

The New World's Contribution to Food Consumption during the Industrial Revolution

John Komlos

University of Munich

At least until 1800, but in some places even thereafter, the European demographic system was in a Malthusian homeostatic quasi-equilibrium, even though the long-run trend of population growth was slightly positive. Whenever population densities reached critical levels, the procurement of food became increasingly difficult, and overshooting prudent Malthusian ceilings increased the risk of a subsistence crisis.¹ During the second half of the eighteenth century Europeans found themselves in yet another phase of rapid demographic expansion, which was bringing in its wake, as numerous times before, both an upswing in economic activity and the simultaneous threat of a major crisis of subsistence. The crisis of 1740/41 was widespread,² but in England at least, it was the last time when the crude death rate exceeded the crude birth rate until World War I. The threat of starvation in the preindustrial world was more than an abstract possibility. As late as 1771/72 tens of thousands perished in Bohemia, across the border in Saxony, in the Wupper Valley, in Sweden, as well as in Norway; in numerous other regions the situation was not considerably better: in Electoral Saxony eight percent of the population is said to have perished in 1772.³ There is

¹ Komlos and Artzrouni, "Mathematical Investigations;" Komlos, "On the Role of Crisis;" Appleby, *Famine*, p. 95.

² The crisis was particularly memorable for its severity in Ireland. O'Grada, *Ireland*, p. 2.

³ Lis and Soly, *Poverty*, pp. 149, 171-193; Kisch, *Die Hausindustriellen Textilgewerbe*, p. 228; Abel, *Massenarmut*, p. 253.

perhaps no more convincing evidence of the dangers posed by rapid population growth to the biological standard of living than the fact that the physical stature of the Europeans diminished markedly toward the end of the eighteenth century, a sign of a biological adaptation to the nutritional crisis.⁴

Even in good times average calorie intake was barely adequate, but by the end of the eighteenth century Europeans were subsisting on a diet that provided 2,700 calories per day for an adult male.⁵ People ate less of the more nutritious foods, and meat and dairy products were seldom seen on the plates of the lower classes.⁶ Given the harsh disease environment, the heavy workloads, and the fact that even simple day-to-day activities required the expenditure of many times the calories it does today, this level of consumption did not provide adequate quantities of energy, protein, and nutrients for a secure biological standard of living.⁷ The distribution of calorie consumption in France was such that, "the bottom 10 percent of the labor force lacked the energy for regular work and the next

⁴ Sandberg and Steckel, "Heights and Economic History;" Komlos, *Nutrition and Economic Development*; *Idem.*, "The Secular Trend."

⁵ Geographical variations were large. In the South of England, for example, where two-thirds of the population lived, the average was closer to 2,400 kcal. Shammass, *The Pre-Industrial Consumer*, p. 135.

⁶ By 1816 per capita meat consumption in Germany was 16 kg annually. In 1850 the average German diet consisted of 23 percent potatoes but only four percent meat by weight. Teuteberg, "Der Verzehr von Nahrungsmitteln." In Austria, too, per capita meat consumption at the end of the eighteenth century was estimated at 14 kg, although this is said to be too low according to Sandgruber, *Die Anf_ nge der Konsumgesellschaft*, pp. 150, 154. Even in Vienna, where meat consumption was far higher, and increasing, the consumption of cheese and butter was decreasing, and milk consumption was a mere 3.4 ounces per capita per day.

⁷ On a per capita basis, calorie consumption is estimated as follows: England: 2,050; Belgium: 2510; France: 2,130 according to Livi-Bacci, *Population and Nutrition*, p. 82. However, Livi-Bacci believes these were adequate levels of nutrient intake. Note that according to Gregory King's figures English daily calorie intake from grains alone was about 2,400 in *circa* 1695. Freudenberger and Cummins, "Health, Work, and Leisure." "On the eve of the Revolution hunger was the great enemy for the majority of Frenchmen." Lefebvre, *The Great Fear*, p. ix. Average daily per capita consumption was circa 1,800 kcal in France. Toutain, *La Consommation alimentaire*, p. 1982.

10 percent had enough energy for less than three hours of light work daily.... Although the English situation was somewhat better, the bottom 3 percent of its labor force lacked the energy for any work...."⁸

Nonetheless, in contrast to prior similar episodes, the threat was relatively mild: crisis mortality was, by and large, attenuated.⁹ European societies had learned how to prepare for and cope effectively with extremes in harvest fluctuations, and their economies were sufficiently advanced to overcome the challenges that faced them. Perhaps the most important factor in this regard was the improvements in transportation networks that enabled grain and other food products to be distributed more evenly among the lower segments of the population than was possible in earlier epochs. Moreover, epidemics of major proportions were less frequent than they had been in prior centuries, and hence, Malthusian ceilings could be broached for the first time in history. Although food prices might still increase substantially, they did so without having an effect on mortality rates as before. Thus, the demographic consequences of the harvest failures of 1816, for example, were much milder than those of earlier episodes of comparable adversity. Though birth rates fell, and death rates increased somewhat, population growth continued unabated in England even at the height of the crisis, though at a reduced rate.¹⁰ There were innumerable reasons for this major achievement. The availability of food to supply the growing population was made possible by gains in agricultural productivity, by the expansion of traditional channels of trade, by lower transportation costs, and by the discovery of a new continent whose contribution to European well being until then had been smaller.

⁸ Fogel, "The Conquest of High Mortality," p. 46. "A large proportion of the [English] population, perhaps half, subsisted on inadequate diets." Freudenberger and Cummins, "Health, Work, and Leisure," p. 9.

⁹ Perenoud, "The Attenuation of Mortality."

¹⁰ Post, *The Last Great Subsistence Crisis*, pp. 111-16; in Bohemia population growth reached one percent per annum even in 1817 although excess births were at a local minimum. Palacky, "Gradation der Bevölkerung."

It is to the exploration of this last issue that this paper is dedicated. The New World's contribution to European food consumption consisted of direct nutrient exports and the cultivation of new food products transplanted to Europe from America, the most important of which was the potato.¹¹ I estimate this contribution circa 1816 by posing the counterfactual question: how much more likely would Europeans have been to fall below the biological subsistence minimum of circa 1,700 kcal per day for an adult male if America had not been discovered. I chose 1816 inasmuch as it was the last general subsistence crisis in Western Europe; 1846 was less serious with the exception of Ireland. If the demographic expansion of the eighteenth century had come to a halt sometime, it would have been in 1816.¹² Thereafter grain prices declined markedly overall, signalling the abatement of the threat of a major subsistence crisis.

The diffusion of the potato plant from the New World to Europe was inexplicably slow, even though it could be grown on lands, and at altitudes at which other crops would hardly flourish. Its use was minimal until the threat of hunger at the end of the eighteenth century forced its increasing adoption. By then it served as a substitute for 30 percent of the cereal consumption in southern Netherlands.¹³ Three major advantages made it a life saving crop for Europeans: its rate of spoilage was less than that of grain, because it did not mold as easily; it was bulky, so it easily satisfied hunger; and the calories it contained were inexpensive relative to those obtained in other products.¹⁴

¹¹ Maize came to be grown fairly extensively in the Mediterranean basin, as well as in southeastern Europe, but in Western Europe was not yet important in 1816.

¹² I am not specifying a precise model of the demographic nutrition relationship. I believe, however, that with a major subsistence crisis in 1816 the Industrial Revolution would have been delayed by as much as several decades.

¹³ Christian Vandenbroeke, "Aardappelteelt en aardappelverbruik in de 17e en 18e eeuw," *Tijdschrift voor Geschiedenis* 82 (1969):49-68, as cited in Morineau, "The Potato," p. 18.

¹⁴ A penny spent on potatoes purchased about as many calories as did one spent on oatmeal, but 2.5 times as many as one spent on wheat bread. Shamma, *The Pre-Industrial Consumer*, pp. 137.

In the early nineteenth century in Germany 1.5 percent, and in France 1.3 percent, of the arable was devoted to the crop. In Flanders its cultivation was more prevalent, and average daily consumption there reached three pounds, six times as high as in England.¹⁵ In Prussia, too, potato output per agricultural worker increased at a phenomenal annual rate of 16 percent per annum during the early decades of the century.¹⁶ Just prior to the famine of 1845/6 one-third of Irish arable land was devoted to the crop, and more significantly, the lives of three million "potato people," the bottom 40 percent of the income distribution, were dependent upon it. On the eve of the famine average per capita potato consumption provided every Irish man, woman and child with 1,400 calories per day.¹⁷ Thus, throughout Europe the subsistence of a large and increasing segment of the population became dependent on the crop during the first half of the century: it is truly doubtful if the demographic expansion could have been sustained without it.

The New World also supplied nutrients directly to Europe: cod from Newfoundland, sugar from the Caribbean, rice from South Carolina, and flour from New York.¹⁸ Rum from the West Indies also added calories to the already substantial alcohol consumption.¹⁹ In England sugar was consumed even by the

¹⁵ Blum, *The End of the Old Order*, p. 274. Perhaps 9 percent of the land area was devoted to it by the turn of the nineteenth century. Vandenbroeke, "Aardappelteelt en aardappelverbruik." Mendels, "Agriculture and Peasant Industry in Eighteenth-Century Flanders," p. 204.

¹⁶ The reference is to the East Elbian region, between 1800 and 1840. The importance of the crop for human consumption was greater than as fodder Dickler, "Organization and Change," p. 286.

¹⁷ *Why Ireland Starved*, p. 7; O'Gráda, *Ireland Before and After the Famine* p. 9.

¹⁸ Between 1770 and 1790 the value of grain and flour exported from the United States had increased by some 50 percent. Gilbert, "The Role of Breadstuffs." At the latter date wheat was the most important commodity exported from the United States. Its value exceeded even that of tobacco. Shepherd and Walton, "Economic Change," p. 408.

¹⁹ One ounce of alcohol provides about 71 calories. To be sure, these are "empty calories," but alcohol, nonetheless, increases one's ability to perform hard work and decreases fatigue. Winick, *et al.* ed., *The Columbia Encyclopedia of Nutrition*, p. 31.

lower orders: in the 1790s workers' families spent 10 percent of their food budget on such luxuries as sugar and tea. In contrast to England, sugar consumption on the continent was generally smaller.²⁰

TABLE 1 - Prices and Demographic Cycles in Vienna during Two Harvest Failures

	Wheat	Rye	Rye/wheat	Population
1769	100.0	100.0	100.0	
1770	150.5	178.3	118.5	
1771	183.9	236.6	128.7	100.0
1772	203.5	215.7	106.0	92.8
1773	123.2	121.9	98.9	92.4
1813	100.0	100.0	100.0	100.0
1814	190.4	245.2	128.8	97.2
1815	253.2	381.3	150.6	98.1
1816	420.6	632.3	150.3	98.8
1817	179.3	231.2	128.9	101.0
1818	80.5	88.9	110.4	102.3

Source: Alfred Pribram, *Materialien zur Geschichte der Preise und Löhne in Österreich* (Vienna: Ueberreuters, 1938) p. 372.

How much did "New World" nutrients contribute to the escape from hunger in 1816, when harvest failures were widespread enough to threaten Europe with the last truly general subsistence crisis of major proportions (Table 1)? Food exports from the United States alone provided Europeans with close to 1,000 million kcal per day, enough to keep alive the inhabitants of Paris, for instance (Table 2). Output of sugar in the New World was about 330,000 tons around 1816, and British retained imports in 1814-16 were 207 million pounds or circa 16.5 pounds per capita per annum.²¹ Hence, European consumption outside of

²⁰ Shammass, *The Pre-industrial Consumer*, p. 136. Per Capita consumption in Austria was 0.4 kg in 1780 and 1.1 kg in 1836, but in capital cities such as Vienna, where its consumption reached 14 lbs per capita per annum in 1783, it could be substantial. Sandgruber, *Die Anfänge der Konsumgesellschaft*, p. 206.

²¹ Davis, *The Industrial Revolution*, p. 31, 45. The figure given for English consumption in Mitchell, *British Historical Statistics*, p. 709, is 16.3 lb. Shammass calculates that sugar imports into England provided an average of 140 kcal per capita daily. *The Pre-Industrial Consumer*, p. 83. Deerr *The History of Sugar*, Vol. I, pp. 112, 131, 193-203, 212, 235-240, 245. Mintz accepts a figure for world sugar consumption of 245,000 tons in 1800 and

TABLE 2 - U.S. Nutrient Exports to Europe

Desti- nation	Actual Exports Distribution (Percent)			Estimated Nutrient Exports millions of kcal per day in 1816/17			
	Nutrients		All ^a	I	II	III	Probable
	1799	1821	1816/17				
England	19.7	36.8	39.7	215	280	500	215
Germany	42.6	13.3	6.7	470	100	85	175
Spain	17.9	2.3	1.5	200	20	20	80
Portugal	7.4	5.1	1.1	80	40	15	50
Gibraltar	2.1	17.8	4.9	25	130	60	100
France	0.0	6.0	17.6	0	50	220	100
Netherlands	1.5	6.1	9.0	20	40	110	80
Other	10.8	12.6	19.5	90	100	240	200
Total	100.0	100.0	100.0	1,100	760	1,250	1,000
Calories							
Total	1,874	1,585					1,984
To Europe	610	345					1,000

^a excludes cotton exports to England.

Note: Year ending 30 September; includes reexports. For derivation see Appendix. European totals do not include exports to Madeira or to the Canary Islands. Estimates I and II are based on the distribution of nutrient exports in 1799 and 1821 respectively. Estimate III is based on the distribution of the money values of exports in 1816/17. See first panel of the table for these percentages, and the appendix for a delianation of the method used. The years 1799 and 1809 were the only ones in which the United States did not export to France directly. Pitkin, *A Statistical View of*, p. 214.

Source: *American State Papers*, Vol. 1, pp. 424-30, Vol 2, pp. 52, 92, 155; House Doc. 39, 17th Cong. 1st Sess.

England must have been about 500 million pounds.²² If one includes the extra calories produced on the acreage devoted to the potato above their alternative uses one has that the nutritional intake of Englishmen would have been reduced by circa 280 kcal

572,000 tons in 1830. *Sweetness and Power*, p. 73. The estimate of Caribbean output given in Mitchell, 341 million pounds, appears to be too low for two reasons. British imports alone (including reexports) were 400 million pounds in 1816, and as early as the 1770s sugar exports to Europe from the Caribbean were estimated at 550 million pounds. Mitchell, *International Historical Statistics*, p. 229; McCusker, *The Rum Trade*, pp. 232, 356. Per capita retained sugar imports in England were only 4 lbs at the beginning of the eighteenth century, but by the 1750s, total sugar imports reached a million pounds per annum. Schumpeter, *English Overseas Trade Statistics*, p. 62. I assume that the quantities refer to unrefined sugar, but that the wastage in processing is negligible inasmuch as treacle, the byproduct of the conversion from muscovado to refined sugar, is also consumed, even if after further processing into rum.

²² This would mean that English sugar consumption would have increased from 30 percent of world total in the 1770s to circa 40 percent in 1816.

per day without the discovery of the New World²³ (Table 3, Figure 1). Although this was about ten percent of probable total consumption, at the margin these extra calories were, nonetheless, quite important. "New World Nutrients" provided a quarter of the energy available for work, in fact, enough energy to sustain 6.9 million hours of heavy labour per day. Their absence could have lowered English GNP by as much as 10 percent, even if only half of the extra calories had been consumed by workers.²⁴

TABLE 3 - "New World" Nutrient Consumption in Europe c. 1816
(millions of kcal per day)

Source	England	France	Germany	Other
U.S. export	215	100	175	555
Sugar	1,000	700	400	800
Rum	82	n.a.	n.a.	n.a.
Cocoa	6	6	n.a.	7
Cod	50	n.a.	-	100
Potato	860	3,792	1,356	n.a.
Total	2,213	4,592	1,976	n.a.
per adult (kcal)	275	20	110	n.a.

Sources: See Appendix and Table 2.

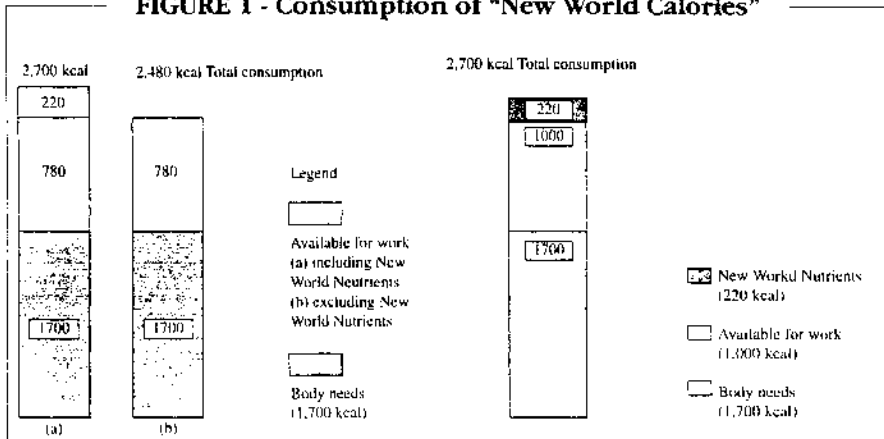
Note: Population figures were converted into adult equivalents by multiplying by a factor of 0.766. Annual cod exports from Newfoundland were about 117 million pounds, three-fifths of which are assumed to have been bound for Europe. Leacy, *Historical Statistics of Canada*, Table N129. Potato output in Germany in 1800 was about 1,291 million kg, and in France 3,610 million kg. Germany had 671,000 and France 381,000 acres devoted to potato production at the beginning of the nineteenth century. Hoffmann, *Das Wachstum*, p. 273; Mitchell, *European Historical Statistics*, pp. 199, 237.

One would need a general equilibrium model for an exact solution of the counterfactual question of how nutrient prices and demand for food would have been affected by the absence of

²³ Per capita consumption of potatoes in England is estimated at 0.47 lbs. Salaman, *History*, p. 613. The calorie value of a pound of potatoes was about 270. An acre planted in potato is assumed to have produced twice as many calories as if it had been planted in wheat. Blum, *The End of the Old Order*, p. 274. However, it was supposed that a quarter of the land used for potato would have been fallow without the plant. Hence, the calorie yield calculated for total potato output was multiplied by 0.625 in order to obtain the net gain in calories due to the potato plant.

²⁴ Assuming 2,000 hours of work per annum, and given that a common labourer earned [£ 44] per year. GNP is estimated in 1821 as £. 291 m. in Mitchell, *British Historical Statistics*, pp. 153, 822.

FIGURE 1 - Consumption of "New World Calories"



"New World Nutrients."²⁵ While that lies outside the scope of this paper, I can propose some possibilities, in order to assess further the order of magnitude of the impact of these new sources of nutrients on the biological standard of living. Suppose that calorie consumption was lognormally distributed.²⁶ If we assume that the consumption of English adult males including New World nutrients was around 2,700 kcal per day with a coefficient of variation of between .25 and .30, then about 3 to 6 percent of the population would have been barely surviving on a subsistence diet, unable to perform any work at all²⁷ (Table 4). These were the ultra-poor, who should concern us the most. If we lower the average intake to 2,425 kcal and also allow for a slight skewing of the distribution, inasmuch as the well-to-do would have been more likely to maintain their nutritional status in the face of the increased food prices, then one obtains that 11 to 15 percent of the population, an additional eight percent, would have been on a subsistence diet. If we assume that just a fifth of this six percent additional ultra-poor

²⁵ For example, in the absence of New World Nutrients East European supplies would have been developed faster, and substitutes might have been found in consumption, i.e., the turnip might have been made more palatable. These complexities are not explored here.

²⁶ Aitchison and Brown, *The Lognormal Distribution*, (Cambridge, 1969).

²⁷ This was the average calorie intake c. 1790, and I am assuming that it did not change during the subsequent quarter century.

would have perished per annum, then the English crude death rate (CDR) would have increased by about 15/1000.²⁸ This would have meant that 1816 would have been a major subsistence crisis, with a the CDR above 40, even exceeding the level of 1741. Hence, it is not difficult at all to conceive of situations such that the marginal contribution of "New World Nutrients" could have made the difference between a successful and an unsuccessful attempt at escaping from the Malthusian trap, and not only in England.²⁹ On the Continent, the impact of the failure to discover America would probably have been of comparable magnitude.³⁰

Given our limited knowledge of the actual distribution of calories within the populations under consideration, the argument that "New World nutrients" did, in fact, enable Europeans to escape from the

²⁸ Fogel supposes that a quarter of the ultra-poor died of hunger or hunger-related diseases in "The Conquest of High Mortality," p. 46.

²⁹ While I believe that the above distribution scheme is intuitively plausible, it is possible to think of alternative ways of distributing the additional calories so that the impact of the New World nutrient become either larger or smaller. Suppose, to take an extreme case, all sugar consumption accrued to the wealthy, while the other calories were distributed so as to maintain the coefficient of variation unchanged. Then (without sugar) the mean calorie intake would have declined to only 2,550 kcal and the proportion of the ultra-poor would have increased by only 2.0 percent. From 3 to 5 percent or from 6 to 8 percent. The increase in the CDR would then have been on the order of 4/1000. But this smaller increase almost would have sufficed to cut population growth by half. In other words, the rate of demographic expansion was quite sensitive to the proportion of the malnourished ultra-poor in the society. If the distribution had become a little more skewed under this scenario, increasing from a c.v. of .25 to .3 with the mean declining from 2,700 to 2,550 then the proportion of the ultra-poor would increase by 5 percent, and the increase in the c.d.r would be 10/1000. This would have sufficed to bring population growth to a halt.

In contrast, one could also suppose that sugar consumption accrued to the rich, and potato consumption to the poor, but not to the bottom of the distribution (the rest of the foods going to the middle of the income distribution). That scheme would have reduced daily intake of the poor by 860 million kcal, a sufficient amount to bring an additional 25 percent of the distribution down to the level of consumption of the ultra-poor. In other words, instead of having to support 3-6 percent of the population, Englishmen would have had to contend with supporting 28-31 percent who would then be on starvation diets, unable to perform any useful work at all.

³⁰ While in France the consumption of "New World nutrients" was less than in England on a per capita basis, it was almost the same percentage of average caloric intake, circa 8 percent in England and 7 percent in France.

TABLE 4 - Hypothetical Lognormal Distributions of Calorie Consumption in England, c. 1816

Decile ^a	With New World Calories mean = 2,700		Without New World Calories			
	c.v. = .25	c.v. = .3	mean = 2,425		mean = 2,550	
			c.v. = .3	c.v. = .35	c.v. = .25	c.v. = .3
10th	3,946	4,288	3,932	4,243	3,824	4,134
9th	3,480	3,679	3,287	3,449	3,290	3,456
8th	3,185	3,303	2,958	3,052	3,011	3,109
7th	2,965	3,028	2,716	2,765	2,804	2,856
6th	2,782	2,800	2,517	2,531	2,630	2,646
5th	2,616	2,598	2,339	2,325	2,473	2,458
4th	2,453	2,403	2,167	2,128	2,320	2,278
3rd	2,284	2,203	1,990	1,929	2,160	2,092
2nd	2,091	1,977	1,790	1,707	1,977	1,882
1st	1,788	1,664	1,497	1,387	1,701	1,574
Percent of Labour Force Able to Work at least the Number of Hours Specified						
zero	97	94	89	85	95	92
3 light	91	87	78	75	87	83
3 heavy	50	50	35	37	40	42
8 light	73	70	56	55	65	63

^aThe calorie values indicated are at the mid point of the decile.

Note: c.v. = coefficient of variation. Calorie requirements were assumed to be as follows: 0 hrs = 1,704 kcal (needed for basal metabolism and for basic bodily functions); the requirement of each hour of light work was assumed to be 77 kcal, and each hour of heavy work 335 kcal. See World Health Organization, *Energy and Protein Requirements*, 1985, p. 78.

Malthusian trap would perhaps be premature. Yet, we demonstrated that these additions to the European nutrient supply were of sufficient magnitude to sustain the demographic revolution.³¹ Hence, they could very well have made the difference in 1816, for instance, in alleviating a crisis of seventeenth-century proportions.

"It seems altogether probable," wrote William Langer a generation

³¹ This is particularly the case, inasmuch as a number of factors have been left out of consideration until now. Sugar consumption, for example, was a complement to drinking coffee and tea. While these drinks, in contrast to the cocoa bean, do not themselves have nutritional value, they are stimulants which enhance muscle strength and endurance, thereby increasing labour productivity. Aymard, "Toward the History of Nutrition," p. 10. Another New World product, tobacco, contains nicotine, another appetite suppressant. Eschleman, *Introductory Nutrition*, p. 230. If the propensity to consume both caffeine and nicotine was higher among the wealthier segments of the population, their food consumption would have been lower than their budget would have allowed, and hence lower than it would have been without the availability of these products. We need to know more about the

ago, "that the introduction and general adoption of the potato played a major role" in the great upswing of the European population.³² I would add to this insight that the other aspects of the New World's contribution to European food supply also softened the impact of subsistence crises of the old-fashioned type. Although undernutrition continued to be widespread, fewer people succumbed to malnutrition or to associated diseases than previously at identical phases of the population cycle.³³ This is not the only, but certainly one, of the fundamental ways in which Europe of 1816 differed from Europe of the seventeenth century, when the Malthusian menace showed its ferocious strength for the last time.³⁴ One of the crucial differences between, say, 1616 and 1816 was that the ability of West Europeans to procure nutrients was made easier by the innovations of the intervening two centuries. This time the nutritional trough was passed without a reversal of the upward trend in population growth. By the time the crisis of 1816 was over, it was evident that the Europeans had broken through the Malthusian ceilings: the Industrial Revolution was under way.

class-specific consumption of these products before we can begin to draw inferences on their effect on the nutritional status of the ultra-poor. In the meanwhile, we can acknowledge that the calorie intake of the lowest centiles of the income distribution might have been enhanced by the fact that their wealthier compatriots were consuming appetite suppressant drugs contained in New World products such as coffee and tobacco.

³² "Europe's Initial Population Explosion."

³³ Food consumption patterns do "not reflect a nutritionally satisfied population, but one resigned to a certain level of malnourishment." Shammass, *The Pre-Industrial Consumer*; p. 148.

³⁴ John U. Nef had, in fact, argued at one point that it did.

³⁵ Pitkin, *A Statistical View*; p. 87.

REFERENCES

- Abel, Wilhelm, *Massenarmut und Hungerkrisen im vorindustriellen Europa* (Hamburg and Berlin, 1974).
- Aitchison, J., and J.A.C. Brown, *The Lognormal Distribution, with Special Reference to its Uses in Economics* (Cambridge, 1969).
- American State Papers. Documents, Legislative and Executive of the Congress of the United States etc.*, Part IV, *Commerce and Navigation* (Washington, 1832).
- Appleby, Andrew, *Famine in Tudor and Stuart England* (Stanford, 1978).
- Aymard, Maurice, "Toward the history of nutrition: some methodological Remarks," in Forster and Ranum, eds., *Food and Drink in History*, pp. 1-16.
- Blum, Jerome, *The End of the Old Order in Rural Europe* (Princeton, 1978).
- Davis, Ralph, *The Industrial Revolution and British Overseas Trade* (London 1979).
- Deerr, Noel, *The History of Sugar* (London, 1949).
- Dickler, Robert A., "Organization and change in productivity in Eastern Prussia," in Parker and Jones, eds., *European Peasants*, pp. 269-92.
- Eschleman, Marian Maltese, *Introductory Nutrition and Diet Therapy* (2nd edn., Philadelphia, 1991).
- Fogel, Robert W., "The conquest of high mortality and hunger in Europe and America: Timing and Mechanisms," in Patrice Higonnet, David S. Landes, and Henry Rosovsky, eds., *Favorites of Fortune. Technology, Growth, and Economic Development since the Industrial Revolution* (Cambridge, MA, 1991), pp. 33-71.
- Forster, Robert, and Ranum, Orest, eds., *Food and Drink in History. Selections from the Annales Economies, Sociétés, Civilisations* (Baltimore, 1979).
- Freudenberger, Herman, and Gaylord Cummins, "Health, work, and leisure before the Industrial Revolution," *Explorations in Economic History* 13 (1976), pp. 1-19.
- Gilbert, Geoffrey, "The role of breadstuffs in American trade 1770-1790," *Explorations in Economic History* 14 (1977). pp. 378-87.
- Hoffmann, Walther G., *Das Wachstum der Deutschen Wirtschaft seit der Mitte des 19. Jahrhunderts* (Berlin, 1965).
- Kisch, Herbert, *Die Hausindustriellen Textilgewerbe am Niederrhein vor der Industriellen Revolution: Von der ursprünglichen zur kapitalistischen Akkumulation* (Göttingen, 1981).
- Komlos, John, "The secular trend in the nutritional status of the population of the United Kingdom, 1730-1860," *Economic History Review* (February, 1993).
- Komlos, John, *Nutrition and Economic Development in the Eighteenth Century Habsburg Monarchy: An Anthropometric History* (Princeton, 1989).

- Komlos, John, "On the role of crisis in historical perspective, a comment," *Population and Development Review*, 14 (1988), pp. 159-164.
- Komlos, John, and Marc Artzrouni, "Mathematical investigations of the escape from the Malthusian trap," *Mathematical Population Studies*, 2 (1990), pp. 269-287.
- Langer, William, "Europe's initial population explosion," *American Historical Review* 69 (Oct. 1963), pp. 1-17.
- Leacy, F. H., ed., *Historical Statistics of Canada* (2nd edn., Ottawa).
- Lefebvre, Georges, *The Great Fear of 1789. Rural Panic in Revolutionary France* (New York, 1973).
- Lis, Catherina, and Hugo Soly, *Poverty and Capitalism in Pre-industrial Europe* (Atlantic Highlands, NJ: 1979).
- Livi-Bacci, Massimo, *Population and Nutrition, An Essay on European Demographic History* (Cambridge, 1991).
- McCusker, John James, *The Rum Trade and the Balance of Payments of the Thirteen Continental Colonies, 1650-1775* (Ph.D. diss., University of Pittsburgh, 1970).
- Mendels, Franklin, "Agriculture and peasant industry in eighteenth-century Flanders," in Parker and Jones, eds., *European Peasants*, pp. 179-204.
- Mintz, Sidney, *Sweetness and Power. The Place of Sugar in Modern History* (New York, 1985).
- Mitchell, Brian R., *International Historical Statistics: The Americas and Australasia* (Detroit, 1983).
- Mitchell, Brian R., *British Historical Statistics* (Cambridge, 1988).
- Mokyr, Joel, *Why Ireland Starved: A Quantitative and Analytical History of the Irish Economy, 1800-1850* (London, 1983).
- Morineau, Michel, "The Potato in the eighteenth century," in Forster and Ranum, *Food and Drink in History*, pp. 17-36.
- O'Gráda, Cormac, *Ireland Before and After the Famine. Explorations in Economic History, 1800-1925* (Manchester, 1988).
- Palacky, Franz, "Gradation der Bevölkerung Böhmens seit den letzten 60 Jahren," *Monatsschrift der Gesellschaft des vaterländischen Museums in Böhmen* 3 (January, 1829), pp. 187-205.
- Parker, William N., and Eric L. Jones, eds., *European Peasants and Their Markets. Essays in Agrarian Economic History* (Princeton, 1975).
- Perenoud, Alfred, "The attenuation of mortality crises and the decline of mortality," in Roger Schofield, David Reher, and Alain Bideau, eds., *The Decline of Mortality in Europe* (Oxford, 1991), pp. 18-37.
- Pitkin, Timothy, *A Statistical View of the Commerce of the United States of America* (New Haven, 1835).
- Post, John D., *The Last Great Subsistence Crisis in the Western World* (Baltimore, 1977).
- Salaman, Redcliffe N., *History and Social Influence of the Potato* (Cambridge, 1949).
- Sandberg, Lars G., and Richard H. Steckel, "Heights and economic history: The

- Swedish case," *Annals of Human Biology* 14 (1987), pp. 101-110.
- Sandgruber, Roman, *Die Anfänge der Konsumgesellschaft. Konsumgüterverbrauch, Lebensstandard und Alltagskultur in Österreich im 18. und 19. Jahrhundert* (Vienna, 1982).
- Schumpeter, Elizabeth B., *English Overseas Trade Statistics, 1697-1808* (Oxford, 1960).
- Shammas, Carole. *The Pre-Industrial Consumer in England and America* (Oxford, 1990).
- Shepherd, James F., and Gary M. Walton, "Economic change after the American Revolution: pre-and post-war comparisons of maritime shipping and trade," *Explorations in Economic History* 13 (1976). pp. 397-422.
- Teureberg, Hans J., "Der verzehr von nahrungsmitteln in Deutschland pro kopf und jahr seit beginn der industrialisierung (1850-1975). Ein versuch einer quantitativen langzeitanalyse," *Archiv für Sozialgeschichte* 19 (1979), pp. 331-88.
- Toutain, Jean C., *La Consommation alimentaire en France de 1764 à 1964* (Geneva, 1971).
- Winick, Myron, et al. ed., *The Columbia Encyclopedia of Nutrition* (New York).

APPENDIX: U.S. NUTRIENT EXPORTS

Between 1800 and 1820 the destination of U.S. exports is not given in the trade statistics.³⁵ The share of a particular commodity destined for Europe between 1815 and 1818 was estimated as follows:

If $Q_b > Q_a$ then $s_a = s_b$

If $Q_b < Q_a$ then $s_a = [(Q_a - Q_b) + s_b Q_b]/Q_a$

where,

Q_b = total quantity exported from the U.S. of a particular commodity in 1798/99;

Q_a = total quantity exported from the U.S. of the same commodity in 1815/16 (in 1816/17, and in 1817/18);

s_b = share of commodity Q exported to Europe in 1798/99;

s_a = share of commodity Q exported to Europe in 1815/16 (in 1816/17, and in 1817/18);

These shares were then used to determine the quantities shipped of any one good to Europe, and then the caloric value of all goods was summed up for the year. The results are displayed in Table 2.

For the year 1816/17 the calculation was repeated using the 1821 weights for s_b instead of the 1799 ones.

The shares going to any one country in 1799 and in 1821 were used to derive U.S. calorie exports to the individual countries (Table 2).