The Big Picture:
Production and environmental impacts of reduced US obesity

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Abstract – This paper assesses how successfully reducing the incidence of overweight and obesity in the US to meet public health objectives might influence agricultural production. We also examine the consequent agri-environmental effects of the production changes. Our estimates show that a reduction in aggregate consumption by between 2 and 6 percent, associated with public health goals being met, would lead to reduced production of primary agricultural commodities, increased exports, and reduced discharge of agricultural pollutants. In both cases, neither the estimated changes in commodity production nor the subsequent environmental impacts would be uniform across the landscape. Results indicate that in value terms, the largest changes (either positive or negative) in agricultural producer net returns would occur in the Corn Belt and the Lake States; conversely, the largest impacts on consumer surplus would occur in the Northeast and Pacific regions.

Keywords: agriculture, obesity, environment

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I. Introduction

In 1999-2000, 65 percent of American adults were overweight and over one-third were both overweight and obese (Surgeon General). The Centers for Disease Control and Prevention (CDC) estimated that the prevalence of obesity in the United States increased from 14.5 percent to 30.9 percent between 1971 and 2000 (CDC, 2003). According to recent estimates (Surgeon General), obesity accounts for $117 billion a year in direct and indirect economic costs, is associated with 400,000 deaths each year, and will soon overtake tobacco as the leading cause of preventable deaths (Mokdad et al.,2004.). Because of these trends, obesity treatment and prevention have become major public health objectives. In November 2000, the US Department of Health and Human Services (DHHS) published “Healthy People 2010” – hereafter referred to as HP 2010 – setting forth objectives to improve health and reduce the incidence of diseases associated with obesity. Among these are to increase the percent of the population with a healthy weight, decrease the percent of the population who are obese, reduce the portion of the population who are sedentary and increase the percent of the population who are active (DHHS, 2000).

Recent analysis suggests that changing US diets to conform to the USDA’s Food Guide Pyramid would require adjustments in agricultural production, prices, and trade (Young and Kantor, 1998). However, there has been no empirical analysis of how much aggregate food consumption in the US would need to change to generate changes in weight distribution. Subsequently, there has been no analysis of how these changes would effect domestic agricultural production and environmental quality. It may be that agricultural producers will face decreasing returns to production if Americans reduce consumption enough to reduce significantly their current levels of overweight or obesity. Alternatively, a continuation of the current trends in obesity may lead to higher returns for the agricultural sector.

The objectives of this paper are: (i) to estimate the impacts of changing food consumption on production patterns and farm income related to primary agricultural commodities; and (ii) to estimate the potential environmental impacts related to possible changes in production. Because of uncertainty over trends in eating habits, we assess the welfare impacts on both producers and consumers under several scenarios for future eating habits (Table 1). Scenario 1 assumes that Americans meet the HP 2010 objectives by eating less, but make no improvements in their level of physical activity. Under Scenario 2, Americans meet the HP 2010 objectives by both eating less and increasing their physical activity. In Scenario 3, the portion of the population that is either overweight or obese increases in 2010 because Americans increase their food consumption and make no changes in their physical activity.[1] Under each of these scenarios, we estimate a distribution of caloric intake for US consumers. We then use these distributions to estimate changes in aggregate US consumption. Changing domestic demand is used to shock a spatial-equilibrium model of agricultural production and commodity prices. We consider how these production and price adjustments may affect farm incomes, consumer welfare, and environmental quality.

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[1] These projections are based on the assumption that the portion of the population falling into either the overweight and obese category will increase at the current rate. This rate is based on how much the percentage of the population that was overweight and obese increased from National Health and Nutrition Examination Survey 1988-1994 to NHANES 1999-2000 (CDC).

II. Methods

Shifting US Consumption Levels

To calculate how much aggregate consumption in the US would change under each scenario, we use the National Health and Nutrition Examination Survey (NHANES) 1999-2000 (CDC, 2003). This survey contains information on the relationship between diet, nutrition, and health for adults older than age twenty. Each year 5,000 civilian, non-institutionalized persons in the U.S receive a thorough medical examination where respondents' heights and weights are recorded. It also collects some information on socio-economic variables, such as age, gender and ethnicity. We exclude pregnant women or amputees in our sample because their measured BMI is less likely to reflect their true weight status.

Our analysis is based on the biological relationship between bodyweight and energy balance, where an individual will gain weight when energy intake (calories consumed) exceeds energy output (physical and metabolic activity). We therefore assume that the only way for individuals to change bodyweight is to change the number of calories they consume relative to the amount of energy they expend. An extension of this assumption is that only the quantity of food eaten changes and the US food basket and production methods remain unchanged. It should be noted that Scenarios 1 and 2 differ only in the assumptions made about how people meet the HP 2010 weight objectives. In Scenario 1, they do so solely by reducing calories consumed. In Scenario 2, they do so by both reducing calories consumed and increasing their level of physical activity. Under Scenario 3, individuals gain weight by consuming more calories. Their level of physical activity stays the same as it was in the NHANES 1999-2000.

Both the HP 2010 objectives for weight loss and 2010 projections for weight gain are set in terms of the population's distribution of Body Mass Index (BMI) classifications (Table 2). For that reason, we use respondents' BMIs to create cumulative density functions (CDF) for men and women. To develop these new BMI distributions, we assume that the individuals who are underweight (3.4%) and extremely obese (2%) in the baseline scenario do not change BMIs, and therefore do not change eating or exercise patterns.[2] For Scenarios 1 and 2, where individuals meet the HP 2010 objectives, we use observations clustered around the 60th percentile and 85th percentile of the cumulative distribution and assume that their body weights change such that their BMI in 2010 average 25 and 30, respectively. We then fit a logistic model through these two clusters and the observations at the tails. The Projected HP 2010 BMI for each individual (i) is calculated as follows:

$$(1)\ \ \mathrm{BMI(i)}_{\mathrm{HP\ 2010}} = \beta \cdot \mathrm{BMI\ Percentile(i)}_{1999-2000}\ ,$$

where β is coefficient derived from the logistic model.[3] We use this same process to calculate the 2010 BMIs under Scenario 3 by using observations clustered around the 24th and 59th percentile for men. We use observations clustered around the 20th and 32nd percentile for women.

To calculate how much aggregate consumption will need to change under each scenario, we estimate the percentage change in each individual's predicted energy requirement (EER). These EER calculations are made using the following formulas developed by the Institute of Medicine Dietary Reference Intakes (Food and Nutrition Board, 2002):

(2.a) Men: EER = 662-9.53* Age+PA*(15.91*Weight [kg]+539.6*Height [m])

(2.b) Women: EER = 354 -6.91*Age+PA*(9.36*Weight [kg]+726*Height [m])

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[2] This assumption provides an anchor with which to estimate the 2010 BMI CDFs.

[3] We assume that individuals will fall into the same 2010 BMI percentile that they were in 1999-2000.

We use each individual's baseline height, age, gender, and population average physical activity (PA) score to calculate the baseline EER.[4] The PA score for men who are inactive, low active and active are 1.00, 1.11 and 1.25. The PA score for women who are inactive, low active and active are 1.00, 1.12, and 1.27. Using each scenario's 2010 BMI, we calculate each individual's 2010 weight. This is then used in conjunction with the appropriate PA score to calculate the 2010 EER under all three scenarios (Figures 1 and 2). The per-person change in demand under each scenario is calculated as the percentage change in aggregate daily EER from the base year. Table 2 provides summary statistics for the original variables and the estimated values for each scenario.

To keep our results representative of the adult US population, we use the appropriate NHANES sample weight and aggregate individuals' EERs under each scenario. In each scenario, the total change in caloric demand is then calculated as the percentage change in consumption from the baseline (Table 3). Our estimates show that in aggregate, the change in overall consumption is relatively small in each scenario. In Scenario 1, total consumption falls by 5.75 percent. In Scenario 2, it falls by a little over two percent. In Scenario 3, where individuals gain weight, aggregate consumption increases by 2.11 percent.

Agricultural Sector Model

We use the US Regional Agricultural Sector Math Programming Model (USMP) to calculate how domestic production of major agricultural commodities may change under each of the 2010 scenarios. The USMP is a comparative-static, spatial and market equilibrium model. It

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[4] For example, in the baseline, first and third scenarios, 40% of the population will be inactive, 45% will be low active and 15% will be active. As such, the PA value for all men in these scenarios is .40*1.0+.45*1.11+.15*1.25=1.087. The PA value is different in Scenario 2 because we assume that more of the population becomes either active or low active.

uses a positive math programming approach (Howitt, 1995) with a nested constant elasticity of transformation function, which allows nonlinear substitutions across the production activities (House et al., 1999). Spatially, the USMP assumes that the agriculture sector operates under a competitive market equilibrium system.

The model allows for equilibrium production scale effects and some composition and technique effects, such as a changing product mix, in response to changes in economic incentives. Domestic consumption shocks developed from section II are simulated for commodity prices and production levels at the regional level, which are integrated into the flow of final commodity demand and stock markets (import, export, and commercial stock levels adjust freely). The supply side of the system is aggregated into production units specified for large geographic areas and sub-regions (*r* and *u*). Twenty-three inputs are included, as are production and consumption of 44 agricultural commodities and processed products.[5]

Production levels, land use, land use management (e.g. crop mix, rotations, tillage, and fertilizer practices), and program participation are endogenously determined spatially according to a constrained optimization approach, maximizing consumer and producer welfare, $\mathcal{L}$:

(1) $Max\ \mathcal{L}$

$$\equiv \mathbf{Z'A^d} - \frac{\mathbf{Z'B^dZ}}{2} - \mathbf{P'A^s} - \frac{\mathbf{P'B^sP}}{2} - \mathbf{Y'W_Y} - \mathbf{INP'_vA^s} - \frac{\mathbf{INP'_VB^sINP_V}}{2} - \mathbf{INP'_FW_{INP}}\,;$$

subject to

(2) $\mathbf{pp'_{cr}X_{cr}} + \mathbf{pp'_{liv}X_{liv}} + \mathbf{pp'_yY} - \mathbf{Z} \geq 0$ (commodity balancing);

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[5] Major crops included are corn, soybeans, sorghum, oats, barley, wheat, cotton, rice, hay, and silage production, accounting for more than 75% of crop production. Livestock enterprises include beef, dairy, swine, and poultry production, accounting for more than 90 percent of livestock production.

(3) $\mathbf{pp}'_{\mathbf{inpcr}}\mathbf{X}_{\mathbf{cr}} + \mathbf{pp}'_{\mathbf{inpliv}}\mathbf{X}_{\mathbf{liv}} - \mathbf{INP}_{\mathbf{V}} \leq 0, \forall r$ (regional input balancing);

(4) $\alpha_{p,u}(\sum_b \delta_{b,u} s_{p,b,u} RAC_{b,u}^{-\rho^{p,u}})^{-\frac{1}{\rho^{p,u}}} - C_{p,u} \leq 0, \forall p, u$ (regional crop balancing);

(5) $\alpha_{b,u}(\sum_t \delta_{b,t,u} X_{b,t,u}{}^{-\rho_{b,u}})^{-\frac{1}{\rho^{b,u}}} - RAC_{b,u} \leq 0, \forall b, u$ (regional rotation balancing); and

(6) $\mathbf{Z, Y, X_{cr}, X_{liv}, INP_V, INP_F, RAC, C} \geq 0$ (nonnegativity constraints).

Matrix **Z** represents consumer demand for produced commodities, matrix **P**, across markets (including trade) and regions. Matrices **A** and **B** are the intercept and slope coefficients for product and market demand (superscripted "d") and supply (superscripted "S"), respectively. Matrices $\mathbf{X_{cr}}$ and $\mathbf{X_{liv}}$ represent cropping and livestock activities across regions and management practices. Vectors **Y** and $\mathbf{W_y}$ represent processing activity levels and net costs of process, respectively. Matrix **INP** represents variable (subscripted "V") and fixed (subscripted "F") inputs into production of primary and processed goods. $\mathbf{W_{INP}}$ represents cost per unit of fixed inputs. The output parameters per share of crop, livestock, and processing activities are represented by matrices $\mathbf{pp_{cr}}$, $\mathbf{pp_{liv}}$, and $\mathbf{pp_y}$, respectively. The input parameters per share of crop and livestock production activities are represented by matrices $\mathbf{pp_{inpcr}}$ and $\mathbf{pp_{inpliv}}$, respectively.

Substitution among the cropping activities is represented using nested constant elasticity of transformation (CET) functions (4 and 5). The crop (*p*) and rotation (*b*) balancing equations ensures that supply of land ($C_{p,u}$) in sub-region (*u*) allocated to a crop is at least at great as the demand for it, given by the sum of rotational acres ($RAC_{b,u}$) multiplied by the share of each crop grown in that rotation (b) ($s_{p,b,u}$) subject to nonlinear CET distribution ($\delta_{b,u}$), shift ($\alpha_{p,u}$), and substitution ($\rho_{p,u}$) calibration parameters. Similarly, the allocation of land to various tillage practices (*t*) used in a crop rotation (*b*) must be no greater than the amount of land in that rotation, also subject to CET distribution ($\delta_{b,t,u}$), shift ($\alpha_{b,u}$), and substitution ($\rho_{b,u}$) calibration parameters. The nonlinear CET equations imply that there is a declining marginal rate of transformation between land used in one crop rotation and land used to produce the same crop as part of another rotation, and between one tillage activity in a particular rotation and land used in other tillage activities used with the same rotation.

Environmental Impacts

The equilibrium production levels, land use, and land use management (e.g. crop mix, rotations, tillage, and fertilizer practices) are next linked to environmental impacts under the three consumption scenarios. We examine environmental impacts historically of concern in US agri-environmental policy: changing levels of nitrogen, phosphorus, pesticides, erosion, and manure. For changes in the level of nitrogen, phosphorus, pesticide and erosion we estimate net environmental impacts using the Environmental Policy Integrated Climate (EPIC) Model (Mitchell et al., 1998). For each crop production activity, EPIC simulates erosion (sheet, rill, and wind), nutrient and pesticide cycling as a function of crop management (rotation, tillage, and fertilizer rates) given historic weather, hydrology, soil temperature, and typography data. Our estimates of field-level discharge represent mean values for a 67-year time horizon. Manure generation on confined feeding facilities is calculated based on USDA manure nutrient and confinement parameters for poultry, swine, beef, and dairy operations (Kellogg et al., 2000).

To assess the full societal costs and benefits of each scenario, we assign monetary values to several of these environmental variables. Determining mitigation costs and monetized human health benefits within a large-scale modeling environment is now standard practice for air quality policy (e.g., greenhouse gas mitigation – Burtraw et al., 2003). However, there are relatively few assessments of the value (monetized or non-monetized) of environmental impacts of agricultural activities. In our model, we use the change in various economic indicators under each consumption scenario along with market and non-market values to estimated the full economic value of changes in regional net returns in the cropping and livestock sectors. These potential changes are expected to have differential effects across farm production regions. For example, a decrease in agricultural productivity is an on-site cost of agricultural soil erosion. The loss of productivity stems primarily from the loss of topsoil and nutrients. To estimate a market value for this loss, we use the soil depreciation indicator, which is the discounted value of the reduction in long-term yields based on current output prices. On the other hand, water pollution is an off-site cost of wind and soil erosion. The monetary impact of increasing sediment run-off comes from its adverse effect on municipal water use systems, industrial use systems, and water storage systems. Additional costs may also come from increased irrigation-ditch maintenance, road-ditch maintenance, and flooding (Claassen et al., 2001; Ribaudo, 1986; Hansen et al., 2002).

To assess the non-market value of changes in environmental quality, we use travel cost analysis to estimate the relationship between recreational waterfowl hunting trips nationwide and sediment and nitrogen concentrations in waterbodies at the recreational sites (Feather et al., 1999). The resulting coefficients reflect the negative correlation between recreational value and pollutant discharge. These and other coefficients are used to link changes in these agri-environmental impacts to changes in consumer and producer surplus associated with fresh water-based recreation, navigation, and estuary-based boating, swimming, and recreation. This set of monetized environmental impacts is by no means an exhaustive list of all activities affected by sediment and nitrogen runoff, let alone that the impacts of other environmental indicators remain to be monetized. Hence, the monetized estimates of off-site damage calculated by USMP are presumably a lower bound on total off-site damages.

III. Agri-environmental Results and Implications

Scenarios 1 and 2: Reduction in percentage of Overweight and Obese Americans

It is not surprising that US commodity production and price fall under Scenarios 1 and 2, where US consumers reduce caloric intake and demand less food (Table 4). However, production, for the most part, does not fall by as much as the domestic demand shock. This is because the amount of commodities exported and commercial stocks generally increase.[6]

Net returns to agricultural production fall most under scenario 1, when US consumers meet the Surgeon General recommendations only by reducing the amount of calories consumed (Table 5). Nationally, net returns to agricultural production could fall by as much as 7.2 percent or $5.5 billion, spread across the ten US farm production regions. However, because consumers are purchasing less food, the corresponding reduction in prices leads to a nearly 1 percent increase in consumer surplus. This increase of more than $4 billion offsets some of the production losses. Under Scenario 2, the direction of these effects is the same; net returns to agriculture fall and consumer surplus rises. However, the magnitude of these effects is reduced.

When consumers reduce their caloric consumption, they may also benefit from a cleaner environment. Corresponding to reduced production, acres planted to the major crops are estimated to fall by as much as 1.6 percent or 5 million acres. This leads to reduced discharge of nitrogen, phosphorus, pesticides, and sediment from crop production (by between 1 and 2 percent of base discharge) and reduced manure generation on confinement livestock operations (by about 3.5 percent) (Table 6). The cleaner environment results in reduced damages due to nitrogen loading and soil erosion, however crop producers may see some increases in soil depreciation due to wind erosion (Table 7).

Scenario 3: Increasing percentage of Overweight and Obese Americans –

Under Scenario 3, where weight gain in the US parallels obesity trends over the last decade, increased production of major commodities and increased prices are estimated to keep pace with the aggregate increase in caloric demand. Net returns to agricultural production could increase by as much as 2.7 percent, or more than $2 billion. Consumer surplus would be expected to fall by approximately the same amount due to the increase in prices. Acres cropped would increase by 0.5 percent, with similar increases in the discharge of agricultural pollutants.

Regional Results

In total dollar value, regional increases and decreases are largest (as a percentage) in the Northeast and smaller in the Southern Plains. In value terms, changes are more pronounced in agriculturally intensive areas such as the Corn Belt and Lake States. Conversely, changes in consumer surplus will be greatest in more populated areas such as the Northeast and Pacific regions. Environmental impacts in the Pacific region run contrary to the generalized results. This is primarily due to an increase in cotton and rice production, which leads to increased discharge of nitrogen and pesticide into the environment.

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[6] These numbers are not reported, but are available from the authors. Note that we assume that dietary habits do not change in other countries.

IV. Conclusions

Today, the US government and its constituents find themselves in a transition period vis-à-vis recommended consumption patterns. Between 1890 and 1990, the US was in an "eat more" mode, promoted by the government to address dietary deficiencies and chronic diseases (Nestle, 2002). Now, the US has moved into a "HealthierUS" initiative (e.g., "avoid excessive portions" coupled with a regime of "moderate exercise") in an effort to reduce the number of Americans that are overweight or obese (The White House, 2003).

We find that aggregate domestic consumption and exercise patterns do not need to change substantially to address the overweight and obesity epidemic facing the United States today. With modest changes in aggregate caloric intake, US consumers can achieve the goals outlined in the Surgeon General's recommendations for 2010. An aggregate reduction in caloric consumption of 5.75 percent implies that the average male and female in our sample would require consuming about 170 and 110 fewer calories each day. When consumers increase their levels of physical activity the requisite reduction in average caloric demand falls to only 2 percent, or about 80 and 30 fewer calories per day for the average man and woman, respectively. We do not mean to imply that these behavioral changes will be easy for the population to achieve (there will be men and women who reduce consumption by more and less than the average levels); if they were, obesity would not likely be such a problem. We also find that small behavioral changes in the opposite direction can lead to significant increases in populations' rate of overweight and obesity. When men and women eat, on average, 70 and 87 more calories a day, the percent of the adult population with a healthy bodyweight falls to less than 25 percent.

Small changes in domestic consumption do have measurable impacts on the returns to agricultural production, on consumer surplus, and on the environment. In general, reduced commodity demand translates into reduced agricultural production and commodity prices. Subsequently, net returns to producers may decline by between 2 and 7 percent. This change is accompanied by an increased consumer surplus and reduced levels of potential pollution discharged in the process of cultivating crops and feeding livestock. The percentage changes in the economic and agri-environmental impacts considered are roughly of the same magnitude as the consumption shocks, with some caveats. Changes in consumer surplus were less than one percent, but were opposite in value to changes in net returns to production. Regionally, impacts on production were largest in the Corn Belt and Lake States.

In summary, the results indicate that reductions in aggregate domestic caloric consumption result in lower commodity prices, increased agricultural exports, decreased farm incomes, and a reduction in the amount of nitrogen, phosphorus, soil, and pesticides discharged into the environment. These results are expected to be muted when consumers supplement dietary restrictions with increased physical activity and reversed if current overweight and obesity trends continue. As obesity is rapidly becoming an issue in a number of developed countries, a future research extension could be to replicate this exercise in a world trade model. Another possible extension of this research would be to analyze how other dietary changes besides reductions in caloric intake may affect agricultural production and environmental quality. Finally, we note that the commodities included in this analysis are by no means exhaustive. For instance, the economic and environmental impacts of changing the diet of nonprimary crops can be examined.

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Table 1: Distribution of Population under each Scenario

Scenario[a]	Body Mass Index (BMI)[b]			Physical Activity Classification[c]		
	Healthy weight	Over-weight	Obese	Inactive	Low Active	Active
Base Line-Men	33.00	39.30	27.70	40.00	14.00	15.00
Base Line-Women	38.00	28.00	34.00	40.00	14.00	15.00
Scenario 1	60.00	25.00	15.00	40.00	14.00	15.00
Scenario 2	60.00	25.00	15.00	20.00	50.00	30.00
Scenario 3 - Men	23.80	35.20	41.10	40.00	14.00	15.00
Scenario 3 - Women	19.70	31.70	48.60	40.00	14.00	15.00

a/ Baseline values are calculated from the 1999-2000 NHANES data;
Scenario 1: BMI distribution of the population in 2010 meets the HP 2010 objectives through individuals consuming fewer calories but not changing physical activity;
Scenario 2: BMI distribution of the population in 2010 meets the HP 2010 objectives through individuals consuming fewer calories and increasing their level of physical activity;
Scenario 3: BMI distribution of the population in 2010 meets projections based on current trends in the increase in the percent of the population that is overweight or obese (due to individuals consuming more calories and not changing their current levels of physical activity), by gender.

b/ Body Mass Index (BMI) is an individual's weight (in kilograms) divided by his or her height squared (in meters). An Individual is considered to have a healthy body weight if his or her BMI is in the range of 18.5 and 24.9. An individual is considered to be overweight if his or her BMI is equal to 25 or more. An individual is considered to be obese if his or her BMI is 30 or higher.

c/ An individual is considered 'inactive' if he or she reports no physical activity beyond that of independent living. An individual is considered to be 'low active' if he or she engages in physical activity equivalent to 1.5 to 3 miles per day at 3 to 4 miles per hour. An individual is considered to be 'active' if he or she engages in physical activity that is equivalent to walking more than 3 miles per day at 3 to 4 miles per hour (CNPP, http://www.usda.gov/cnpp/pyramid-update/FGP%20docs/TABLE%202.pdf).

Table 2: Summary Statistics: Mean and (Standard Error)

Variables	Men	Women
Observations	2,043	2,071
PA[a] $_{1999\text{-}2000,\ S1,\ S3}$	1.09	1.10
PA_{S2}	1.13	1.14
Age	44	46
	(0.61)	(0.56)
Height	175.75	162.00
	(0.26)	(0.24)
$\text{BMI}_{1999\text{-}2000}$	27.67	28.26
	(0.20)	(0.28)
$\text{BMI}_{S1,\ S2}$	24.51	24.31
	(0.22)	(0.25)
BMI_{S3}	28.99	29.44
	(0.21)	(0.25)
$\text{EER}_{1999\text{-}2000}$	2,757	2,090
	(13.33)	(7.10)
EER_{S1}	2,588	1,979
	(13.27)	(6.51)
EER_{S2}	2,680	2,061
	(13.78)	(6.74)
EER_{S3}	2,827	2,177
	(13.10)	(6.66)

a: The PA (physical activity) value is the population's weighted average PA score, where each PA coefficient is weighted by the percentage of population that falls into that physical activity classification. For example, in the baseline, first and third scenarios, 40% of the population will be inactive, 45% will be low active and 15% will be active. As such, the PA value for all men in these scenarios is .40*1.0+.45*1.11+.15*1.25=1.087. The PA value is different in Scenario 2 because we assume that more of the population becomes either active or low active.

Table 3: Estimated Changes in Caloric Consumptions (%)

Scenario	Description	Total	Men	Women
Sc1	Meet Surgeon General recommendations with no change in physical activity	-5.75	5.26	6.13
Sc2	Meet Surgeon General recommendations with small increase in physical activity	-2.05	2.68	1.23
Sc3	Obesity trends [1988 - 2000] continue unchanged with no change in physcial activity	2.11	2.68	1.37

Table 4. Price and Quantity Changes Adjusting for Changing Domestic Caloric Intake

Commodity[a]	Change in Price (%)			Change in Production (%)		
	Sc1	Sc2	Sc3	Sc1	Sc2	Sc3
Corn (bu)	-2.12	-0.77	0.8	-1.60	-0.60	0.7
Sorghum (bu)	-1.64	-0.50	0.47	-2.60	-0.50	-0.5
Barley (bu)	-0.32	-0.04	0.07	-1.90	-1.10	1
Oats (bu)	-1.51	-0.83	1.53	-3.20	-1.00	0.6
Wheat (bu)	-1.02	-0.36	0.42	0.10	0.10	-0.2
Rice (cwt)	-0.47	-0.17	0.17	0.10	0.00	0
Soybean (bu)	-1.54	-0.55	0.04	-0.60	-0.20	0.2
Cotton (bales)	-1.30	-0.47	0.51	-1.30	-0.50	0.4
Silage (tons)	-11.11	-4.14	4.61	-4.30	-1.50	1.6
Hay (tons)	-11.39	-3.76	3.33	-4.10	-1.50	1.6
Eggs (dozen)	-3.07	-1.09	1.13	-5.60	-2.00	2.1
Broilers (lbs)	-1.42	-0.51	0.52	-2.00	-0.70	0.7
Turkey (lbs)	-2.05	-0.73	0.76	-2.60	-0.90	0.9
Fluidmilk (lbs)	-4.34	-1.54	1.82	-5.70	-2.00	2.1
Butter (lbs)	4.12	1.49	-0.1	-5.70	-2.00	2.1
Icecream (lbs)	-5.13	-1.82	2.15	-5.80	-2.10	2.1
Fedbeef (cwt)	-1.05	-0.37	0.36	-1.20	-0.50	0.5
Pork (cwt)	-0.54	-0.19	0.2	-4.70	-1.70	1.7

Note: Sc1 = reduced caloric consumption and no change in physical activity; Sc2 = reduced caloric consumption and increased physical activity; Sc3 = increased consumption and no change in physical activity.

a/ Changes in prices and production are in reference to the USDA projected baseline for 2010 (USDA, 2001).

Table 5. Economic Impacts by Region and Scenario ($million)

Scenario[a]		Region[b] NE	LA	CB	NP	AP	SE	DL	SP	MN	PA	US
Agricultural Net Returns	Sc1	-623	-818	-1,213	-569	-545	-256	-211	-316	-414	-640	-5,573
	Sc2	-220	-293	-425	-202	-192	-93	-74	-115	-146	-229	-2,013
	Sc3	134	181	277	116	114	57	48	73	88	148	2,090
Consumer Surplus	Sc1	887	298	565	85	393	481	147	358	268	636	4,118
	Sc2	391	131	249	38	173	212	65	158	118	280	1,813
	Sc3	-486	-163	-309	-47	-215	-263	-80	-196	-146	-348	-2,253

a/ Sc1 = reduced caloric consumption and no change in physical activity; Sc2 = reduced caloric consumption and increased physical activity; Sc3 = increased consumption and no change in physical activity.

b/ Northeast = CT, DE, MA, MD, ME, NH, NJ, NY, PN, RI, VT; Lake = MI, MN, WI; Corn Belt = IA, IL, IN, MO, OH; Northern Plains = KS, ND, NE, SD; Appalachia = KY, NC, TN, VA, WV; Southeast = AL, FL, GA, SC; DELTA = AR, LA, MS; Southern Plains = OK, TX; Mountain = AZ, CO, ID, MT, NM, NV, UT, WY; Pacific = CA, OR, WA.

Table 6. Non-monetized Impacts on the Environment (%)

Scenario[a]		Region[b]										
		NE	LA	CB	NP	AP	SE	DL	SP	MN	PA	US
Nitrogen Losses to the Environment from Crops	Sc1	-2.52	-2.56	-0.90	-2.14	-1.76	-0.94	-1.11	-1.23	-1.26	0.96	-1.41
	Sc2	-0.84	-0.86	-0.32	-0.86	-0.62	-0.33	-0.39	-0.40	-0.43	0.33	-0.51
	Sc3	0.47	0.83	0.21	0.93	0.41	0.25	0.36	0.32	0.31	-0.27	0.43
Phosphorus Losses to the Enviornment from Crops	Sc1	-2.54	-2.48	-1.05	-1.59	-1.80	-1.11	-1.19	-0.87	0.60	-0.75	-1.35
	Sc2	-0.86	-0.82	-0.37	-0.72	-0.65	-0.39	-0.42	-0.31	0.29	-0.25	-0.50
	Sc3	0.42	0.68	0.17	0.57	0.40	0.29	0.37	0.20	-0.44	0.21	0.32
Total Pesticide Use on Crops (Active Ingredient)	Sc1	-2.40	-2.07	-1.00	-5.12	-4.45	-0.99	-0.89	-1.09	-3.64	0.68	-1.99
	Sc2	-0.84	-0.77	-0.36	-1.90	-1.67	-0.36	-0.32	-0.36	-1.59	0.24	-0.74
	Sc3	0.58	0.82	0.30	2.45	1.62	0.31	0.32	0.25	1.42	-0.18	0.77
Sheet, Rill, and Wind Erosion	Sc1	-2.61	0.53	-0.97	-2.80	-1.24	-0.95	-0.74	-0.88	-0.58	0.07	-1.01
	Sc2	-0.94	0.13	-0.34	-1.17	-0.46	-0.34	-0.26	-0.29	-0.18	0.02	-0.39
	Sc3	0.50	-0.10	0.11	0.86	0.11	0.19	0.23	0.10	-0.02	-0.03	0.19
Manure Nitrogen Generated on Confined Facilities	Sc1	-4.42	-4.60	-3.90	-2.56	-3.54	-2.76	-2.47	-2.68	-3.47	-4.57	-3.50
	Sc2	-1.57	-1.64	-1.40	-0.94	-1.26	-0.98	-0.88	-0.98	-1.27	-1.64	-1.25
	Sc3	1.61	1.73	1.46	1.01	1.29	1.01	0.90	1.04	1.35	1.79	1.32
Manure Phosphorus Generated on Confined Facilities	Sc1	-4.32	-4.25	-3.81	-2.66	-3.78	-2.83	-2.50	-2.56	-3.06	-4.21	-3.43
	Sc2	-1.53	-1.52	-1.36	-0.97	-1.35	-1.01	-0.89	-0.94	-1.13	-1.51	-1.23
	Sc3	1.58	1.60	1.42	1.03	1.38	1.03	0.91	1.01	1.21	1.65	1.29

a/ Sc1 = reduced caloric consumption and no change in physical activity; Sc2 = reduced caloric consumption and increased physical activity; Sc3 = increased consumption and no change in physical activity.

b/ Northeast = CT, DE, MA, MD, ME, NH, NJ, NY, PN, RI, VT; Lake = MI, MN, WI; Corn Belt = IA, IL, IN, MO, OH; Northern Plains = KS, ND, NE, SD; Appalachia = KY, NC, TN, VA, WV; Southeast = AL, FL, GA, SC; DELTA = AR, LA, MS; Southern Plains = OK, TX; Mountain = AZ, CO, ID, MT, NM, NV, UT, WY; Pacific = CA, OR, WA.

Table 7. Monetized Environmental Impacts (%)

Scenario[a]		Region[b]										
		NE	LA	CB	NP	AP	SE	DL	SP	MN	PA	US
Nitrogen Damages	Sc1	-1.80	-2.40	-1.00	-2.00	-1.90	-1.00	-1.10	-1.10	-3.00	0.60	-1.30
	Sc2	-0.60	-0.70	-0.40	-0.80	-0.70	-0.30	-0.40	-0.40	-1.00	0.20	-0.40
	Sc3	0.40	0.60	0.20	0.60	0.70	0.30	0.40	0.30	0.70	-0.20	0.40
Sheet and Rill Erosion Damages	Sc1	-2.70	-0.90	-0.90	-1.80	-1.20	-0.90	-0.70	-1.10	-0.10	0.40	-1.20
	Sc2	-1.00	-0.40	-0.30	-0.90	-0.50	-0.30	-0.30	-0.40	0.00	0.10	-0.50
	Sc3	0.50	0.30	0.10	0.80	0.10	0.20	0.20	0.30	-0.20	-0.10	0.20
Soil Depreciation	Sc1	-2.80	25.10	-0.30	2.10	-1.90	-9.30	-0.40	-3.80	1.40	-2.40	0.60
	Sc2	-1.10	6.40	-0.10	0.60	-0.70	-3.30	-0.10	-1.70	0.60	-0.80	0.10
	Sc3	1.10	-4.40	-0.20	0.50	0.10	1.70	0.10	2.80	-1.50	0.70	0.10

a/ Sc1 = reduced caloric consumption and no change in physical activity; Sc2 = reduced caloric consumption and increased physical activity; Sc3 = increased consumption and no change in physical activity.

b/ Northeast = CT, DE, MA, MD, ME, NH, NJ, NY, PN, RI, VT; Lake = MI, MN, WI; Corn Belt = IA, IL, IN, MO, OH; Northern Plains = KS, ND, NE, SD; Appalachia = KY, NC, TN, VA, WV; Southeast = AL, FL, GA, SC; DELTA = AR, LA, MS; Southern Plains = OK, TX; Mountain = AZ, CO, ID, MT, NM, NV, UT, WY; Pacific = CA, OR, WA.

Figure 1. Men's Projected Energy Requirement (EER) Distribution

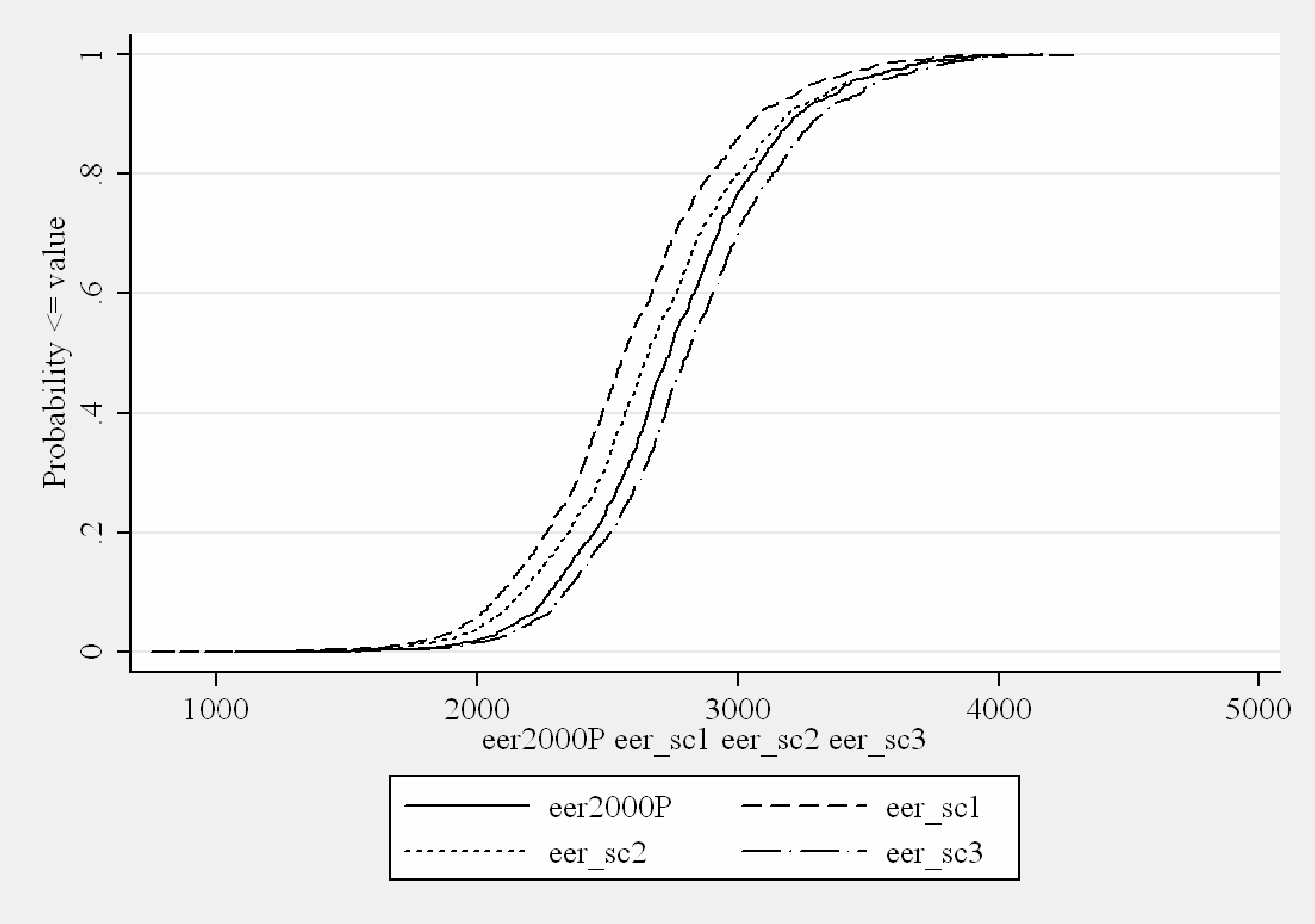

Figure 2. Women's Projected EER Distribution