Bad Choices in Our Food System

Bad Choices in Our Food System

By

Lydia Zepeda

Cambridge Scholars Publishing

Bad Choices in Our Food System

By Lydia Zepeda

This book first published 2021

Cambridge Scholars Publishing

Lady Stephenson Library, Newcastle upon Tyne, NE6 2PA, UK

British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library

ISBN (10): 1-5275-6466-5
ISBN (13): 978-1-5275-6466-4

To Steve, never patient, though helpful,
and sadly, rarely wrong

TABLE OF CONTENTS

List of Figures

LIST OF TABLES

ABBREVIATIONS

2,4-D	2,4-dichlorophenoxyacetic acid, a herbicide
ABC	Attitude, Behavior, Context theory
ADHD	attention deficit hyperactivity disorder
AL	Alabama
AQUASTAT	FAO's global information system on water and agriculture
AR	Arkansas
ARC	Agriculture Risk Coverage, a US Farm Bill farm subsidy program
BE	Belgium
BLS	Bureau of Labor Statistics of the US
BMI	body mass index
CA	California
CAFO	concentrated animal feeding operation
CDC	Centers for Disease Control and Prevention of the US
CEO	chief executive officer
CFBAI	Children's Food and Beverage Advertising Initiative
CO	Colorado
CO2	carbon dioxide
CO2e	carbon dioxide equivalent
COVID-19	corona virus disease 2019
CPI	consumer price index
CRP	Conservation Reserve Program of the USDA
CRS	Congressional Research Service of the US
CSA	community supported agriculture
CSP	Conservation Stewardship Program of the USDA
CVD	cardiovascular disease
DDT	dichlorodiphenyltrichloroethane
DHHS	Department of Health and Human Services of the US
e. coli	escherichia coli, a common bacteria in the intestines of humans and animals
ELM	Elaboration Likelihood Model
EPA	Environmental Protection Agency of the US
EQIP	Environmental Quality Incentives Program of the USDA
ERS	Economic Research Service of the USDA
EU	European Union

EURO	Regional office of WHO for Europe
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	FAO food and agriculture data
FAS	Foreign Agriculture Service of the USDA
FAV	fruits and vegetables
FDA	Food and Drug Administration of the US
FMI	Food Marketing Institute
FNS	Food and Nutrition Service of the USDA
FQPA	1996 Food Quality Protection Act of the US
FY	fiscal year
g	grams
GA	Georgia
GBD	Global Burden of Diseases collaborative group
GBP	glyphosate based product
GDP	gross domestic product
GHG	greenhouse gases
GNI	gross national income
H1N1	influenza A virus (1918 flu and 2009 swine flu pandemics)
H2-A	visa for temporary agricultural workers in the US
H5N1	influenza A virus, avian influenza
ha	hectare
HFCS	high fructose corn syrup
HMO	health maintenance organization
IA	Iowa
IARC	International Agency for Research on Cancer of WHO
ICE	Immigration and Customs Enforcement of the US
ID	Idaho
IL	Illinois
IN	Indiana
IOM	Institute of Medicine of the US
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IQ	intelligence quotient
IRS	Internal Revenue Service of the US
K-12	kindergarten through 12th grade; US elementary and secondary education
kg	kilograms
km	kilometers
km^2	kilometers squared
km^3	kilometers cubed
KS	Kansas

KY	Kentucky
LA	Louisiana
MA	Massachusetts
MERS	Middle Eastern Respiratory Syndrome (viral infection)
MI	Michigan
MMT	million metric tons
MN	Minnesota
MO	Missouri
MS	Mississippi
MT	metric tons
MT	Montana, Figure 2.4 only
MyPlate	US nutrition guidelines
NASA	National Aeronautics and Space Administration of the US
NASS	National Agriculture Statistics Service of the USDA
NC	North Carolina
NCFH	National Center for Farmworker Health
n.d.	no date
ND	North Dakota
NE	Nebraska
NHL	non-Hodgkin lymphoma
NJ	New Jersey
NY	New York
OECD	Organisation for Economic Cooperation
OH	Ohio
OK	Oklahoma
PA	Pennsylvania
PLC	Price Loss Coverage, a US Farm Bill farm subsidy program
POP	persistent organic pollutant
pppd	per person per day
R&D	research and development
RMA	Risk Management Agency of the USDA
SD	South Dakota
SDG17	WHO's 17 sustainable development goals for 2030
SDT	Self Determination Theory
SNAP	Supplemental Nutritional Assistance Program, program that provides money for food assistance to poor Americans
TX	Texas
UK	United Kingdom
UNEP	UN Environment Programme
US	United States of America
USDA	United States Department of Agriculture

WA	Washington State
WHO	World Health Organization
WI	Wisconsin
WIC	Women, Infants, and Children nutrition program of USDA
WWI	World War I
WWII	World War II

CHAPTER ONE

BAD CHOICES

The simple act of eating reflects our choices, policy, and culture. It also affects our health, economy, environment, and society in ways we often do not understand.

Introduction

We live in a time when we have the most knowledge about nutrition that we have ever had. Yet diet is implicated in one in five deaths worldwide (GBD2017 Diet Collaborators, 2019) and diet-related illnesses are the leading cause of death in the US (The US Burden of Disease Collaborators, 2018). How is it that we have the most knowledge and yet the worst diets?

Many people claim that it is because nutrition information is confusing, contradictory, or too complex. The food industry has been behind research that has tried to muddy the waters and it has lobbied to make nutritional information less transparent (Nestle, 2002, 2006). However, despite this, the core advice has been consistent for decades: limit overall calories, sugar, and fats; obtain a greater portion of our diet from fruits, vegetables, and whole grains; and get regular exercise. This sensible advice has been drowned out by the advertising of unhealthy foods, cooking shows, the media, and fad diets. It is easy to ignore the rational, consistent voice of reason against the hype of "miracle diets" and the promotion of "food porn." Everyone wants an easy solution.

The truth is more complicated. Indeed, blaming diet exclusively for our food-related health problems is simplistic. Other factors include lack of exercise; being too sedentary; too much or too little sleep; too much screen time; gut flora; and genetics. However, this book focuses on dietary choices and the role the food system has had in shaping those choices because we are presented with more temptations every day. Restaurants advertise new variations of food that add even more bacon or cheese. Food manufacturers advertise new junk foods and beverages, and variations of existing ones.

Cooking shows, blogs, and books promote new foods and ingredients. Social media addicts post their meals. Across all platforms, what the foods seem to have in common are empty calories. The sheer noise, prevalence, and attention given to unhealthy foods reinforce unhealthy eating habits.

Yet when we fail to lose weight or get our blood sugar under control, we are told it is our fault; we lack sufficient self-control. Is it possible that everyone lacks self-control? Unhealthy diets occur in all countries and across all income levels. Globally, we eat too much sodium, sugar, processed meat, and red meat, and too few nuts, seeds, fruits, and whole grains (GBD 2017 Diet Collaborators, 2019). This points to a systemic problem in the composition and quality of our diets. Why is this so?

In part, the sheer abundance and availability of food contribute to overeating. It is predictable that if food is cheap, we will eat more of it. In many parts of the world, people spend a significant amount on food, but despite this, obesity is now a global problem. However, nowhere is food so relatively cheap as in the US; in 2018, food eaten at home made up only 7.3% of household expenditure (US BLS, 2019). We spent more on healthcare: 8.1% of household expenditure.

In theory, our demand for food should be relatively inelastic because our stomachs have a limited capacity. A closer look at our food might explain why we are ingesting and absorbing more calories—our food is increasingly refined, digestible, and high in calorie density. Despite this, we may not feel fuller, even though our foods and beverages are packed with fat, sugar, alcohol, and salt. Processing, cooking, refining, juicing, and grinding our foods increase the digestibility and availability of those calories for our bodies. The processes may also make foods easier and quicker to eat, so that we eat too much before feeling full. Add to that the distraction of screens when eating, and we may simply not notice that we are full until we have eaten more than we intended. The result is not only that we eat more, but our bodies may also have to work less to absorb more calories, due to foods being highly processed. Also, we may be too sedentary and lack adequate exercise. We also consume large amounts of beverages, full of sugars and alcohol. While they are full of empty calories, they are easy to consume, do not make us full, and may even stimulate our appetites.

In addition, food is all around us, and has found its way into places where it never used to exist. Food can be purchased online and delivered, any time of day, in virtually any place. Mealtimes are moot, eating at a table is passé,

and eating with others means looking at one's phone or a screen. We may rarely eat with others in our homes; table manners and the accompanying implicit restraints and pacing of food consumption now constitute a lost art. We do not eat meals, rather, we eat continuously. There are no limits to when or where we eat. We eat in cars, on public transport, during work time, in bed, and while exercising. It would appear that going an hour without eating is impossible. We are distracted when eating, oblivious to what we consume while looking at our phones or other media.

Unsurprisingly, the continuous eating of calorie-dense foods and beverages, the lack of exercise, and the fact we are sedentary result in weight problems, obesity, hypertension, heart disease, type 2 diabetes, strokes, and cancers. The individual is blamed for these diet-related problems and assumed to have the self-control of a two-year-old. Doctors prescribe pills, insulin pumps, and surgery, believing patients are incapable of changing their behavior. People turn to technology, like phone apps and Fitbits, to remind them to achieve their steps, tell them what and when to eat, or help them to sleep. These approaches digitize the well-known principles of behavior change: monitoring, accountability, and support. Anyone familiar with 12-step programs knows how effective real people are in promoting behavior change using these principles, without technology, and at no cost. However, there is money to be made by selling us technology and apps to accomplish what people and culture used to do. There is not just the initial purchase price of the technology, but all the information about our behaviors is collected and sold to third-party companies to target advertising.

While personal choice is often blamed as the cause of our diet-related problems, unlike alcohol or other addictions, one cannot break a food addiction by living in a food-free environment. We need to eat. We must be around food. Our diets may be associated with many health complaints: we are overweight, we feel bloated, we cannot sleep, we are constipated or gassy, we experience pain, and we may find it difficult to simply move. There is an industry who claims to have the perfect diet to lose weight or feel better. This involves fad foods, fad diets, superfoods, fad food preparation, etc. The sad truth is boring by contrast: avoid processed foods; eat regular meals; control portion size; exercise; spend less time sitting and in front of screens; and repeat as long as you wish to live. Diets do not work because they are temporary. However, telling people they need to change what they eat and how they live forever runs counter to the desire for an easy, miracle cure. This is the irony of blaming personal choice; we simultaneously tell people they can "cure" their food-related problems by a

short-term change or by adding a fad food. Essentially, we give them tools of personal choice that cannot work.

In addition, we fail to acknowledge how our food choices, sedentary behavior, and lack of activity are influenced by external factors. Much has been written about "food deserts" as a cause of poor eating habits. While many non-profits, healthcare providers, and policymakers assume that the lack of grocery stores causes poor eating habits, reviews of the research do not provide conclusive evidence to support this (Caspi, Sorensen, Subramanian, and Kawachi, 2012; Feng, Glass, Curriero, Stewart, and Schwartz, 2010).

The placement of grocery stores may be as segregated as housing in the US, and even stores in the same chain may carry different items in different neighborhoods. However, while some stores have more and better produce, more than half of all produce harvested in the US is wasted and 45% of all produce harvested globally is wasted (FAO, 2011). In the US, shoppers spend less than 1% of their household budget on fresh produce; US households spend about the same amount on prescriptions, and they spend nearly twice as much on cell phone services (US BLS, 2019). What people do spend their money on is food away from home: 44% of US household food purchases relate to food eaten away from home. It would appear that it is not just people who live in food deserts who make bad choices; everyone is making bad choices.

Looking at grocery stores, it is not hard to see why people make bad choices. There are over 38,000 grocery stores in the US; they average over 41,000 square feet and carry over 33,000 items (Food Marketing Institute, 2019). Most of these items are highly processed (Toops, 2017). In a study of ten countries, 41% of all shelf space was dedicated to soda and junk food, and the greater the shelf space devoted to unhealthy foods, the higher the national BMI (Norman, Hoffman, and Cheskin, 2014). In the US, processed foods account for over three-quarters of calorie intake (Poti et al., 2015). We consume processed food because that is what is available.

If you walk through a typical grocery store, you will see the space devoted to processed foods. In the US, there are entire aisles devoted to frozen pizzas, ice cream, sodas, chips, or cookies. One side of the store wall is usually covered with meats, another with dairy products. Fruits and vegetables are usually placed near the entrance, so one walks through them, conveying a sense of healthiness. At the checkouts, shoppers pile up their

purchases of frozen pizzas, soda, ice cream, cookies, and salty snacks. For the convenience of customers too large to walk, stores now provide electric carts to transport shoppers.

To identify what people do buy, one need only look at the shelf space devoted to processed foods. Sales are calculated in terms of floor space or shelf space (Hudson, 2018). Stores charge brands for the space and location of their products. These "slotting fees" make up 2% of grocery store sales (Achrol, 2012). Brands must pay to ensure that their products are not only in stores, but visible, with higher charges for products at eye level. Slotting fees are an important component of grocery retail profitability since their profit margins are so low: only 1.2% after taxes (FMI, 2019).

Somehow, the grocery shopper is supposed to overcome the fact that they are faced with bad choices because nutritional advice tells us what we should eat. However, you have to understand the jargon and the way the information is presented to use the information correctly. The food pyramid tried to present recommended servings of different food groups without being clear about what a serving was. Ironically, in the US, at a time when hardly anyone eats off a plate, MyPlate has been proposed as a means to convey serving size. While the food pyramid recommended moderation in consuming fatty or sugary foods and beverages, MyPlate obfuscates the issue by omitting any mention of junk foods. The omission leaves the eater thinking, "If I eat what MyPlate recommends, I will be healthy, regardless of what I eat in addition." This may simply encourage more overeating because junk foods are invisible and hence not counted.

The prevalence of eating out and the consumption of processed foods further confuse consumers. We assume items are sold in serving sizes. Nothing could be further from the truth; when you read the labels of processed foods, you may be surprised that a product has 2.3 servings, or that a serving size is 1.5 cookies. Restaurants routinely serve twice or more the recommended serving size of meat and never seem to come close to the recommendations for fruits and vegetables or whole grains. If we are never offered a healthy diet, how can we choose it? How are we even to recognize it?

So, are shoppers unable to choose healthy foods? Are they misinformed? Are they being manipulated? Or are they merely being rational by choosing the cheapest foods? The answer is yes to all of these and that is why food-related illnesses continue to rise. It is not simply a matter of personal choice,

or even of policy; it is these factors interacting with culture that is at the heart of the current crisis. We have worked very, very hard and very, very long to get to where we are. This book explores the paths that have led to our current crisis and identifies how we might be able to find a new path.

Food-related illnesses, the environment, and societal problems are tied to the policies and culture that influence consumers' food choices. The individual makes food choices within this context, but our choices are both influenced by and reinforce the status quo. To change food choices, we need to examine the co-dependency between food and agricultural policy and consumers' choices and health impacts. This is done by drawing from empirical data and findings on the health, environmental, and societal impacts of food and agriculture; consumer theory; the history of agricultural policy; cultural trends; and current policies.

One limitation of this book is the focus on the US. This is in part because the US has been a leader in industrializing its agricultural and food systems, and is also leading the way in food-related illnesses, but mostly because a writer should write about what they know. For those desiring a more global perspective, either take the US example as a warning or invite me to see how things function in your country.

The intention of this book is to provide a resource, both to inform the individual and to use in the classroom. Data and sources are used to ensure the findings are evidence-based and transparent. The content can be summarized as follows. Chapter Two describes our food system: the resources it uses, its role in our economy, and the impacts it has on our health and environment. Chapter Three examines how we got here, with a focus on US agricultural policy and the rise of the international agro-food industry. Chapter Four examines the health, environmental, and social costs of our global food system. Chapter Five examines social, cultural, and economic trends in food and agriculture. Chapter Six identifies economic, psychological, marketing, and sociological theories that explain why we choose the foods we do. Chapter Seven looks at the role of non-profits in creating a healthier, more environmentally sustainable, and socially just food system. Chapter Eight examines the role of government policies in creating a food system that is aligned with health and environmental objectives. Chapter Nine, the Epilogue, looks at why we blame the individual and why we avoid examining policy solutions. The purpose of this book is to provide information about our current food system: what it

is; how it came to be; how it influences what we eat and our health; and what we can do about it.

Exercise: Honor a home cook

Rather than looking to strangers and paid professionals as your heroes, honor someone who has cooked a healthy meal for you, despite the food system we are in. Maybe that person is you. Reflect a minute on why our food heroes are strangers who profit from us rather than the people who feed and love us.

References

Achrol, R. S. 2012. Slotting allowances: a time series analysis of aggregate effects over three decades. Journal of the Academy of Marketing Science, 40(5), 673–694. doi:10.1007/s11747-011-0260-7.

Caspi, C. E., Sorensen, G., Subramanian, S. V., and Kawachi, I. 2012. The local food environment and diet: A systematic review. Health & Place, 18: 1172–1187. http://dx.doi.org/10.1016/j.healthplace.2012.05.006, accessed May 20, 2016.

FAO. 2011. Global Food Losses and Food Waste. http://www.fao.org/3/a-i2697e.pdf, accessed November 15, 2019.

Feng, J., Glass, T. A., Curriero, F. C., Stewart, W. F., and Schwartz, B. S. 2010. The built environment and obesity: A systematic review of the epidemiologic evidence. Health & Place, 16: 175–190. doi:10.1016/j.healthplace.2009.09.008.

Food Marketing Institute. 2019. Supermarket Facts. https://www.fmi.org/our-research/supermarket-facts, accessed November 25, 2019.

GBD 2017 Diet Collaborators. 2019. Health effects of dietary risks in 195 countries, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. The Lancet, 393, May 11, https://www.thelancet.com/gbd, accessed November 14, 2019.

Hudson, M. 2018. 8 ways to measure retail performance and productivity. The Balance. https://www.thebalancesmb.com/measuring-retail-performance-and-productivity-2890277, accessed November 25, 2019.

Nestle, M. 2002. Food Politics: How the Food Industry Influences Nutrition and Health. Berkeley, CA: The University of California Press.

Nestle, M. 2006. What to Eat. New York: North Point Press.

Norman, M., Hoffman, J. and Cheskin, L. J. 2014. Shelf space devoted to nutritious foods correlates with BMI. American Journal of Food and Nutrition, 2(2), 18-22. doi:10.12691/ajfn-2-2-1.

Poti, J. M., M. A. Mendez, S. W. Ng, and B. M. Popkin. 2015. Is the degree of food processing and convenience linked with the nutritional quality of foods purchased by US households? American Journal of Clinical Nutrition, 101(6), 1251–62.

Toops, D. 2017. Chapter 2: How did the food industry get (from there) to here? Accelerating New Food Product Design and Development, Second Edition. Edited by J. H. Beckley, L. J. Herzog, and M. M. Foley. Hoboken, NJ: John Wiley & Sons Ltd and the Institute of Food Technologists. http://www.ift.org/~/media/Knowledge%20Center/Publications/Books/Samples/IFTPressBook_ANFPDD_Chapter1.pdf, accessed November 15, 2019.

The US Burden of Disease Collaborators. 2018. The state of US health, 1990-2016: Burden of diseases, injuries, and risk factors among US states. Journal of the American Medical Association, 319(14), 1444–1472. doi:10.1001/jama.2018.0158.

US BLS (Bureau of Labor Statistics). 2019. Consumer Expenditure Survey. Table 1101. Quintiles of income before taxes: Annual expenditure means, shares, standard errors, and coefficients of variation. Consumer Expenditure Survey, 2018. https://www.bls.gov/cex/2018/aggregate/quintile.pdf, accessed November 15, 2019.

CHAPTER TWO

WHAT IS OUR FOOD SYSTEM LIKE?

There is a lot of talk about our food system, but what exactly is it? This chapter examines how much land and water are used by agriculture and what crops and animals we raise. What do we actually eat? How much does our food system contribute to our economy? How much do we spend on food?

Let's start with some basic information about our food system and land use. Roser and Ritchie (2018) estimate that of the 149 million square kilometers of land on Earth, 71% is habitable, and the rest is barren or covered with glaciers. Of the habitable land, 50% is used for agriculture and the rest is covered in forest (37%), shrubs (11%), manmade structures (1%), or freshwater (1%). That means 5.1 billion hectares of land are used for agriculture. Of this, 4 billion hectares are used for livestock and their feed, while only 1.1 billion hectares are used for crops for human use globally. Thus, crops for human consumption use only 23% of the total agricultural land, yet they provide 83% of global caloric intake and 67% of global protein intake.

While much of the agricultural land used for animals is only suitable for pasture or animal production, one-third of all cropland is used to produce animal feeds (FAO, 2012). Almost all the pastureland is used by ruminants like cattle and sheep, yet the largest source of meat globally by weight is from pigs, followed by chickens (FAO, 2019). Pigs and chickens are largely raised in confinement on feeds, while ruminants are kept largely for milk production and for fattening prior to slaughter for meat.

Globally, there is less than one hectare of agricultural land per person (Roser and Ritchie, 2018). Most of that land (77%) is devoted to livestock and their feed; therefore, arable land for crops for human consumption is about 0.2 hectares per person. While that may sound like very little, it is worth noting how productive agricultural land is. The average yields for maize (corn) are 5.8 metric tons per hectare (FAS, 2018), implying 0.2 hectares of maize

would produce 3.2 kilos of maize (almost 7 pounds) per person per day (pppd) or almost 2.5 kilos of rice (5.4 pounds) pppd, far more than a person could eat. Given this productivity, the OECD and the FAO predict demand for commodities to be stable over the next decade (OECD, 2018), despite population growth. They also predict that the real prices for most foods will fall. That is largely because agricultural productivity is expected to continue to rise, albeit more slowly.

What does our global agricultural landscape look like? Cereals comprise 65% of all cropland (Roser and Ritchie, 2018). Four crops make up almost half of the cereal cropland (FAOSTAT, 2018): wheat, maize, rice, and soybeans (Figure 2.1). The crop that uses the most land is wheat: 216 million hectares globally, an area the size of Greenland. Maize or corn is second, 188 million hectares globally, somewhat smaller than the entire area of Mexico. Rice is third, at 163 million hectares, somewhat bigger than the size of Mongolia. The global area planted with soybeans is roughly the size of Peru: 128 million hectares.

Given the yield differences per hectare between maize and wheat, the global production of maize is much larger than that of wheat (Table 2.1). The US and China together produce 57% of the world's maize; Brazil is a distant third with less than 9%. Wheat production is much less concentrated because it is widely distributed across many countries. The country with the largest wheat production is China—at 132.5 million metric tons (MMT) in the 2018-19 growing season, it produced 18% of the world's wheat (USDA FAS, 2018). India was the second-largest wheat-producing nation, with almost 100 MMT, followed by Russia at 70 MMT. The 28 nations of the European Union (EU) together produced 137 MMT of wheat. The US is estimated to produce about 7% of global wheat production at 51.3 MMT.

The third-largest crop worldwide in terms of area and yield is rice, with China and India producing 51% of global production by weight. The US produces less than 1.5% of global rice production. Two-thirds of the world's soy, the fourth largest crop, is produced in the US and Brazil. China is a small player, producing only 16 MMT.

Figure 2.1 Global plantings of the top 12 crops, 2016 (million hectares).

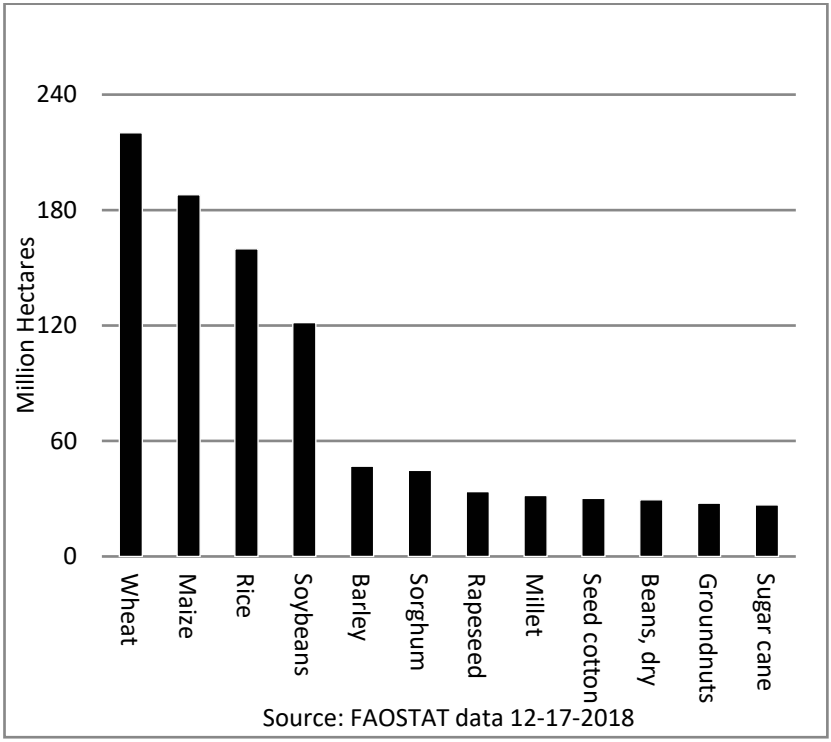

Table 2.1 Crop production, USDA predictions in million metric tons (December prediction 2018-2019).

	World	US	China	Next Largest
Wheat	733.4	51.3 7%	132.5 18%	99.7 India 13.6%
Maize	1100	371.5 34%	256 23%	94.5 Brazil 8.6%
Rice	491.4	6.9 1.4%	143.6 29%	111 India 22.6%
Soybeans	369.2	125.2 34%	16 4.3%	122 Brazil 33%

Source: USDA FAS, 2018.

All fruits make up 4.7% of global cropland, and all vegetables 4.1% (FAOSTAT, 2018). So, fruits and vegetables (FAV), excluding tubers, comprise 8.8% of cropland, about the same area as is planted with soybeans. Putting this in perspective, US dietary recommendations (MyPlate) suggest that 50% of one's food intake should be FAV. Yet the land used to produce FAV makes up less than 9% of global cropland and less than 3% of all agricultural land. What would our landscapes look like if agriculture followed nutritional guidelines?

In addition to land, agriculture is water intensive. It uses the most water of any human activity. Estimates for 2010 indicate agriculture used 69% of all water withdrawals (FAO AQUASTAT, 2016), while the World Bank estimates that agriculture uses 70% of global freshwater (Khokhar, 2017). It is estimated that animal production, including animal feed, comprises 29% of total water usage (Mekonnen and Hoekstra, 2012). Water usage for animal production comes largely from producing crops for animal feeds.

Agricultural production is expected to continue to increase, but more slowly, driven by improvements in productivity, rather than the expansion of land use (OECD/FAO, 2018). Real prices are expected to fall for cereals, oilseeds, dairy, and meat over the next decade. Trade volumes are expected to slow down and exports will continue to be concentrated in a few countries, with five countries selling more than 70% of all exports for 18 of the 19 top commodities.

What is striking about agriculture is the amount of food waste. It is estimated that globally, one-third of all food produced is wasted: 58% of fruits and vegetables, 40% of fish and seafood, 37% of cereals, 23% of meat, and 18% of milk (FAO, 2011). In the US, estimated food waste is even higher at 40%, which is equivalent to US$ 165 billion per year or 20 pounds (9 kilos) of food per person per month (Gunders, 2012). In Europe and North America, over a third of this waste occurs after consumers purchase the food, while in developing countries, much of the waste occurs between production and retail sale (FAO, 2011).

Food waste has massive environmental consequences. The carbon footprint of global food waste is estimated at 3.3 gigatons, a larger CO2 equivalent than any country except China or the US (FAO, 2011). The blue water footprint (surface and groundwater) used to produce global food waste exceeds the amount of water used by any single country, and the amount of land needed to produce global food waste exceeds the territory of any single

country except Russia (FAO, 2011). This means that the land and water used to produce wasted food contributes to deforestation, habitat loss, and species extinction, and all for nothing because the food produced is not eaten.

So, when we think about our food system, think about how agriculture is incredibly productive, and also massively wasteful; a third of production globally is wasted, while 40% of the food produced in the US is wasted. Our food system also dominates land and water use. Globally, our food system uses half of the habitable land, and most of the world's water, with animal production using over three-quarters of that land and about a fifth of the global water footprint.

What foods do we produce with our food system?

It is estimated that there were 7.7 billion people in the world in November 2018. The population is expected to continue to rise to about 11 billion by the end of the 21st century (Roser and Ortiz-Ospina, 2017), with population growth slowing and leveling off. The OECD and the FAO (2018) predict food demand will grow from 1.6 billion MT in 2015-17 to 1.9 billion MT in 2027, with 30% of the additional demand for food due to China. The OECD/FAO predict a 2% increase in per capita cereal demand over ten years; 3% for meat and fish; and the strongest growth for poultry at 5.5%. Demand for sugar will be driven by developing countries because consumption is already very high in OECD countries (over 30 kg per capita per year). The OECD and the FAO identify population as the main cause for increased food demand, even though population growth is slowing.

While wheat and rice are largely used for human consumption, much of the worlds' maize, soy, and coarse grains are used for animal feed. In the US, estimates for the conversion of maize weight to beef weight gain vary considerably: from 5:1 to 9:1, with a target of 6:1 (CSU, n.d.). Using data from Peters et al. (2014), the ratio of maize to edible meat (rather than weight gain) is 5.3:1 for beef, 3.9:1 for pork, and 2.8:1 for chicken. The conversion rate of feed to meat is the reason that it takes so much more land to produce the same amount of protein or calories from meat than from plants. Plants are much more efficient at producing calories and protein than animals are.

The FAO estimated the number of animals globally in 2016 as 23 billion chickens, 1.5 billion cattle, 1.2 billion ducks, 1.2 billion sheep, 1 billion goats, 982 million pigs, plus assorted turkeys, geese, rabbits, buffaloes, etc. (FAOSTAT, 2018a). This is equivalent to three chickens per person, one cow for every five people, one sheep and one duck for every six people, a goose, guinea fowl, turkey, rabbit or hare for every seven people, and one pig and one goat for every eight people. This gives the impression of ample meat available per person globally. The average person consumed about 43 kilos of meat (beef, chicken, pork, lamb, etc.) in 2014, more than twice as much as in 1961 (Ritchie and Roser, 2017).

However, meat consumption is distributed unequally. Industrialized countries account for 15% of the world's population, but 40% of the world's milk consumption and 37% of the world's meat consumption (FAO, 2003). To illustrate the unequal distribution of meat (beef, pork, chicken, etc.) consumption, in 2013, Australians were the biggest meat eaters, consuming 116 kilos (256 pounds) per person per year (Table 2.2), while in India, the average amount of meat eaten was four kilos (less than nine pounds) per person per year (Ritchie and Roser, 2017). Fish and seafood consumption ranged from five kilos (11 pounds) per person per year in India to 35 kilos (77 pounds) per person per year in China. Milk consumption varied from 15 kilos (33 pounds) per person per year in Indonesia to 255 kilos (562 pounds) per person per year in the US. Egg consumption varied from three kilos (less than seven pounds) per person per year in India to 19 kilos (almost 42 pounds) per person per year in China.

Using a boneless meat equivalent, the USDA ERS (2018a) estimates that in 2016, Americans ate a total of 191.6 pounds (86.9 kilos) per capita of meat, poultry, fish, and shellfish. In terms of composition, chicken was the most prevalent at 63.1 pounds (28.6 kilos), followed by 52.9 pounds (24 kilos) of beef, 46.6 pounds (21.1 kilos) of pork, 14.9 pounds (6.8 kilos) of fish and shellfish, and 13.1 pounds (5.9 kilos) of turkey. Compare the 191.6 pounds (86.9 kilos) of boneless flesh eaten to the weight of the average American adult male, 197.9 pounds (89.8 kilos), and the average American adult female who weighed 170.6 pounds (77.4 kilos) in 2015-16 (Fryar et al., 2018). This means that, on average, Americans ate more than their weight in animal flesh in 2016. This equals in excess of a half-pound (227 grams) of meat per person per day. For the average adult woman or man, that is 70% more protein than the recommended daily allowance (MyPlate, 2018), without taking into account other sources of protein, such as dairy or plant-based proteins.