True Cost Accounting For Food and Agriculture
David A. Bainbridge

I have been interested in the true cost of agriculture for more than 40 years (Bainbridge, 1983; Mitchell and Bainbridge, 1991) and decided to take a new look at the true cost of American Agriculture in more detail. Tegtmeier and Duffy (2004) provided a good starting point and I used their categories to begin. I searched the literature and worldwide-web to update and to add social costs. The estimated true costs for American Agriculture are presented in Table 1. This suggests a true cost for US agriculture and food of $1.9 trillion a year, this is almost double what Americans spend on food. The Rockefeller Foundation study of the food system was even more pessimistic, estimating true cost at $3.2 trillion. Detailed footnotes and discussion for my table at www.truecostalways.com.

Table 1. Estimated True Cost of American Agriculture

	Millions
1 Biodiversity loss cost	453,000
2 Cost related to subsidies related obesity 20% of $1.7 trillion	344,000
3 Reactive nitrogen leakage from agriculture	210,000
4 Terrestrial ecosystem function disruption	200,000
5 Lost livelihood underpaid, displaced, health and safety	134,000
6 Cost related to corn subsidies related diabetes 33% of $327 billion	107,000
7 Damage to aquatic ecosystems	90,000
8 Food pre and post production GHG at $100 ton	69,600
9 Resistance to anti-microbials	55,000
10 Fuel combustion CCG at $100 ton	40,400
11 Crop cultivation CCG at $100 ton	34,000
12 Value of lost soil 1.5 billion tons at $20 ton	30,000
13 Federal crop support and other programs, average 1995-2019	28,000
14 GHG emissions livestock at $100 ton	25,400
15 Cost related to cancer pesticide exposure 33% of $57 Billion	17,100
16 Drinking water treatment for N	14,250
17 Cost of food born illness	15,600
18 Other costs of undocumented farm workers 20% of $50 billion	10,000
19 Drug trafficking displaced farmers 5% of $193b	9,650
20 Cost to replace lost reservoir capacity	8,462
21 Cost related to fine particulates	4,800
22 Damage to recreation	4,457
23 Flood damage (10% attributed to agriculture)	3,200
24 Remittances by farm workers 10% of $28.8 billion	2,800
25 Compliance cost to collect taxes to pay subsidies	2,800
26 Bird kills from pesticides	2,200
27 Salinization of soil	2,000

28 Crop damage from air pollution related to agriculture	2,000
29 Habitat conversion 1 million acres, restoration cost as value $20,000 acre	2,000
30 Cost of undocumented farm worker medical care 20% of 10 billion	2,000
31 Subsidies for water and water project energy	2,000
32 Instream impacts:fisheries, preservation values	1,706
33 Pesticide resistance	1,500
34 Crop lost due to pesticides	1,400
35 Cost to water industry for added processes to remove pesticides	1,164
36 Water conveyance costs	1,106
37 Dead zone in the Gulf of Mexico 8,000 sq miles	1,000
38 Loss of beneficial predators from pesticide	934
39 Off-stream impacts: industrial users, steam power plants	616
40 Cost to navigation: shipping damages, dredging	474
41 Honeybee and pollination losses from pesticide use	283
42 Added cost for treatment of surface water for microbial pathogens	166
43 Facility infrastructure needs for pesticide treatment	157
44 Ethanol program subsidies	150
45 Harmful algal blooms	100
46 Cost to comply with hazard control rules	92
47 Fish kills due to pesticides	72
48 Consumptive water use	43
49 Fish kills from manure spills	17

Total true cost for agriculture and food	$1,936,699
True cost per acre	$2,152
Total farm and ranch million acres	900
Farm net income acre 2019	$88
Net loss acre	**$2,064**

A good year corn yield 200 bushels acre at $9	$1,800
After expenses	$1,405
Net loss acre	**$1,107**

Look for my book on **True Cost Accounting** available late in 2022.

Sources and assumptions for the true costs of American Agriculture

1. Biodiversity loss —Rockefeller Foundation estimate $453 billion.

Rockefeller Foundation. 2021. True Cost of Food: Measuring what matters to Transform the US Food System. July.

Biodiversity losses results from climate change, habitat destruction, air pollution, water pollution, pesticides, herbicides, nutrient overdose, dewatering wetlands riparian areas, and dropping groundwater levels. Pollution is a problem for aquatic systems. Biodiversity costs include the value of genetic diversity and its importance to develop more resistant cultivars. The biodiversity of Yellowstone hot springs led to many of todays genetic tools and understanding.

2. Obesity

Milken Institute. 2018. ScienceDaily. Oct. 30, 2018. Economic impact of excess weight now exceeds $1.7 trillion.

Costs include $1.24 trillion in lost productivity, according to study documenting role of obesity and overweight in chronic diseases. The estimate includes $480.7 billion in direct health-care costs and $1.24 trillion in lost productivity, as documented in America's Obesity Crisis: The Health and Economic Impact of Excess Weight (www.milkeninstitute.org/publications/view/944).

CDC. The prevalence of obesity was 42.4% in 2017~2018. From 1999–2000 through 2017–2018, the prevalence of obesity increased from 30.5% to 42.4%, and the prevalence of severe obesity increased from 4.7% to 9.2%. The estimated annual medical cost of obesity in the United States was $147 billion in 2008 US dollars.

Bocarsly, M. E., E. S. Powell, N. M. Avena, and B. G. Hoebel. 2010. High-fructose corn syrup causes characteristics of obesity in rats: increased body weight, body fat and triglyceride levels. Pharmacology Biochemistry and Behavior. 97(1):101–106.

High-fructose corn syrup (HFCS) accounts for as much as 40% of caloric sweeteners used in the United States. Translated to humans, these results suggest that excessive consumption of HFCS may contribute to the incidence of obesity.

Hernández-Díazcouder, A., R. Romero-Nava, R. Carbó, L. G. Sánchez-Lozada, and F. Sánchez-Muñoz. 2019. High fructose intake and adipogenesis. International Journal of Molecular Science. 20(11): 2787.

High fructose intake has an important role in the current obesity epidemic.

3. Reactive nitrogen leakage

Nitrogen pollution has a very detrimental impact on the biodiversity of land and water ecosystems. The Rothamsted long-term plots showed a decline from 33 to 3 species from added nitrogen. One way to estimate cost is to estimate treatment cost to avoid damage. The treatment for terrestrial nitrogen pollution is likely to prove to be difficult and costly. Offsetting damage from nitrogen pollution on the ground requires intensive and precise weed control. This is very costly and carries its own ecological risks. Careful herbicide application and hand weeding can cost several thousands dollars per acre per year. In Southern California intensive treatment would be required for natural areas, conservation lands, parks, and other protected areas and total costs might range up to $5 billion dollars, with nationwide costs likely to exceed $50 billion.

Allen, E. B., P. E. Padgett, A. Bytnerowicz, and R. A. Minnich. 1996. Nitrogen deposition effects on coastal sage vegetation of southern California. In Bytnerowicz, A., M.J. Arbaugh and S. Schilling, tech. coords. Proceedings of the international symposium on air pollution and climate change effects on forest ecosystems, Riverside, California. General Technical Report PSW-GTR 164, Albany, California, Pacific

Southwest Research Station, USDA Forest Service, http://www.rfl.pswfs.gov/pubs/psw-gtr-164/index.html

Ayers, R. U., W. H. Schlesinger and R. H. Socolow. 1997. Human impacts on the carbon and nitrogen cycles. pp. 121-156. In R. Socolow, C. Andrews, F. Berkhout and V. Thomas. Industrial Ecology and Global Change. Cambridge University Press, NY.

Bainbridge, D. A. 1997. The nitrogen pollution problem. Ecesis. 7(3):3-4.

Brenchley, W. and K. Warington. 1958. The Park Grass Plots at Rothamsted 1856-1949. Rothamsted Experiment Station, Harpenden. England

Kaiser, J. 2001. The other global pollutant: nitrogen proves tough to curb. Science 294(5545):1268-9.

Sobota, D. J., J. E Compton, M. L McCrackin and S. Singh. 2015. Cost of reactive nitrogen release from human activities to the environment in the United States. Environmental Research. Letters. 10 025006 National estimate of potential damages $210 billion year with $157 billion in costs related to agricultural sources.

4. Terrestrial ecosystem function disruption

Between 1997 and 2011, the world lost an estimated US$ 4-20 trillion per year in ecosystem services owing to land-cover change and US$ 6-11 trillion per year from land degradation. DB 10-30 trillion total.

5. Lost livelyhood

Job loss, underpaid, resources depleted. Rockefeller Foundation

6. Diabetes

The American Diabetes Association (March 22, 2018) estimating the total costs of diagnosed diabetes have risen to **$327 billion** in 2017 from $245 billion in 2012. Perhaps 1/3 due to food/farm/farm policy $107 billion.

7. Damage to aquatic ecosystems

The California State Water Board identified roughly 730 waterbody impairments in the Central Valley in 2010 with agriculture identified as the source of 269 of these impairments covering 1,572 waterway miles. Restoration costs run about $50,0000 per river mile. Control and restoration could cost $78 million — and require water diversion from agriculture to nature.

OECD (2019), Biodiversity: Finance and the Economic and Business Case for Action, report prepared for the G7 Environment Ministers' Meeting, 5-6 May 2019.

8. Food pre and post production CCG at $100 ton.

Tubiello, F. N., K. Karl, A. Flammini, et al. 2022. Pre- and post-production processes increasingly dominate greenhouse gas emissions from agri-food systems. Earth Systems Science Data. 14:1795–1809

9. Resistance to microbials

Dadgostar P. 2019. Antimicrobial Resistance: Implications and Costs. Infection and Drug Resistance. 12:3903–3910.

CDC estimate $55 billion a year.

10,11

Fuel combustion for pumping, transport, refrigeration, processing cultivation. EPA

12. Soil erosion

Uri, N. D. 2001. Agriculture and the environment – the problem of soil erosion. Journal of Sustainable Agriculture 16(4): 71–91. Suggests the cost of soil erosion from agriculture is $38 billion a year — $30 used to avoid double counting.

Pimentel, D., C. Harvey, P. Resosudarrmo, K. Sinclair, D. Kurz, M. McNair, S. Crist, L. Shpritz, L. Fitton, R.. Saffouri, R. Blair. 1995. Environmental and economic costs of soil erosion and conservation benefits. Science. 267:1117-1123.

Odgaard, A. J. 1987. Bank erosion contribution to stream sediment load. Iowa State Water Resources Research Institute Report No. 140. 31 million tons out of Iowa in rivers per year.

13. Farm subsidies

EWG. 2020. Farm subsidy database. https://farm.ewg.org

Since 1995 farmers have gotten $400 billion dollars. Direct crop subsidies, Marketing assistance, Counter-cyclical payments, Price supports (causing consumers to pay above world market price), Crop insurance (enabling farmers to take more risks), Disaster assistance (for when gambles go wrong), Conservation reserve payments, Water project subsidies, Energy project subsidies, Pollution abatement subsidies, Tariffs and trade barriers, Agricultural research subsidies, Tax and investment credits. *also* add also subsidies of un paid environmental and social external costs, War fighting to keep oil prices low.

14. CCG from livestock

EPA

15. Cost related to cancer, pesticide exposure

Overall $57 billion, perhaps 33% related to food and exposure.

16. Drinking water treatment costs for nitrate

Sobota, D. J., J. E. Compton, M. L McCrackin and S. Singh. 2015. Cost of reactive nitrogen release from human activities to the environment in the United States. Environmental Research. Letters. 10 025006.

17. Cost of food born illness

CDC Food borne illness is common, costly, and preventable. CDC estimates that each year 1 in 6 Americans get sick from contaminated food or beverages and 3,000 die from food borne illness. The US

Department of Agriculture (USDA) estimates that food borne illnesses cost the United States more than $15.6 billion each year.

Tegtmeier, E. M. and M. D. Duffy. 2004 had suggested just $525 million, just 3% of the more detailed estimate today.

18. Other costs of undocumented workers

Camarota, S. 2004. The High Cost of Cheap Labor: Illegal Immigration and the Federal Budget. Center for Immigration Studies. https://cis.org/Report/High-Cost-Cheap-Labor

Based on Census Bureau data, this study finds that, when all taxes paid (direct and indirect) and all costs are considered, illegal households created a net fiscal deficit at the federal level of more than $10 billion in 2002. They also estimated that, if there was an amnesty for illegal aliens, the net fiscal deficit would grow to nearly $29 billion.

Dudley, M. J. 2019. These US industries can't work without illegal immigrants. The Conversation. CBS News. https://www.cbsnews.com/news/illegal-immigrants-us-jobs-economy-farm-workers-taxes/ 53% of undocumented workers are in farming.

Richwine, J. and R. Rector. 2013. The Fiscal Cost of Unlawful Immigrants and Amnesty to the US Taxpayer. May 6. Report. The Heritage Foundation. Households headed by immigrants living in the US illegally impose a net fiscal burden of around $54.5 billion per year. This includes education, healthcare, justice system, etc.

19. Drug trafficking and crime related to displace farm workers from US exports of subsidized crops

Alexander, R. 2018. Want to understand the border crisis? Look to American corn policy. GrassrootsPR. https://thecounter.org/border-crisis-immigration-mexican-corn-nafta/

Between one and 3 million small farmers in Mexico and Central America had to leave their farms after subsidized corn from the US flooded the market. Some found the only economic opportunity was drug production and trafficking

20. Cost to replace reservoir capacity lost to sedimentation

Tegtmeier, E. M. and M. D. Duffy. 2004. External costs of agricultural production in the United States. International Journal of Agricultural Sustainability 2(1):1-20. adjusted for CPI by times 1.4.

21. Cost related to fine particulates

Bennett J. E., H. Tamura-Wicks, R. M. Parks, R. T. Burnett, C. A. Pope III, M. J. Bechle et al. 2019. Particulate matter air pollution and national and county life expectancy loss in the USA: A spatiotemporal analysis. PLoS Med 16(7): e1002856. https://doi.org/10.1371/journal.pmed.1002856

PM<2.5 pollution in excess of the lowest observed concentration (2.8 µg/m3) was responsible for an estimated 15,612 deaths (95% credible interval 13,248–17,945) in females and 14,757 deaths (12,617–16,919) in males. These deaths would lower national life expectancy by an estimated 0.15 years (0.13–0.17) for women and 0.13 years (0.11–0.15) for men. The life expectancy loss due to PM2.5 was largest around Los Angeles and in some southern states such as Arkansas, Oklahoma, and Alabama. At any PM2.5 concentration, life expectancy loss was, on average, larger in counties with lower income and higher poverty rate than in wealthier counties.

Tschofen,P. I., L. Azevedo and N. Z. Muller. 2019. Fine particulate matter damages and value added in the US economy. PNAS. 116(40):19857-19862.

Deryugina, T., G. Heutel, N. H. Miller, D. Molitor and J. Reif. 2019. The mortality and medical costs of air pollution: evidence from changes in wind direction. American Economic Review. 109(12):4178-4219.

Understanding how air pollution affects mortality, health care use, and medical costs is essential for crafting efficient environment policies, such as Pigouvian pricing. PM 2.5 decreased by 4.9 µg/m3 nationwide between 1999 and 2013. The estimate reported in column of Table 4 implies that such a decrease saved 235,374 life-years annually among the 44 million Medicare beneficiaries alive in 2013. If we assign each life-year a standard value of $100,000 each (Cutler, 2004), the mortality reduction benefits of this decrease added up to about $24 billion in 2013.

22. Lost recreational opportunity

Tegtmeier, E. M. and M. D. Duffy. 2004. External costs of agricultural production in the United States. International Journal of Agricultural Sustainability 2(1):1-20. adjusted for CPI by times 1.4.

Certainly a low estimate.

23. Flood damage related to agriculture

Wing, O., C. Kousky, J. Porter, P. Bates. 2022. New maps show US flood damage rising 26 percent in next 30 Years. The Conversation. January 31.

Flooding is the most common and costliest natural disaster in the United States, and its costs are projected to rise as the climate warms. Decades of measurements, computer models and basic physics all point to increasing precipitation and sea level rise. Today $32 billion nationwide.

Baumhardt, R. L., J. R. Dockal, G. L. Johnson, D. K. Brauer and R. C. Schwartz. 2020. Controlling stormwater runoff that limits water availability and dryland crop productivity. Frontiers in Sustainable Food Systems. 9 October. Sec. Water-Smart Food Production

Rainfall events exceeding 1 inch 25.5 mm practically always generated runoff. Sorghum fallow on a 1.8° slope runoff was 45 mm 1.7 inches. On a thousand acre field that is 141 acre feet or 45 million gallons.

Fallow farm land, channel straightening, and overgrazing contribute to faster runoff. Assume farms contribute 10% to US flood perhaps $3.2 billion

24. Remittances of farm workers

O'Brien, M., S. Raley and C. Ryan. 2019. The United States Loses $150 Billion Annually in Remittances. Issue Brief. Federation for Immigrant Reform. https://www.fairus.org/issue/workforce-economy/united-states-loses-$150-billion-annually in remittances. DB Undocumented farm workers may send $2.8 billion home annually in the form of remittances.

25. Administrative and compliance cost for taxes used to pay subsidies

$28 billion subsidy per year at 10% compliance cost $2.8 billion

All in all, tax compliance will cost the US economy $409 billion this year. Tax Foundation

Federal collection $4 trillion. About 10% for compliance.

26. Bird kills by pesticides

Pimentel, D. 2005. Environmental and economic costs of the application of pesticides primarily in the US. Environment, Development and Sustainability. 7: 229–252. $2.2 billion.

Deinlein, M. 1998. When it Comes to Pesticides, Birds are Sitting Ducks. Smithsonian's National Zoo. Jan. 01.

From songbird declines beginning in the 1940s, to population crashes of peregrine falcons, ospreys, and other predatory birds first detected in the 1960s, to the more recent deaths of over 5% of the world's population of Swainson's hawks during the winter of 1995, birds have been unwitting victims of pesticide contamination. It is estimated that of the roughly 672 million birds exposed annually to pesticides on US agricultural lands, at least 10%– or 67 million– are killed. This staggering number is a conservative estimate that takes into account only birds that inhabit farmlands, and only birds killed outright by ingestion of pesticides. Many will starve do to lack of food. If we say 100 million are killed at $22 each.

Tegtmeier, E. M. and M. D. Duffy. 2004. External costs of agricultural production in the United States. International Journal of Agricultural Sustainability 2(1):1-20. adjusted for CPI by times 1.4.

T&D Estimated $48 million in 2004 but now revised to $2.2 billion, this is 50 times more. Other figures would probably increase as much if detailed studies are done.

27. Soil salinization

Welle, P. D. and M. S. Mauter. 2017. High-resolution model for estimating the economic and policy implications of agricultural soil salinization in California. Environmental Research Letters. 12(9):1-17. 094010

Their median estimate was $3.7 billion just for California. Being more conservative I used $1 billion for California and $1 billion for other states. We can include S. L. Morford. 2009. Colorado River Basin Salinity. Bureau of Reclamation. Estimated future costs of $1 billion a year for the river basin.

Brennan, J., and M. Ulmer. 2010. Salinity in the Northern Great Plains, Natural Resources Conservation Service, Bismarck, ND 5.8 million aces affected in North Dakota Several other areas impacted by salinity and sodicity.

28. Air pollution effects on crops

Hong, C., N. D. Mueller, J. A. Burney et al. 2020. Impacts of ozone and climate change on yields of perennial crops in California. NatureFood 1:166–172. In California, their models suggest current production losses due to ozone damage can be as high as **$1 billion** (95% CI: US$0.5–1.3 billion) per year.

This framework also enables comparisons of each sector's contribution to gross domestic product (GDP) relative to its share of gross external damage. Damages dropped from 5.9% of GDP in 2008 to 4.2% in 2014. External damage from air pollution from agriculture is estimated at more than 230 billion dollars a year. **DB** almost 100 times the numbers suggested in this table. Agricultural GED is driven by ammonia and primary particulate matter damages, which are caused primarily by livestock emissions and fertilizer application (NH3), and field burning, as well as combustion emissions from agricultural equipment and other crop-related activities (primary PM<2.5).

29. Habitat conversion loss

EWG 1 million acres out of CRP or natural areas, $20,000 per acre restoration cost.

30. Cost of undocumented workers medical care

Perhaps 20% of 10 billion.

Moore, R. J. 2013. Care costs for undocumented immigrants absorbed by hospitals—Hospitals lump such costs into bad debt. Health Care Finance. Nov. 19.

https://www.healthcarefinancenews.com/news/care-costs-undocumented-immigrants-absorbed-hospitals

Since undocumented immigrants can't participate in the healthcare insurance exchanges created by the Affordable Care Act hospitals continue to pick up the cost of their care. According to Pew Research, there are approximately 10.5 million undocumented immigrants in the US The current cost of treating uninsured undocumented immigrants, primarily at emergency rooms and free clinics, is estimated at $4.3 billion annually, according to the Center for Immigration Studies. In California alone, where approximately 2.5 million residents are undocumented immigrants, the annual cost of unpaid hospital care is between $1 billion and $1.5 billion estimates the Hospital Association of Southern California. The unreimbursed cost of providing care for all uninsured or underinsured patients totaled a record-high $41.1 billion in 2011, according to the American Hospital Association.

Flavin, L., L. Zallman, D. McCormick, J. Wesley Boyd. 2018. Medical expenditures on and by immigrant populations in the United States: A systematic review. International Journal of Health Services, 48(4):601–621.

Nationally, from 2000 to 2009, undocumented immigrants -accounted for $96.5 billion of health care. Approximately 13% of undocumented immigrants had at least 1 uncompensated visit in a year - not much different than 11% of U.S.-born citizens. Many undocumented workers are primarily farm workers. In California estimates are still up to 75% of farmworkers.

31. Water and energy for water subsidies

Water in the West. Section I. Energy for Water. Stanford University https://waterinthewest.stanford.edu/sites/default/files/SectionI.pdf

2010 GWh farmer pumps 6 gwh, State Water Project 5.6, Colorado River Aqueduct 1.8, Central Valley Project 0.8 DB calculation - total energy for irrigation in California may be 14 GWh or 14 million KWh. If discounted 5¢ KWh that is $70 million dollars. The report concluded that the annual subsidy at historic cost with full cost recovery was $1.232 billion for the Bonneville Power Administration (BPA) and $505 million for the Western Area Power Administration (WAPA) in 1990. The subsidy at estimated market price of electricity was $213 million for the BPA and $1.2 billion for the WAPA. Federal power remains close to the cheapest power in any region of the country.

Klein, G. et al. 2005. The California's Water-Energy Relationship. 2005. November. CEC-700-2005-011-SF Water supply and treatment for agricuture 3,188 GWh End use agriculture 7,372 GWh 10,560 GWh electricity [at .007 tons kwh, 7,000 tons per GWh x10560 = 74 million tons CO_{2e}] 18 million therms Natural Gas [95,000 metric tons $C0_{2e}$] 88 million gallons of diesel [22,000 tons $C0_{2e}$] total 74 million tons CO2e = at $15 ton California price $1.1 billion and a Sweden's $100 ton $C0_{2e}$ $7.4 billion.

The State Water Project uses low−cost hydroelectric and recovery generation resources, but they only provide about 50 percent energy needs in an average water year. The SWP relies on the wholesale market and contractual resources with exposure to market price volatility for as much as 30 to 35 percent of its needs.

R. Cohen, G. Wolff, B. Nelson. 2004. Energy Down the Drain—The Hidden Costs of California's Water Supply. Natural Resources Defense Council.

Water subsidies reduce incentives for increasing efficiency and effectively increase the demand for water (thereby increasing energy use). Energy subsidies encourage transporting water over great distances and pumping groundwater from depths that would not be economically feasible if water users had to pay just the full costs of energy and water. For the Central Valley Project, energy and water charges vary widely from parcel to parcel, contractor to contractor. This makes it difficult to calculate the full value of the subsidies given to users of irrigation water. This difficulty helps keep the energy costs of water systems buried. Many California farmers have paid as little as $2 per acre-foot for water. In many cases they pay as little as 10 percent of the "full cost" of the water. Farmers are paying more now as contracts are revised (e.g., $35-50 per acre-foot). For new projects built or proposed by the Bureau of Reclamation, water costs can exceed $250 and may reach $500 per acre-foot.

DB**:** This results in millions and perhaps billions of dollars in subsidies but they are very hard to untangle.

The Bureau of Reclamation's Columbia Basin Project was selling power to irrigators for less than 4 percent of the market rate. To take advantage of this cheap power, some water districts in the CBP realized they could add low-head hydropower generators to their water canals and sell the energy. This practice reduces water conservation incentives even further because every drop of water added to the canals provides more hydropower profits for the district. The Bureau of Reclamation created a perverse incentive for intensive pumping, leading to excess water and energy use and unnecessary environmental impacts, all at the taxpayers' expense.

Irrigation water use in California https://en.wikipedia.org/wiki/California_State_Water_Project

The disparity of costs to the project's various constituents has been a frequent source of controversy. Although the overall average cost of SWP water is $147 per acre-foot ($119 per 1,000 m3), agricultural users pay far less than their urban counterparts for SWP water. The Kern County Water Agency (the second largest SWP entitlement holder) pays around $45–50 per acre-foot ($36–41 per 1,000 m3) of SWP water, which is mostly used for irrigation. The Metropolitan Water District of Southern California (the largest entitlement holder) pays $298 per acre-foot ($241 per 1,000 m3). Cities are subsidizing the cost of farm water, even though the cities also provided primary funding for the construction of the SWP. **DB** The subsidy from metro to farmer about $250 per acre foot ($300-$50) less transport cost.

32. Instream impacts, fisheries, preservation value

Tegtmeier, E. M. and M. D. Duffy. 2004. External costs of agricultural production in the United States. International Journal of Agricultural Sustainability 2(1):1-20. adjusted for CPI by times 1.4.

Bair, B. 2004. Stream restoration cost estimates. pp.104-113. in Proceedings of the Salmon Habitat Restoration Cost Workshop. S. T. Allen, C. Thomson and R. Carlson, eds. Pacific States Marine Fisheries Commission. Portland, Oregon.

Costs for bank stabilization on public lands within the Wind River range from approximately $46,000 to $222,000 per river mile. For channel rehabilitation, the USFS cost range from $41,000 to $137,000 per river mile with a mean of $86,000 per river mile. Riparian reforestation cost range from approximately $4,000 to almost $8,000 per mile, and with and average of $5,000 a river mile, or $110 per acre.

33. Pesticide resistance

34. Loss of crops to pesticide,

Pimentel, D. 2005. Environmental and economic costs of the application of pesticides primarily in the US. Environment, Development and Sustainability. 7: 229–252.

35. Cost to water industry for added treatment

36. water conveyance

Tegtmeier, E. M. and M. D. Duffy. 2004. External costs of agricultural production in the United States. International Journal of Agricultural Sustainability 2(1):1-20. adjusted for CPI by times 1.4.

37. Dead Zone

Union of Concerned Scientists. 2020. Reviving the Dead Zone—Solutions to Benefit Both Gulf Coast Fishers and Midwest Farmers. https://www.ucsusa.org/sites/default/files/2020-05/reviving-the-dead-zone.pdf External cost range $98 million to $2.8 billion. Two thirds of the nitrogen originates from cultivated crops, primarily corn and soybeans. https://water.usgs.gov/nawqa/sparrow/gulf_findings/faq.html#14

38. Loss of beneficial predators from pesticides

Tegtmeier, E. M. and M. D. Duffy. 2004. External costs of agricultural production in the United States. International Journal of Agricultural Sustainability 2(1):1-20. adjusted for CPI by times 1.4.

39. Off stream impacts

Tegtmeier, E. M. and M. D. Duffy. 2004. External costs of agricultural production in the United States. International Journal of Agricultural Sustainability 2(1):1-20. adjusted for CPI by times 1.4.

40. Cost to navigation, shipping, dredging

Tegtmeier, E. M. and M. D. Duffy. 2004. External costs of agricultural production in the United States. International Journal of Agricultural Sustainability 2(1):1-20. adjusted for CPI by times 1.4.

41. Honey bee and pollination losses from pesticide

Pimentel, D. 2005. Environmental and economic costs of the application of pesticides primarily in the US. Environment, Development and Sustainability 7: 229–252. $283 million US for pollination loss.

The major economic and environmental losses due to the application of pesticides in the USA were: public health, $1.1 billion year; pesticide resistance in pests, $1.5 billion; crop losses caused by pesticides, $1.4 billion; bird losses due to pesticides, $2.2 billion; and groundwater contamination, $2.0 billion.

The annual market value of crops dependent on animal pollination ranges from US$ 235 billion to US$ 577 billion.

42. Treatment of surface waters for microbial contamination

Tegtmeier, E. M. and M. D. Duffy. 2004. External costs of agricultural production in the United States. International Journal of Agricultural Sustainability 2(1):1-20. adjusted for CPI by times 1.4.

43. Facility infrastructure needs for pesticide removal

Tegtmeier, E. M. and M. D. Duffy. 2004. External costs of agricultural production in the United States. International Journal of Agricultural Sustainability 2(1):1-20. adjusted for CPI by times 1.4.

44. Ethanol program subsidies

Hahn, R. and C. Cecot. 2009. The benefits and costs of ethanol: an evaluation of the government's analysis. Journal of Regulatory Economics. 35:275–295.

Because almost all of the current ethanol produced for fuel in the US is made from corn, ethanol producers also benefit from the federal subsidies given to corn. The International Institute for Sustainable Development estimates that about 15% of the total subsidy to ethanol comes from ethanol's share of corn producers' subsidies, which is about $1 billion annually. $150 million.

45. Harmful algal blooms

Schechinger, A. 2020. The High Cost of Algae Blooms in US Waters. EWG August 26.

$1 billion in 22 states. Assume 10% from farms. perhaps $100 Million.

46. Cost to comply with hazard control rules.

Tegtmeier, E. M. and M. D. Duffy. 2004. External costs of agricultural production in the United States. International Journal of Agricultural Sustainability 2(1):1-20. adjusted for CPI by times 1.4.

47. Fish kills pesticides

Tegtmeier, E. M. and M. D. Duffy. 2004. External costs of agricultural production in the United States. International Journal of Agricultural Sustainability 2(1):1-20. adjusted for CPI by times 1.4.

For example, a neonicotinoid insecticide may not have a direct effect on the fish populations within a river or lake, but there may be a direct effect on the aquatic invertebrate community which may be an essential source of food for certain fish species.

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48. Consumptive water use

USDA $43 million. This deserves a closer look.

49. Fish kills from manure

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