada for the year 2004 is estimated at 1870457 tonne.

4.8 Estimation of the required grain products consumption for healthy diet

Canada's Food Guide (2007) recommends number of food guide servings per day. According to Health Canada guideline each serving of grains contains Bread; Bagel; Flat bread or tortillas; Cooked rice, bulgur or quinoa; Cereal; and Cooked pasta or couscous. On the basis of age wise serving, we have calculated the required consumption of grain products which is estimated at 3529551 tonnes for the year 2004(appendix 4).

Appendix 4 reveals that actual grains product consumption is 47% less than the required consumption suggested by Health Canada. However, the healthy diet guideline of Canada

specified that to “Eat atleast half of the grains product as whole grain”. According to that guideline the whole grain consumption is estimated at 1764775.69 tonne. But Canadian eats only 451321.70 tonne, which is roughly 25% of the targeted consumption (falls short off 75%) of whole grains.

The actual and required consumption of four food products –fruits and vegetables, Meat, milk and dairy products and grains show that required consumption is more than the actual consumption except meat. The actual meat consumption in Canada is higher than the targeted one set by Health Canada, 2007. The central challenge of the study is to find out the impact on the whole economy if Canadian household adopts the targeted consumption of four food products. We have estimated that by applying Input-Output methodology. The impact results are discussed in section 5.

5. Results and discussions

A combination of healthy diet strategies has been applied in the model to estimate the impact on whole economy. The five strategies applied on the private household are– i) increase in fruits and vegetables consumption; ii) reduction in meat consumption; iii) combining fruits and vegetables consumption to increase and reduction in meat; iv) combining fruits and vegetables and dairy consumption to increase and reduction in meat; v) combining fruits and vegetables, dairy and grains consumption to increase and reduction in meat. The whole economy impact on total output, GDP, employment and sectoral output adopting various strategies towards healthy diet will be discussed in this section.

Table 1 analysed the total output of the Canadian economy in different healthy diet strategy. The highest output gains (0.09%) is observed in case of strategy 5 which describes the adoption of required amount of fruits and vegetables, dairy, grains and Meat according to Health Canada guideline 2007. The positive output gains are also achieved in case of application of only vegetables and fruits (strategy 1, table 1). The major reduction in output (0.2%) of the economy is noticed in case of only Meat adoption (strategy 2, table 1). An interesting feature is to be noted in strategy 3 and 4 which have also found negative output growth. This negative output

growth is due to reduction in meat consumption which cannot be compensated with the increase in consumption of vegetables and fruits (strategy 3) and combination of vegetable and fruits and dairy(strategy 4).

5.1 Total Output

Table 1 Total output of the Canadian economy adopting various strategies of healthy diet, 2003

		Total Output (million CAD)	Change in output (million CAD)	% change in output
1	Output calculated using Only Veg, Fruits Increase	1858038.804	1470.024741	0.08
2	Output Calculated Using Only Meat Reduction	1852810.505	-3758.274643	-0.2
3	Output calculated using Veg, Fruits Increase And Meat Reduction	1854280.529	-2288.249902	-0.12
4	Output calculated using Veg, Fruits, And Dairy Increase And Meat Reduction	1856310.614	-258.1652702	-0.014
5	Output calculated using Veg, Fruits, Dairy And Grains Increase And Meat Reduction	1858260.868	1692.088959	0.091

5.2 Impact on GDP and Employment

Table 2 presents the GDP and employment growth of the Canadian economy is due to the adoption of healthy diet. It is observed that more employment generation (0.09%) would be possible in case of strategy 5 which states the required consumption of four foods. The same scenario (strategy 5) also achieves highest GDP growth of about 0.112%. Even though change in output is marginally negative (-0.014%) in strategy 4(table 1), but achieves nominal employment generation (0.017%) and positive GDP growth (0.001%). The highest negative impact on the economy is observed in case of reduction in meat consumption (strategy 2). It follows a reduction in employment and GDP estimated at -0.128% and -0.189% (table 2) respectively.

Table 2 GDP and employment growth of the Canadian economy adopting various strategies of healthy diet

	Total employment generation (Numbers)	Extra employment generation (Numbers)	% change	Total GDP (Million CAD)	Changes in GDP (Million CAD)	%Increase of GDP	%Increase of output
1. Only Vegetables and fruits Consumption increase	14157625.31	11031.65	0.078	995783.27	747.38	0.075	0.089
2. Only Meat Consumption reduction	14128556.1	-18037.6	-0.128	993808.36	-1227.54	-0.124	-0.189
3. Vegetables and fruits, Consumption increase, and Meat Consumption reduction	14139587.75	-7005.91	-0.050	994555.73	-480.16	-0.049	-0.100
4. Vegetables and fruits, Dairy Consumption increase, and Meat Consumption reduction	14149039.35	2445.693	0.0173	995205.78	169.889	0.017	0.001
5. Vegetables and fruits, Dairy and Whole Grains Consumption increase, and Meat Consumption reduction	14160312.98	13719.32	0.097	995950.94	915.04	0.092	0.112

Table 1 and 2 elaborates the total impact on the Canadian economy, adopting combination of food strategies towards healthy diet. It conveys that highest economic growth in employment, output and GDP can be achieved in strategy 5, which deals with four major food groups' consumption according to healthy diet guideline (fruits and vegetables, dairy and dairy products, whole grains consumption and meat).

5.3 Sectoral impact

The sectoral impact of various strategies can give us further insight into the study. Tables 3,4,5,6 capture the positive and negative impact distributed among sectors in different food combination strategy towards healthy diet.

Table 3 Sectoral Impact on Output by adopting Vegetables and Fruits consumption increase

<i>Positive impact</i>	<i>(%)</i>
Fresh fruit, excluding tropical	42.68
Other vegetables, fresh or chilled	24.91
Seeds , excluding oil seeds	3.93
Fruits and vegetable products	3.37
Fertilizers	0.66
Agricultural services	0.65
Grain corn	0.47
Fluid milk	0.42
poultry	0.39
Soybeans	0.36

The first strategy of this study deals with the implementation of fruits and vegetable consumption according to the healthy diet guideline. The sectors having major impact are fresh fruits (42.68%) and other vegetables (24.91%) along with seeds and fruits and vegetable products. There are few other sectors have also marginal positive gain such as fertilizers, soybeans, agricultural services (between 0.99% to 0.36%).

Table 4 Sectoral Impact on Output by adopting reduction in Meat consumption

<i>Negative Impact</i>	<i>(%)</i>	<i>Negative Impact</i>	<i>(%)</i>
Other live animal	-0.97	Wheat flour and starches	-2.37
canola	-1.01	hogs	-2.57
Agricultural services	-1.11	Wheat, imputed feed	-2.57
Other grains	-1.22	Other grains and fodder	-2.63
potatoes	-1.28	Hay and straw	-2.67
Fish and seafood fresh	-1.36	Corn fodder	-2.83
Yarns and fibres	-1.51	soybeans	-2.97
feeds	-1.71	poultry	-3.23
sugar	-1.88	Fluid milk	-3.42
barley	-2.12	Grain corn	-3.80
Cattle and calves	-2.30	Meat products	-9.52
pharmaceuticals	-2.34		

Table 4 shows that large numbers of sectors have negative output growth which indicates a high linkage of meat sector with the rest of the economy. The aggregated impact on the economy from table 1 and 2 also imply that reduction in meat consumption is having major impact on the Canadian economy. The major reduction is observed for the sectors such as Meat products, grain corn, poultry, fluid milk, hogs. Apart from that, a number of sectors are also in the negative impact list (ranges between 2-4%) such as corn fodder, other oil seeds, other grains and fodder, hay and straw, wheat, pharmaceuticals, wheat flour and starches, cattle and calves, sugar, barley, feeds, other grains, agricultural services, yarns and fibre, other live animal.

The sectoral impact achieves under strategy 3 (household consumption of fruits and vegetables to increase and meat reduction according to healthy diet) will have a mixed impact of sectors combining tables 3 and 4.

Table 5 Sectoral impact on Output by adopting the strategy of increasing consumption of Vegetables and Fruits and dairy and reduction in Meat

<i>Positive Impact</i>	<i>% change</i>	<i>Negative Impact</i>	<i>% change</i>
Fresh fruit, excluding tropical	42.40	Hogs	-0.82
Other vegetables, fresh or chilled	24.63	Wheat, unmilled	-0.92
Dairy products, mayonnaise, salad dressing and mustard	8.14	Other grains and fodder	-0.93
Seeds	3.61	Hay and straw	-0.95
Fruits and vegetable products	3.25	soybeans	-0.95
fabrics	0.78	Corn fodder	-0.99
Fertilizer	0.33	poultry	-1.06
Yarns and fibre	0.30	Fluid milk	-1.09
Agricultural machinery	0.12	Grain corn	-1.21
		Meat products	-8.95

Table 5 describes the sectoral impact due to increase in fruits and vegetables and dairy products and reduction in meat consumption according to healthy diet guideline. The major positive sectoral impact derived from fruits, vegetable, milk and dairy products and related sectors such as fertilizer and seeds, while meat products, poultry, soyabean, corn fodder are on the negative impact list due to meat reduction.

In table 6, most of the sectors are already listed as having positive output growth in table 3 and 5, the only sectors added in the list are breakfast cereal and bakery products, wheat flour and starches. The major negative impact derives only from meat products (discussion in table 4) and marginal impact on hunting and trapping products and raw wool and mink skins. Overall the sectoral impact states that the application of only meat reduction in the Canadian economy shows a large negative impact on many sectors of the economy (table 4). When meat reduction applies with other food sectors such as fruits and vegetable, dairy and grains, its overall impact will turn out to be positive (except meat products).

Table 6 Sectoral impacts on Output by adopting Vegetables and Fruits, dairy, whole grains and Meat in household consumption towards healthy diet

<i>Positive Impact</i>	<i>(%)</i>	<i>Negative Impact</i>	<i>(%)</i>
Fresh fruit, excluding tropical	42.69	Raw wool and mink skins	-0.0047
Other vegetables, fresh or chilled	24.92	Hunting and trapping	-0.012
breakfast cereal and bakery products	13.30	Meat products	-8.57
Dairy products	8.39		
seeds	3.90		
Fruits and vegetable products	3.37		
Wheat flour and starches	1.78		
fertilizer	1.005		
Yarns and fibres	0.97		
fabrics	0.65		

6. Conclusion

Results show that Canadian diet is influenced by more meat and less vegetables, fruits, milk and whole grains than the recommended guideline of Health Canada. The impact on the whole economy shows both gain as well as loss in different combination of food strategy. The positive impact on output is observed in case of only increase in fruits and Vegetables(0.08%) and combination of increase in fruits and vegetables, dairy, whole grains and reduction in Meat(0.09%). The negative impact in output shows for only reduction in meat (-0.2%); and reduction in meat in combination of increase in Vegetables and fruits and dairy (-0.014%). The total GDP of the economy is expected to affect in similar manner. A significant reduction in GDP (-0.12%) is observed, if Canadian diet adopts only the reduction in meat consumption according to Healthy diet guideline. On the other hand, country would gain in GDP wise, if it applies a combination of strategy (both reduction in meat and increase in consumption of fruits vegetables, dairy and whole grains). Sectoral impact (including high indirect effect) varies according to the adoption of food strategies. Apart from agriculture and agri food sectors, some changes have been noticed in case of industrial sectors also. The study also accounts job creation and loss due to the implementation of household food consumption strategy. For the increase in Vegetables and fruits consumption generates employment of 0.08% while more than double reduction in employment (-0.13%) is observed in case of reduction in meat consumption. The combined strategy will generates some space for job. Overall it is apparent that Canadian economy is more meat based compared to fruits, vegetables and others.

According to the CCHS , 2004 study (Garriguet,2006) the majority of Canadians do not eat the recommended amount of vegetables and fruit, dairy products and whole wheat grains, while meat consumption is well above than the recommended level. Our study finding from section 3 (detail in appendix 1-4) is also in similar tune. The macro economic impact shows marginal gains for the economy, if we adopt the recommended healthy guideline for four food groups together. In view of these a suitable fiscal policy is needed to guide the household consumption to achieve the goal of healthy diet and minimize the nutrition related chronic disease.

Recent concerns about the burden of disease such as coronary heart disease, diabetes and obesity, both globally and in Canada, have raised questions about which policy approaches that might be used to best address the issues of healthy eating. A World Health Organization /Food and Agriculture Organization report shows the cost of healthy foods as being a key element in prevention, driven in part by the rise in diet-related non communicable diseases. A set of tools being considered by governments around the world involves the increased use of consumption taxes to achieve health goals. Herein we aim to suggest the policies ranging from taxation of unhealthy foods (“fat tax,” “snack tax” or “junk food tax”) to subsidies on healthy foods - removing sales taxes on healthy foods, subsidizing healthy foods (also called the “thin subsidy”), and subsidizing transportation of healthy foods in remote regions.

More specifically, government can encourage the consumption of fruits and vegetables by providing a subsidy for these commodities and also placed a tax on meat and meat products to reduce their consumption. Such policies would provide an incentive to consume more fruits and vegetables and reduce the consumption of meat, which could reduce the prevalence of chronic disease.

References

Census of Canada (2006) Statistics Canada, catalogue number 97-551-XWE2006002

Dube,L, J. Beauvais,P.J. Thomassin, D. Sparkling(2009). Building Convergence: Toward an Integrated Health and Agri-Food Strategy for Canada. *The Canadian Agri-food Policy Institute*, Retrieved October 20, 2009 from http://www.capi-icpa.ca/pdfs/BuildingConvergence_Summary.pdf

Food standards Agency, Eat Well be well, <http://www.eatwell.gov.uk/healthydiet/>accessed on November 2010

Fresh patents (2008) Process for the production of refined whole-wheat flour with low coloration, <http://www.freshpatents.com/Process-for-the-production-of-refined-whole-wheat-flour-with-low-coloration-dt20080717ptan20080171114.php>

Garriguet Didier (2006) Overview of Canadian eating habits, Nutrition: Findings from the Canadian Community Health Survey, Catalogue no. 82-620-MIE — No. 2, Published by Stat Canada, Ministry of Industry, Ottawa.

Government Office for Science (2007). Tackling Obesities: Future Choices. London: Department of Innovation Universities and Skills.

Health Canada (2007) Eating Well with Canada's Food Guide, www.healthcanada.gc.ca/food_guide

Janssen, I., Peter T. Katzmarzyk, William F. Boyce, Matthew A. King, and W. Pickett (2004). "Overweight and Obesity in Canadian Adolescents and their Associations with Dietary Habits and Physical Activity Patterns", *Journal of Adolescent Health*, 35:360-367

Katzmarzyk P.T (2002). "The Canadian Obesity Epidemic: an Historical Perspective". *Obesity Research*, 10(7):666-74.

Lock,K, Smith,R, Dangour,A, Keogh-Brown,M, Pigatto,G, Hawkes,C, Fishberg,RM, Chalabi,Z(2010). Health, agricultural, and economic effects of adoption of healthy diet recommendations. *Lancet*; 376: 1-11.

Mozaffarian, D., & Ludwig, D. S. (2010). Dietary guidelines in the 21st century—a time for food. *JAMA : The Journal of the American Medical Association*, 304(6), 681-2.

Murphy, S.P. and S.I. Barr (2007) Food Guides Reflect Similarities and Differences in Dietary Guidance in Three Countries (Japan, Canada, and the United States), *Nutrition Reviews*, April 141-148

NHMRC (2003) National health and Medical Research Council, Dietary Guidelines for Australian Adults, Endorsed 10 April 2003

North American Association for the Study of Obesity (2006). Obesity Statistics: US Obesity Trends, http://web.archive.org/web/20060206185213/www.naaso.org/statistics/obesity_trends.asp. Retrieved 2008-03-08.

Nugent, R. (2008) "Chronic Diseases in Developing Countries: Health and Economic Burdens", *Annual New York Academy of Sciences*, 1136: 70–79

Statistics Canada (2009) Food available for Consumption in Canada – 2008, Canada Food Statistics, <http://www.statcan.gc.ca/ads-annonces/23f0001x/hl-fs-eng.htm>

Statistics Canada (2010) Food Statistics 2009, Agriculture Division, Catalogue no. 21-020-X, May

The Globe and Mail (2009). "Diabetes: A Brewing Economic Tsunami" by Andre Picard, December 7

USDA (2005) US Department of Agriculture, Department of Health and Human Services. Dietary Guidelines for Americans 2005. Available online at; www.healthierus.gov/dietaryguidelines.

USDA (2005a) US Department of Agriculture, Department of Health and Human Services. Finding Your Way to a Healthier You: Based on the Dietary Guidelines for Americans. Available online at: <http://health.gov/dietaryguidelines/dga2005/document/html/brochure.htm>.

Wang, Y; M. A. Beydoun (2007). "The Obesity Epidemic in The United States-Gender, Age, Racial Ethnic and Geographic Characteristics: A Systematic Review and Meta Regression Analysis", *Epidemiologic Reviews* 29:6-28

WHO (2003). Global Strategy on Diet, Physical Activity and Health, Geneva, Switzerland, World Health Organization.

WHO (2004). The World Health Report 2004: Changing History, Geneva, Switzerland, World Health Organization.

WHO (2004a) Diet, Nutrition and the Prevention of Chronic Diseases, WHO technical report series 916, Report of a Joint WHO/FAO Expert Consultation, WHO Geneva

Yoshiike N, Hayashi F, Takemi Y, Mizoguchi K, Seino F(2007). A new food guide in Japan: The Japanese Food Guide Spinning Top. *Nutrition Reviews*; 65:149–154.

Appendix 1

Estimated requirement and actual consumption of fruits and vegetables in Canada, 2004

Estimated requirement of Fruits and Vegetables (tonne)	Actual consumption of fruits and Vegetables(tonne)	Ratio of actual consumption to required estimates (%)	Gap to meet the required estimates (%)
Healthy guide,2007	Stat Canada, 2010	--	---
12196127	6075228	49.81	50.18

Appendix 2

Meat consumption scenarios prepared on the basis of recommended healthy guideline of Canada, 2007.

First scenario -Considering (1 serving) 75gm per person per day, the total meat consumption in 2004 is 855896.85 tonnes. Second scenario Considering 75 gm (1 serving) for population (2-13 years) and female population (14-51+ years) and 150 gm (2 servings) for male population (14-51+years), the total meat consumption is 1215117.30 tonnes. Third scenario Considering 75 gm (1 serving) population (2-13 years), female population (14-51+ years), and 112.5 gm (1.5 servings) for male population (14-51+years), the total meat consumption is 1035507 tonnes.

Estimated requirements and Actual consumption of Meat in Canada 2004

Estimated requirements of Meat consumption (Tonne)		Actual meat consumption	Ratio of actual consumption to required estimates (%)	Gap to meet the required estimates (%)
Healthy guide,2007		Food statistics 2009 (StatCanada,2010)	---	---
First scenario	855896.85	1242712	145.19	45.19
Second scenario	1215117.30	1242712	102.27	2.27
Third scenario	1035507	1242712	120.01	20.01

Appendix 3

Estimated requirements and Actual consumption of milk and dairy products in Canada, 2004

Estimated requirements of milk and dairy products (tonne)		Actual milk and dairy products consumption (tonne)		Ratio of actual consumption to required estimates (%)		Difference between actual and estimated requirements (%)	
Healthy guide,2007		Food statistics 2009 (StatCanada,2010)		---		---	
Milk	Dairy products	Milk	Dairy products	Milk	Dairy products	Milk	Dairy products
2915273.408	2212551.943	1925085.551	1097036.804	66.03	49.58	33.96	50.41
		Less fat Milk		Less fat Milk			
		1510171.15		51.80		48.2	

Here are some observations related to dairy products consumption in Canadian diet. According to food statistics, 2009 the cheese consumption per person per day is 33.12 gram unadjusted for losses. According to healthy guideline the required consumption of Cheese is 50gm per day per person. Hence the ratio of actual to required is 66% (falls short off 34%). Similarly for Yogurt the actual consumption is 18.54 gram per person per day unadjusted for losses and required consumption is 175 gm (according to healthy guide) thus meeting only 11% of the targeted consumption. These are the facts, which indicate the large percentages of shortages in dairy products compared to target.

Appendix 4

Grain serving estimation equivalent to gram

	gm
3servings	145
4servings	180
6servings	285
7servings	320
8servings	365

Estimated requirements and Actual consumption of grains products in Canada, 2004

Estimated requirements of grains consumption (tonne)	Actual grains consumption (tonne)	Ratio of actual consumption to required estimates (%)	Gap to meet the required estimates (%)
Healthy guide,2007	Food statistics 2009 (StatCanada,2010)	---	---
3529551	1870457	52.99	47.00
1764775.69*	451321.708**	25.57	74.42

*Half of the total required grains i.e. whole grains, **actual whole grains consumption