

Raising Food for Thought

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Editor's Note

We all depend on agriculture to provide our food. Further, agriculture is a major player in the quality of our water to drink and air to breathe, the only two things we need even more immediately than food. What can the sciences and Christian faith tell us about how we should best raise and consume food? How should we proceed with GMOs, catching or farming fish, eating down or up the food chain, organic or factory farming, vegetarian, locavore, or omnivore...?

Steven G. Hall (PhD Cornell University) raises a gamut of such questions. He is well prepared to lead us on this topic as a professor in the Department of Biological and Agricultural Engineering, and Director of the Marine Aquaculture Research Center, at North Carolina State University. He is Past President of the Aquacultural Engineering Society, Editor of the journal *Aquacultural Engineering*, and a Fellow of the American Scientific Affiliation.

In this essay, Hall invites consideration of critical technical and ethical aspects of the food system from production to distribution, from biological to environmental resources. Readers are encouraged to take up one of the insights or questions, or maybe a related one that was not mentioned, and draft an article (typically about 5,000-8,000 words) that contributes to the conversation. These can be sent to Dr. Hall at shall5@ncsu.edu. He will send the best essays on to peer review and then we will select from those for publication in a theme issue of *Perspectives on Science and Christian Faith*.

[The lead editorial](#) in the December 2013 issue of *PSCF* outlines what the journal looks for in article contributions. For best consideration for inclusion in the theme issue, manuscripts should be received electronically before 31 January 2020.

Looking forward to your contributions,

James C. Peterson, Editor-in-Chief
Perspectives on Science and Christian Faith

Agriculture provides a fascinating and important intersection point to explore issues that have both theological and practical implications. This article is an introduction and invitation for contributions to an upcoming special issue focused on raising our food. We all eat, and so depend on agriculture to survive. What do science and theology have to say about agriculture, food, and human flourishing? This paper provides a broad overview of the food system, with focus on areas of interest and conflict. It is also an invitation to address some of these challenge areas in a deeper fashion, drawing on scientific and theological bases to provide vision to move forward toward a more sustainable food system.¹

Food is a fundamental of life. Where does it come from, who grows it, how is it grown, treated, distributed, processed, consumed; and how does that impact our health, society, and planet? Water is also fundamental to most food production. Only oxygen is more physically critical for our survival. Despite amazing improvements in food production in the last century, hundreds of

millions are still hungry, and world population continues to rise, with predictions of 9 billion or more by 2050.² At the same time, extreme weather events such as droughts, floods, powerful storm systems, and temperature extremes are making sustainable food production more difficult.

How can we produce sufficient, safe, healthy, food and fiber while reducing inputs, and minimizing impacts on local and global ecosystems? Our agricultural and related systems must also become more robust and adaptable in changing times. Further, a sustainable food system should provide this food and fiber while also enhancing human flourishing, protecting and restoring God's creation, and be economically and environmentally sustainable, all while enhancing farming communities and society in general. This is a grand challenge, an opportunity to stand in the gap, a call to both prayer and humility, and an opportunity to consider what the Bible has to say about food and water, the culture of and with plants and animals, and how God sees humans, the earth, and His other creatures.

Biblical Context A'dam, the man created from dust (the earth-ling) was placed in the garden to *sh'mar* and *a'bad* the garden (tend and keep; protect and serve, Gen. 2:15). So we were originally made of “the earth” – elements common in the earth's crust, oceans and atmosphere (hydrogen, oxygen, nitrogen, carbon...). “From dust we came, to dust we return” (Gen 3:19b). We have spirit in that physical “earthy” body. It is this intersection that helps define what it is to be human. In ways healthy or unhealthy, this also influences our approach to raising and preparing food. One could argue that in both “secular” history and in Biblical history, our first foods were “wild” – God provided fruit from trees in the garden, or humans as hunter-gatherers before developing agriculture, which itself allowed more stable civilization to emerge.

In the Bible, the “people of God” were seen as primarily nomadic, living in tents (even the ark of God was kept in a tent or tabernacle). Cain and Abel, the first children of Adam and Eve, brought nomadic animal sacrifices; and settled grain sacrifices; and we see tension both there and later in conflicts between the more settled Canaanites and Philistines, and the more nomadic Israelites. Similar tensions continue today in some parts of the world and food supply, for example, in tensions between (wild caught) fishers and (settled) aquaculture practitioners;³ or between nomadic tribes (e.g. the Fulani in Nigeria) and nearby settled cultures. Thus, tensions in our food system have had and continue to have social or even spiritual aspects.

Jesus addresses and interacts with food in at least two ways: first, food is a real physical aspect of our human experience and he enjoys it, eating the regular food of his day with his disciples and also with unexpected peoples and in unexpected (boundary pushing) ways or times (e.g. Sabbath). He also uses food and agricultural images to share visions of God's transformative kingdom. He eats normal food such as bread/grain; fruits/wine; water... but makes it special. What makes food special or celebratory? The night of the last supper, Jesus shared bread (a very simple food) and used it to remind his disciples of their personal and spiritual lives; after supper he poured wine (a product of local fruit) and said “This cup is the new covenant in my blood, poured out for you” (Luke 22:20), comparing himself to traditional animal sacrifices. After his resurrection he appeared to the disciples and broke bread and ate fish with them (John 21:9-13). Again, these simple foods remind us he too became an “earthling”. Some even conjecture that

Jesus took his earthly body to heaven and that heaven will have “earthly” qualities. Addressing both the physical and spiritual aspects of food and agriculture is critically important.

Second, food is not the ultimate point. Jesus initially resisted Mary’s request to turn water into wine. Granted he then acquiesces with a very high quality beverage (John 2:1-10). He was tempted by the devil to turn a stone into needed bread, but resisted: “After fasting forty days, He was hungry” (Matt 4:2); his reply: “Man shall not live on bread alone but on every word that comes from the mouth of God.”

There are many unique images of food in the Bible. Starting early, God creates *ex nihilo*, an unfolding cosmos over periods of time, with the development of the heavens, the production of plants and animals on earth, and eventually A’dam, the earthlings. And God saw that it was good. Adam is given the responsibility of naming all the creatures. Surely, this accepting of God’s handiwork and the naming implies a knowledge that humans should have of the other creatures. God creates the “beasts of the field”, creatures of water and sky, and places A’dam in dominion over them (Gen 1:28-30). “God blessed them and told them to be fruitful and multiply”. As of the early 20th century we have an even more dominant dominion, dominating even the large carnivores, fishing out the oceans,⁴ toppling the great forests, and feeding more people than ever before. We have a moral obligation to allow humans to provide for themselves, but we are having a much harder time of caring for other creatures and keeping species alive. Is this our responsibility and how does this link with a responsible Christian view of agriculture?

In our day we are blessed to live with the largest population the planet has ever hosted; but also challenged in how to care for creation and each other with limited resources. Agriculture uses the most land and may be the largest total contributor to environmental degradation,⁵ but Christians cannot in good conscience allow people to starve. In fact, we are called to care for “the least of these”. How can we raise food and provide water and other basic necessities in a way that honors God and provides for the present population, but also allows for a sustainable future for those who come after us? This too is a moral imperative, as it could be argued that the unsustainable way we are using resources is actually stealing food and water from our children and grandchildren. In this light, we should consider our place in history, and some of the immense transitions that have happened and will continue; and the implications for Christian thought and action in these realms. But to consider these, we need to explore the where, who, why, when, and how of our food system.

Where does our food come from? Clearly the land, water, human, and biological inputs to the agricultural system are essential to the enterprise, and critical considerations. The environment at large is of interest: agriculture is practiced around the world, in varying ways, but always with growth of plants and animals, and always with need of soil or other media, and water. Biblically, both soil and water have theological implications. A’dam was taken from the dust, as were all other creatures – we are literally earth-lings. Both practical stories (Boaz and Ruth harvesting and sharing in fruitfulness, Ruth 2-4); and parables (e.g. the parable of the sower) speak of “good soil”. Yet many forms of agriculture encourage erosion of soil, reduce nutrient content in soil, and otherwise have negative impacts on soil. Aldo Leopold suggested a “Land Ethic” in the last century,⁶ and many of his ideas have been beneficial when put into practice, with conservation

tillage, low-till or no-till practices, organic farming, and other techniques intended to conserve and enhance soil. What is good soil? How can we reduce our impact on soil? Are there types of agriculture that can conserve or even restore soil?

Similar things can be said of water. Water is essential for all forms of agriculture. Even “soil-less” agriculture requires water. Sometimes plants can flourish with natural rainfall, but many areas use various forms of irrigation. There are numerous challenges with water, and likely water challenges will continue to contribute to both environmental and social stresses around the world. In the American southwest, laws are based on “riparian rights”,⁷ which imply limits to water supplies. Ongoing tensions between urban users and agricultural needs are serious there, but water tensions are even more severe in other parts of the world. How are we to address these challenges? How can we have a fruitful agriculture while also allowing both the natural environment and other humans sufficient water? These questions are global.

Food itself is now grown and shipped, many times traveling thousands of miles, essentially shipping water and resources to other areas.⁸ While global trade has many positives, what are the limits? Should agriculture be encouraged at a more local level? And what are the implications for rich and poor? How are we to care for our local and global neighbors? How does agriculture and the food system play into this?

In Genesis 2:15, *A'dam* is told to protect and serve; to till and keep. We are instructed to take an active role, but also to “keep” or “protect”, implying we are not to destroy entire species or ecosystems. Later, in Exodus, the Israelites were even instructed to be a little less efficient: food was provided in the desert in the form of *manna*, and later, birds were provided for meat, but in both cases, the Israelites were instructed not to “store up” too much, rather to trust God to keep providing. This contrasts with Joseph’s exploits in storing up during good years (Gen. 41), and other instructions which allow for a “Sabbath for the land” (Lev. 25:2-4), but we are told that the land will still provide (there does appear to be some room for storage) and the “tillers” are to become something closer to hunter/gatherers during these “rest” times. Also in Leviticus, we are told not to harvest grain to the edge of the field, but to leave some for gleaners (Lev 23:22). This provides for the poor by allowing the poor to work for their food, and ultimately does allow a high level of efficiency for the overall society. This idea of differentiation of labor and of some kind of social net which still allows active participation, appears to be a template for a modern version of sustainable agriculture.

What about working conditions for agricultural laborers? Agriculture is and has been hard work. After the fall, Adam was told he would work “by the sweat of his brow” (Gen 3:19). Are there ways to reduce the labor demands of agriculture? Is it a good thing (physically and spiritually) to work? What are the implications for transient laborers? Are there biblical examples? Boaz greeted his workers and they greeted him back (Ruth 2:4). How could a “fair treatment” of laborers, and respect be instilled in the modern context? Who or what else should we treat well? Surely, water, air, and land must be cared for better than we are currently doing.

Many specific challenges have been noted, including unsustainable use of fresh water (rivers dammed, aquifers and waters dramatically reduced, geographic tensions over water); degradation

and erosion of arable land; eutrophication of water bodies including oceanic waters by excess nutrient runoff; excess use of fossil fuel in food production (and thus air pollution and carbon dioxide changes in the atmosphere).⁹ It is now recognized that atmospheric changes are leading to various other impacts including more extreme tropical storms; melting of glaciers and polar ice; rising sea levels and changes in precipitation. Clearly each of these could ultimately have significant impacts on agriculture and civilization itself.

What does modern science have to say about these questions? Are there fundamental limits to resource use or biology? Have we reached or exceeded some limits? What are other ways we might provide for people's caloric needs while still allowing flourishing for other species? Are there ways we can minimize degradation of the environment as we pursue agricultural goals? Are there ways we can restore habitat and species while also providing sufficient food for humans?¹⁰ How and why might we pursue these methods? What are reasons we might not pursue them? Physical or spiritual?

How do we farm, and who does the farming? This varies dramatically around the globe. In Africa, most growing of crops is done by women. Water is often carried by women and children. In America, the image of a strong male farmer is often presented, although the actual participants in agriculture are quite diverse. What is the relationship between owners of land and workers on the land? Can land be “owned” in the biblical sense? The psalmist tells us “The Earth is the Lord's and the fullness thereof”. Some societies have practiced various forms of communal land ownership, while others have allowed individuals to claim rights to land. What are advantages and disadvantages of each approach? The US, in practice, has a mixed approach, with substantial amounts of land owned by private individuals or families (e.g. family farms); companies and industries (timber, paper, integrated farming operations); and massive tracts of land managed by state and federal government entities (Bureau of Land Management, for example, leases land for timber harvest, grazing and other activities).¹¹ Some moderately large areas are owned or managed by non-governmental organizations, including environmental and church groups. Is there a “best” or “biblical” approach? The Bible speaks of long-term ownership, with concepts such as Sabbath (rest for the land once every 7 years); and Jubilee (every 50 years, land reverts to a more “distributed” ownership model).

What about how we treat the land? What do we plant? A very limited number of crops and a limited biological diversity of those crops is now planted.¹² The implications of this is that there are high yields of selected crops. Chickens grow bigger and faster, cows give over 100 pounds of milk per day, yields of corn and soybeans are higher than ever. However, this is a precarious system, where a disease or other disaster can decimate large areas of crops. Should we care about heirloom varieties of vegetables, fruit trees, or other crops? The US government has developed National Germplasm Repositories (for plants in New York State, for animals in Colorado)^{13, 14}, to “save”, often in the form of seeds or sperm, genetic diversity. Should our farming systems preserve living strains of more diverse organisms? How should this be funded or managed?

What do we add to the land? Plants tend to remove nutrients, requiring additional applications of fertilizers, either natural (e.g. manure, compost) or artificial (phosphorus, nitrogen), often at cost both in the mining or manufacture, but also in the loss of excess. The hypoxic zone in the Gulf of

Mexico¹⁵ and similar eutrophic areas elsewhere, e.g. Lake Erie (freshwater) or red tide areas (marine/estuarine saltwater), are the result of excess nutrients that encourage the growth of algae and bacteria and can reduce oxygen in the water column, often killing other species. And these are relatively benign chemicals, generally helpful in plant growth. What about more toxic chemicals we add to the environment?

Synthetic pesticides and herbicides, antibiotics administered to animals, and other chemicals have left a mark. DDT famously killed insects but also impacted the health of animals such as predatory birds, almost driving our national symbol, the bald eagle (and others) to extinction. DDT inspired Rachel Carson's "Silent Spring"¹⁶ and ushered in laws in the 1960s and 1970s that helped protect the environment in the US. Internationally, many toxic chemicals are still used. More recently, the herbicide glyphosate has been used extensively on "Roundup Ready" crops, in concert with genetically modified crops.

Genetically modified organisms (GMOs) or GM crops are generally plants or animals whose DNA has been modified using genetic engineering techniques. This may involve inserting or deleting genetic information to add or change the organism. These traits may come from other plants, animals, or microorganisms. There are currently ten GM crop species, including corn, cotton, and soy. In the US, more than 75% of the crop land used to cultivate these species is now GM¹⁷. GM crops may be more drought tolerant or resistant to disease organisms, potentially reducing inputs. In some cases, they may be resistant to herbicides, thus encouraging heavier use of those herbicides, in a tension with reduced tillage and erosion, since land does not need to be cultivated as much to reduce weeds. In the US a very high percentage of plant crops are now GM crops (94% since 2014 for GM corn)¹⁸, and many other parts of the world are using them. Some researchers note that adding these traits can reduce the need for expensive pesticides and may result in enhanced yields. Others argue that in many cases, these create new challenges, such as excess use of certain chemicals that "match" the GM traits (e.g. herbicide resistant crops). Others worry about the effects of current or future chemicals on both the environment and human health.

What are we to think about new technologies, biological, chemical or otherwise? Do we "play God" too much? How much intervention in the natural system is helpful? Are there limits? It could be argued that agriculture itself is a technological innovation, and part of what has allowed high human densities in the first place. The plow, fossil fueled farm equipment, artificial fertilizers, genetically modified organisms (GMOs) as food, pesticides, and antibiotics are each technological advances that can enhance food growth, but also each have potentially damaging side effects. The dust bowl (and likely desertification in the Mediterranean basin and other areas) was a result partially of excess soil tillage. Fossil fuels have increased CO₂ in the atmosphere, leading to climate change; too much fertilizer has led to eutrophication in both fresh (e.g. great lakes) and ocean waters (e.g. hypoxic zone in the Gulf of Mexico)¹⁹. GMOs are a much broader description of many kinds of plants and animals whose genetic editing has been much faster than the genetic selection used since Biblical times, but at a much slower rate of selection. These new technologies raise questions, as do other methods of agriculture that may impact the surrounding environment or genetics. Pesticides can kill selected pests, but may have unintended consequences, while antibiotics kill microbes, but may thus select for resistant bacteria or weeds.

Is selection of genetic traits (by traditional or GM technologies) a good thing, leading to better producers, possibly resistant to temperature extremes or biological impacts, or is selection encouraging excess use of antibiotics or pesticides, a challenge?

Other technologies are more physical, traditionally including tractors and other equipment, but more recently including electronic and geographic information systems. Automation and robotics is another area of both interest and controversy. Automation is increasing, with artificial intelligence, automated tractor and processing systems, remote sensing to identify problems in fields early, and on the horizon even larger, more automated farming systems,²⁰ ultimately reducing the contact between many humans and the land even further. Is this a good thing? Can thoughtful approaches to automation enhance our understanding of the land, reducing environmental impact while improving yield? Are there moral imperatives in the Bible or Christian thought that apply here? As God sent Adam and Eve from the garden, He said humans would work “by the sweat of the brow”. The Puritans, Amish, and other Christian groups have seen work as something good for the human body and soul. Can an approach like co-robotics (where robots allow humans to still be involved and make “high level” control decisions) possibly enhance our connections with the land? Could virtual farm tours help educate the general public?

Moral treatment of animals in agriculture has some basis in the Bible. The Mosaic law places some limits on working animals. Jesus asks a hypothetical question about helping an animal to respond to a theological question about the Sabbath (Luke 14:5). He suggests that it is normal and good to treat animals well. “Animal rights”, by contrast, is fairly modern terminology,²¹ but the Bible does address moral treatment of working and food animals. As animal agriculture has become more concentrated, with “feedlots” and confined animal feeding operations (CAFOs), a number of physical as well as moral issues have come up.²² The excess concentration of nutrients is one challenge, and the actual treatment of the animals is another. What is acceptable treatment of animals in agriculture? Should Christians seek to treat animals better than the “minimum acceptable” level? Are there technologies that can reduce reliance on animals or enhance animal welfare? Will we move to a primarily or totally vegetarian food system?

Thus, there are moral aspects to biotechnology, animal agriculture, food technology, and related practices. Each possible technology or practice has benefits and possible dangerous side effects, both direct and indirect. Is there a moral or even “Christian” way of vetting such technologies and practices? Could we learn from groups such as the Amish, who abstain from many technologies but do have a technique for vetting new technologies, and are more likely to adopt new technologies partially, rather than full scale, such as use of electricity in barns but not in houses? Is there a logical and moral approach to these questions?

Jesus speaks in metaphorical (and physical) terms about food and water, animals and even the technologies of the day, often placing himself in the story. At the beginning of his ministry, Jesus is tempted by the devil. After 40 days of fasting “he was hungry”. The devil offers to turn “stones into bread”. Interestingly, given that Jesus not only turns water into wine but heals and raises from the dead, he would have been able to do this, but declines. This is instructive for our modern world: just because we can, does not mean we should. By extension, one should be

careful why one is “playing God” – for “good” purposes, or out of evil ones: pride, fear, greed or other sinful reasons? Jesus, instead, replies “One does not live by bread alone, but by every word that proceeds from the mouth of God” (Matt. 4:4, citing Deut. 8:3).

Jesus next temptation was to take a risk “throw yourself from the pinnacle of the temple”. Again, this is something he could have done, and the devil even tempts him by citing scripture: “He shall give his angels charge over thee, to keep thee: and in their hands they shall bear thee up, lest at any time thou dash thy foot against a stone” Luke 4:9-13, citing Ps. 91:12. The response is parallel to the first and equally useful in our current context “thou shalt not tempt the Lord thy God”. This has a secular parallel called the precautionary principle.²³ Interestingly, this environmental principle has health related implications, often linked to environmental chemicals or risks.²⁴ This of course, is among the limits of human existence: we are not God, and we do not know all. We would be wise to follow a kind of biblical “precautionary principle” and “not tempt the Lord”. The theology and science behind this is complex and invites further discussion and writing. It also leads us humbly back to Jesus, who Christians acknowledge as “My Lord and my God” (John 20:28), and guides us to observe his actions and words with regard to the environment, people, and human flourishing. Human flourishing as well as flourishing of God’s good creation are both objectives that seem consistent with a Christian worldview. This leads to issues of food safety and food security.

How is food distributed and processed? What techniques for distributing food (e.g. global shipping) are positive (feeding people in need with excess from other areas, diversifying the diet to enhance human health)? What are negatives (food safety issues involving biological (e.g. disease) organisms or chemical (e.g. pesticide residue) aspects of the food system? How are food safety and security linked to our current system?

Food processing has historically been a way of preserving food. Drying and salting were two ancient techniques. Grain was harvested, dried, and stored. Meat was often salted or smoked. In the last century, a number of additional techniques have been developed to process and preserve food, while a very large number of techniques have been used to enhance value.²⁵ Many of these techniques (refrigeration, processing to separate out valuable products) have been helpful, many have also led to concerns, often in the food safety realm.

Food processing can help provide sufficient quantities of food during times of low food availability, and of keeping food safe by reducing microbial spoilage. However, modern food has often been processed to the point where many native antioxidants and other healthy components have been removed, leaving empty calories. We enjoy sugary drinks and processed salty snacks, but they do little for us other than make us fatter and less healthy. Many of these foods also have substantial loadings of food preservatives that may further degrade the healthy aspects of the food, but allow them to sit on shelves longer. Should the food processing industry be involved in not only food safety from a microbial point of view, but also food quality for nutrition? Are there techniques for processing food to keep nutrients in, while also providing food safety? Are we too married to convenient food- fast or rich? Are we idolizing these foods? Addicted to unhealthy foods?

How is food consumed? The health effects of food are significant. Food is God's way of providing for us, and sharing it is a blessing. However, there may be types of food or ways of consuming that can be harmful. Food that is laden with unwanted chemicals, or which has toxins from natural processes (e.g. botulism) can be a problem. However, the form and amount of food consumed may be the biggest challenges in the 21st century. Specifically, more food is available in processed forms which likely exclude many needed nutrients, leading to sufficient calories but deficient micronutrients, antioxidants, and other food components that are present in more raw forms of food. In other cases, desirable ingredients such as salts and flavor compounds are provided at excessively high levels in processed foods, leading to other health challenges such as high blood pressure due to excess sodium.

Is it the fault of the food growers that individuals may choose to eat cereals made largely of processed grains and sugars, or choose to eat excess calories, salt or fats? While individuals make choices, it is clear that the US and now many other developed and developing countries have excess calories and significant health issues related to excess calories and calories in nutrient deficient forms. Is there a biblical approach to food consumption that could help reduce these issues? While there are still hundreds of millions hungry,²⁶ more people are being fed more calories than ever before, but not with uniform enhancements to health. How can we move toward more healthy approaches to food, enjoying the fruitfulness God has provided while not exceeding limits of the land or the human body, indeed, treating the body as "the temple of the spirit"? Biblically, we are called to "fasting and prayer". Is fasting also a healthy practice for the body and soul? Could limited fasting also have positive effects on our views and practices in the food system? For how we treat ourselves may be linked to how we treat the land and other people and creatures.

For example, both per capita and total consumption of animal products has risen in recent decades. Chicken, pork, and fish are at all-time record levels of consumption. Beef has not increased in recent years but still accounts for a substantial impact on the planet. Feed conversion ratios (FCRs) of these animals mean that in most cases raising animals is less efficient and uses more resources than eating primarily plant-based products. For example, cows require about 25 kg of feed to produce one kg of meat; pork requires about 5; poultry 2-3; eggs, milk and fish are generally more efficient,²⁷ and of course, eating plants does not require the conversion to animal products at all. Interestingly, both Genesis and Daniel seem to suggest a vegetarian diet can be a Godly diet. On the other hand, Jesus ate fish; Peter was told to eat "what the gentiles eat" including many kinds of animals. Finally, early Christians who came from non-Jewish backgrounds (or lived in these communities) were instructed to "abstain from food sacrificed to idols, or blood" (Acts 15:29). This leaves the door open to eat with (and fellowship with) a wide variety of individuals, reflecting the inclusive nature of the world Christian community.

Jesus too links food with social and spiritual action, often using images of food and beverages. His first miracle was performed at the urging of his mother, where he turned water into wine at a wedding. This provision is not just a necessity but a celebration. Jesus does celebration food. In fact, on further consideration, almost all of Jesus food related stories and miracles have a celebration aspect, while many also earnestly seek to share provision at both a basic and a much

deeper level. He famously shared meals both with “good” people and with “tax collectors and prostitutes”. Here the focus was not on the food but on the social aspects of food, often with a sense of sharing. He did talk about himself as both food and drink: “I am the bread of life; Whoever comes to me will never go hungry and whoever believes in me will never be thirsty. (John 6:35).”

Jesus modeled and encouraged transformations. How would Jesus suggest we redeem ways of relating to food. The Bible speaks to healthy and unhealthy ways to enjoy and share food. There are numerous examples of both in Old and New Testaments. Excess consumption of wine led to both drunkenness (spoken against in the New Testament), and other immoral behavior. Gluttony, the excess consumption of food as well as drink, is understood as a moral failure in the New Testament. However, celebration with food and drink appears not just acceptable but even central to Biblical community. For example, the biblical tithe (Leviticus 27:30-34) included a portion of food produced, offered to the Lord; to be eaten in community at the temple (Deuteronomy 12). There was also a poor tithe (Deuteronomy 12:27-29; 26:12) intended for the foreigner, the fatherless, the widow who would eat in community with the people of God in a kind of celebration.

In fact, many images of food in the Bible are considered positive: feast days, sacrifice of special plants or animals, and ultimately many examples from Jesus’ life; as well as his ultimate substitution of himself as the ultimate sacrifice, where he speaks of His body and blood as not just physical, but spiritual, and parallels this with food items (bread and wine). Many types of food are mentioned in the Bible, including wine (Ezra 6:9, numerous times in the New Testament); olive oil (Deuteronomy 8:8); bread (both Old and New Testament); honey (Exodus 33:3, Judges 14); eggs (Job 6; Luke 11); grape juice (Numbers 6); vinegar (Ruth 2, John 19); and vegetables (Daniel).

This does appear to be a Biblical food principle: plants are good (see Gen 1:11-12, 29-30; Daniel 1:12-16; Revelation 22:1-2) and by extension, a plant based diet, low on the trophic order, may be a wise diet. They are not only morally allowed for consumption; but they appear to be good for health. Modern medicine more and more is confirming this. While a modest amount of protein is a good thing for health, many of our modern illnesses may be exacerbated by excess consumption of meat, especially processed red meat.^{28, 29, 30} This is an area where modern science and ancient scripture largely agree, and further detail could be added to this area to enrich our understanding of both science and theology.

Thus, moving “down the trophic levels”, to a more plant-based diet, and encouraging food animals toward a more plant based diet, can be both environmentally beneficial and likely healthy. Considering ways to minimize impacts on the ecosystem while providing healthy food for humans is important in this era of fossil fuel, growing populations, and growing consumptive attitudes. We also need to wisely use “wastes”, often nutrients in the wrong places; possibly to grown healthy and valuable plants, algae, or other green products. Since plants in general are more efficient at producing food calories, this could be a wise way to reduce our impact as world populations continue to grow.

Demographic trends suggest that, over the next few decades, overall demand for food will rise, dramatically in some areas: FAO projections are 2-3 billion additional people in the next 30 years.³¹ In addition, as people in developing countries gain wealth, they tend to eat “richer” animal based foods, so at this point it appears that more food must be produced. Two fundamental approaches, or a combination of them, will likely be needed. One is to be more efficient with our land: growing more crops on less land, possibly by more inputs or more efficient use of inputs or technology. A second approach is to alter our consumption: reduce instead of increase meat consumption, especially in the middle class and wealthy areas of the world. A more plant-based diet might be healthier in many developed areas, and could allow us to feed more people. Possibly the protein we do use would include more efficient protein, such as milk, eggs, and fish.

This brings up another area of interest: aquaculture, the culture of food (often fish, shellfish, seaweed) in water. Is aquaculture good? Is aquaculture necessary? Some authors suggest that aquaculture may do damage or at least not improve wild fisheries as well as had been hoped.^{32, 33} However, with aquaculture now producing more seafood than our stressed oceans total (wild) fisheries production, we may have to go forward with this more sustainable aquaculture.³⁴ How do we develop an even more productive aquaculture (possibly largely in coastal or oceanic waters), while minimizing or even reversing impacts on water and the coast?

Did Jesus favor fish? Interestingly, Jesus rarely is seen eating meat. Perhaps this was simply the food availability of the day (bread was a basic staple; water or wine were basic beverages). He did cook fish, and there are other images of aquatic foods. Does this reflect on our overfishing of wild fish stocks? Should we abandon aquaculture because we have damaged our oceans? Or should we do more sustainable aquaculture to take pressure off wild fish stocks? While this is an animal protein, it is arguably one of the most efficient animal proteins. Fish have excellent feed conversion ratios, partially because fish do not have to grow large supportive skeletons; they are supported by the water. Can alternative food sources such as aquaculture help take pressure off other land and water resources, or will we simply impact the waters further? And are there ways that these considerations can remind us of what our ultimate goal is: healthy people and a healthy planet.

Prophets such as Daniel acted out and followed tenets of the faith despite challenges, to witness to their fellow believers but also to witness to even their captors. Daniel actually put less, not more strain on the food system of his day, refusing meat and wine in favor of plant foods. Whether powerful or powerless by earthly standards, our conduct can be influential. Daniel was a healthy young man who “showed aptitude for every kind of learning, was well informed, quick to understand...” (Daniel 1:4) who was selected to be trained to be a cross-cultural leader. He was provided with rich food including meat and alcohol. He declined these, resolving “not to defile himself” and went lower on the trophic level to a plant-based diet, “nothing but vegetables and water” Daniel 1:12. He “looked healthier and better nourished” (Dan. 1:15) than others. This too is a hint and a reflection back to Genesis where God “gives you every seed-bearing plant on the face of the whole earth and every tree that has fruit with seed in it. They will be yours for food” Gen 1:29. These biblical precedents suggest that our agriculture and food choices can have negative or positive impacts on the world and our health.

What is the impact that agriculture does or could have on the land, water, and air? How can we minimize environmental impacts of agriculture and food? Excess nutrients can have negative impacts on downstream water bodies, excess chemicals can have negative impacts on other creatures, and excess consumption can have negative impacts on our very health and lives. At the same time, modern agriculture has allowed the largest human population the earth has known. More people are able to hear the good news of Jesus than ever before. Is this system sustainable?

There are those who argue that eating animals that can convert feed that humans cannot consume (e.g. grass, trees, saltwater algae) is a way of harvesting human food without excessively impacting the environment. One could argue that some of these activities are a kind of agriculture that is actually closer to wild food harvest, a kind of cultured “hunter-gatherer” approach. There are, in fact, a number of agricultural activities of this sort, including various “permaculture” and tree or bush types of culture (e.g. cranberries, nut and fruit trees); as well as some types of animal culture (nomadic or “range” type culture of grazing animals like cows or goats). Other examples include some unique “semi-cultured” techniques such as the biculture of rice and crayfish (~200,000 acres cultured in Louisiana³⁵), which encourages wild crayfish to harvest the standing biomass of the rice after harvest, producing another crop (crayfish are harvested by traps) and providing a diversified income over a longer period of the year, and enabling a native species to flourish, while providing a stable income. This might be considered low intensity agriculture (or aquaculture). By contrast, some argue for highly intensive agriculture to focus the impacts of agriculture on smaller surface areas of the planet. Specifically, some argue for very intensive agriculture on lands that are extremely fertile; and allowing less fertile or optimal land to be held or restored to a wild state. The regrowth of forest on former marginal agricultural lands has been cited as having a positive impact by sequestering carbon in forests growing back on otherwise marginal lands.³⁶ Large swaths of undisturbed habitat may allow conservation of flora and fauna, and some “charismatic megafauna” may in fact require large and wild areas of habitat. Again, how can we care for and protect the biodiversity of God’s creation while still providing for human flourishing?

Is there danger in focusing on extremely intensive agriculture: the Bible suggests that absolute harvest is not the objective. It is said the “land shall have rest”, but also that the “beasts of the field” shall also be able to graze on the excess and the plants that grow (perhaps including legumes or other nitrogen fixing plants) during the Sabbath year (Lev 25:2-7). In Ezekiel, the prophet warns against abusing the environment: “Is it not enough... must you also muddy the rest...” in reference to not caring for the land; God’s response through John’s vision includes this warning: “God will destroy those who destroy the earth” (Rev 11:18). The underlying sins of such in both the Old and New Testament appear to be greed and violence, still common in our day. Challenges abound, but scientists and theologians of good will must consider these challenges to our food system, and seek a vision for a more sustainable future.

How can we move toward a more sustainable food system? Does the Bible have advice on how to treat the land, other creatures, and each other? How can we use these to enhance our food system and lives? Are there ways to consider eternity as we thank God for our food? Are

there ways we could manage, sustain, or even restore land, the environment, human lives and the overall food system?

While much focus has rightfully been on reducing, could we go beyond just reducing impact, and actively work on restoration of degraded lands, perhaps by reducing agricultural impacts, but possibly by a dramatic reconsideration of agriculture itself? Could we move from management or conservation to something like restoration? Is this not what Jesus does with us - finds us in a degraded state, accepts us as we are, but then guides us toward holiness, cleanness, joy and fruitfulness? Can we move from an exploitative approach to the land to a view of wise use and stewardship? What will this take in terms of attitude, technology, even philosophical or spiritual approach? Are there already examples, and could these examples be expanded or used in other contexts?

A biblical approach to food means we need to go beyond just reducing our impact to actually restoring ecosystems. Our food system could be part of this: perennial plants and trees could be harvested, while minimizing impacts on the soils. Some of these plants may be native to their respective locations, and could enhance the environment. In coastal waters, growth of shellfish could protect valuable coastal land while growing food. Since most shellfish are filter feeders, this process could clean coastal waters. With some creativity, what other agricultural techniques could enhance the environment, mimic natural systems, and possibly even restore local and global ecosystems?

In summary, are there current examples of agriculture that “protect and serve” (Gen 2:15)? In what ways or places are Christian values encouraging conservation, restoration, care for creation and others? This article and this journal can help share these stories, both documenting the biophysical and the human spiritual aspects of these efforts. Food and water are essential for life. Agriculture ostensibly has the largest land area impact and some of the largest net impacts on the planet. Yet it is not moral to allow people to starve. Are there techniques or approaches that can enhance sustainability, while still producing healthy food? How are environment and human health linked? How do we approach new technologies? And, as we look toward Christ’s eventual return, and see images of “the river of the water of life...” and “leaves for the healing of the nations”, can we imitate God’s agriculture and have “edible landscapes”, restorative agriculture and aquaculture, and demonstrate both dominion over God’s good creation, as well as a grace-filled approach to agriculture on the planet, in harmony, allowing for fruitfulness of both humans and other creatures?

Endnotes

¹Dorothy Boorse, “New Findings in Environmental Science and their Implications for Christians.” *Perspectives on Science and Christian Faith* 66(4), p. 194-202, 2014. Boorse reviewed a number of environmental issues, some related to food production, including fisheries, population growth, irrigation, antibiotic resistance, “playing God”, water stresses in agriculture, climate change, soil health, and heavy metals.

²The Food and Agriculture Organization of the United Nations (www.fao.org), tracks demographic, food production, and related information and projections. “The Future of Food and Agriculture: Trends and Challenges” published in Rome, 2017, is available at <http://www.fao.org/3/a-i6583e.pdf>. This publication notes “world population is expected to grow to almost 10 billion by 2050”. Their “medium” prediction is 9.7 billion in 2050. They also note “income growth in low- and middle-income countries would hasten a dietary transition towards higher consumption of meat... requiring commensurate shifts in output and adding pressure on natural resources (p.x).”

³Trond Bjørndal and Jordi Guillen, “Market Competition Between Farmed and Wild Fish: A Literature Survey”, Food and Agriculture Organization of the United Nations, FAO Fisheries and Aquaculture Center, Rome, 2016. Accessed at: <http://www.fao.org/3/a-i5700e.pdf>, 22 pp.

⁴Rosamond L. Naylor, Rebecca Goldberg, Jurgenne Primavera, Nils Kautsky, Malcolm Beveridge, Jason Clay, Carl Folks, Jane Lubchenco, Harold Mooney and Max Troell, “Effect of Aquaculture on World Fish Supplies” *Nature* v. 405 June 2000:1017-1024. This article warned against excess “appropriation of net aquatic primary production” – using small wild fish to feed to aquaculture, thus potentially damaging wild fish stocks. This article encouraged reducing the use of fish to feed aquacultured fish, and instead using algae, plant materials or other byproducts to encourage environmentally sound aquaculture and allow natural fish stocks to recover. This article also noted the “increasing scarcity of freshwater resources”, hinting at future expansion of marine (ocean/coastal) aquaculture.

⁵David Tilman, “Global Environmental Impacts of Agricultural Expansion: The Need for Sustainable and Efficient Practices”. *PNAS* 1999, 96(11):5995-6000. This article notes not only that agriculture already has massive impact, but that intensification of agriculture is expected to increase those impacts unless substantial improvements in technique are made.

⁶Aldo Leopold, *A Sand County Almanac*, 1949, Oxford Univ. Press, 240 pp. Leopold used a series of nonfiction chapters to present the concept of a Land Ethic, a kind of contract or relationship between humans and the land. This has been influential in environmental theory and practice.

⁷Brett A. Boisjolie, Mary Santelmann, Rebecca Flitcroft and Sally Duncan, “Legal Ecotones: A Comparative Analysis of Riparian Policy Protection in the Oregon Coast Range, USA. *Journal of Environmental Management* 2017, 197:206-220.

⁸Christopher Weber and H. Scott Matthews, “Food Miles and the Relative Climate Impacts of Food choices in the United States”, *Environ. Sci. Tech.* 2008(42):10 (3508-3513). This article claims 1640 km delivery distance for food in the US, but also notes additional impacts of the food system, with a focus on greenhouse gas emissions.

⁹Boorse, “New Findings in Environmental Science” (*PSCF*) addresses a number of environmental issues that overlap with agricultural practices and production (p. 195-200).

¹⁰Alex Saturday, “Restoration of Degraded Agricultural Land: A Review” *J. Env. And Health Science* 2018 <https://doi.org/10.15436/2378-6841.18.1928>. This review article addresses a number of challenges with the loss of agricultural land due to unsustainable practices. These are diverse, but include salinity issues, fertility loss, erosion and other challenges. Consideration of techniques for reducing these challenges while still farming; and ways to restore land that is no longer productive are discussed. While this article does not explicitly address Christian morals, it would appear that these techniques and approaches could be considered within a Biblical context.

¹¹Bureau of Land Management General Land Office Records (accessible at <https://gloreCORDS.blm.gov/>) includes many documents related to BLM and government land ownership, primarily in the western parts of the US.

¹²Gary Benckiser, Sylvia Schnell, *Biodiversity in Agricultural Production Systems*, 2007 CRC Press, 438 pp. This book discusses soil and plant biodiversity, and a number of techniques used to address genetic challenges in agriculture.

¹³The National Animal Germplasm Program https://nrrc.ars.usda.gov/A-GRIN/main_webpage_dev/ars?record_source=US is run by the United States Department of Agriculture, and has objectives to “develop and expand a scientifically based germplasm and DNA/tissue collection”; “develop methods for population regeneration”; and “improve cryopreservation methods...”.

¹⁴The National Plant Germplasm System “acquires, conserves, evaluates, documents and distributes crop germplasm”. Both the NAGP and the NPGS are funded by USDA; and acknowledge that “intensification (of agriculture) has relied heavily on producing crops with increasing genetic uniformity”. <https://data.nal.usda.gov/dataset/national-plant-germplasm-system>

¹⁵Mary Caperton Morton, “Gulf Dead Zone Looms Large in 2019”. *Earth and Space Science News* (AGU), accessed at <https://eos.org/articles/gulf-dead-zone-looms-large-in-2019>, notes “A new forecast predicts widespread hypoxia after a wet Midwest spring”. This article defines the hypoxic zone as having oxygen levels of less than 2 parts per million, and is predicted to be over 22,000 square kilometers in 2019. The so called “dead zone” reduces survival of aquatic life and is driven significantly by fertilizer runoff (nitrogen and phosphorus).

¹⁶Rachel Carson, *Silent Spring*, Houghton Mifflin 1962, 403pp. This is a classic book written by the late Rachel Carson, focused on addressing now confirmed issues with widespread chemical use, including the pesticide DDT, which was later banned. This book was influential in both agricultural and environmental fields.

¹⁷USDA ARS, “Recent Trends in Genetically Engineered Crop Adoption” <https://www.ers.usda.gov/data-products/adoption-of-genetically-engineered-crops-in-the-us/recent-trends-in-ge-adoption.aspx>, summarizes data from 1996-2018, showing soy, cotton and corn each are planted on very high acreages, and explains more about the specific traits that are most common in genetically engineered crops.

¹⁸Ibid.

¹⁹Nancy Rabalais, R. Eugene Turner, Robert Diaz, Dubravko Justic, “Global Change and Eutrophication of Coastal Waters. *ICES Journal of Marine Science* 66(7):1528-1537. This article addresses both “local” Gulf of Mexico eutrophication and the hypoxic or “dead zone”, as well as implications for worldwide eutrophication driven by both agricultural and other impacts. They argue that “nutrient loadings to coastal waters need to be reduced now, so that further water quality degradation is prevented”.

²⁰Wouter H. Maes and Kathy Steppe, Perspectives for Remote Sensing with Unmanned Aerial Vehicles in Precision Agriculture. *Trends in Plant Science* 24(2):152-164. This article discusses use of UAVs to assess and manage agricultural issues including drought stress (and irrigation); pathogen detection, weed detection and nutrient status (and fertilization).

²¹Peter Singer is well known for his sometimes controversial philosophical views, espoused in books such as *The Ethics of What we Eat Why Our Food Choices Matter* (2007 with Jim Mason, Rodale Press), which addresses a number of ethical issues in the food system; and *Animal Liberation* (revised edition, 2009) Harper Collins, 304 pp, which specifically addresses morality in the production of food animals. Singer claims he and his wife gave up eating meat in 1971.

²²Dana Cole, Lori Todd and Steve Wing, “Concentrated Swine Feeding Operations and Public Health: A Review of Occupational and Community Health Effects” *Env. Health Perspectives* 2000, 108(8):685-699, reviews over 250 previous studies, providing a broad context for confined animal feeding operations (CAFOs) and considers animal and human health perspectives.

²³D. Kriebel, J. Tickner, P. Epstein, J. Lemons, R. Levins, EL Loechler, M. Quinn, R. Rudel, T. Schettler and M. Stoto. “The Precautionary Principles in Environmental Science” *Env. Health Perspectives* 2001, 109(9): 871-876. This article comes from a scientific perspective and acknowledges a number of ethical challenges in environmental areas, including implications for agriculture.

²⁴Joel D. Kaufman and Cynthia Curl. “Environmental Health Sciences in a Translational Research Framework: More than Benches and Bedsides”. *Env. Health Perspectives* 2019, 127(4) doi: 10.1289/EHP4067. This article acknowledges that health practice may have more complexity as well as ethical and policy implications.

²⁵Xin-li Ran, Min Zhang, Yuchuan Wang and Benu Adhikari, “Novel Technologies Applied for Recovery and Value Addition of High Value Compounds from Plant Byproducts: A Review. *Critical Reviews in Food Science and Nutrition* 2017, 59(3):450-461. This article reviews a number of other studies on value added technologies, and acknowledges both challenges and opportunities in food storage and quality.

²⁶Food and Agriculture Organization of the United Nations “Hunger and Food Insecurity” accessed at <http://www.fao.org/hunger/en/> estimates 820 million undernourished people in 2017,

estimated at 10.7% of world population. This site clarifies terms and how these estimates were made.

²⁷A. Shopon, G. Eshel, E. Noor and R. Milo, “Energy and Protein Feed-to-food Conversion Efficiencies in the US and Potential Food Security Gains from Dietary Changes” *Environmental Research Letters* 2016 11(10): 8p. This article estimates “efficiency” for a variety of animal protein sources, finding eggs and dairy best at 17% efficiency; poultry at 13, port at 9, and beef at 3% efficiency (implying a 97% loss of energy calories). They do imply that feed for beef is largely from pasture and “processed roughage”, both largely inedible to humans.

²⁸Saeed Alshahrani, Gary Fraser, Joan Sabaté, Raymond Knutsen, David Shavlik, Andrew Mashchak, Jan Lloren, Michael Orlich. “Red and Processed Meat and Mortality in a Low Meat Intake Population”. *Nutrients*, 2019; 11 (3): 622 DOI: [10.3390/nu11030622](https://doi.org/10.3390/nu11030622)

²⁹D. Demeyer, B. Mertens, S. DeSmet, M. Ulens, “Mechanisms Linking Colorectal Cancer to the Consumption of Processed Red Meat: A Review.” *Crit. Rev. Food Sci Nutr.* 2016, 56(16):2747-4766.

³⁰AM Bernstein, M. Song, X. Zhang, A. Pan, M. Wang, CS Fuchs, N. Le, AT Chan, WC Willett, S. Ogino, EL Giovannucci and K Wu, 2015. “Processed and Unprocessed Red Meat and Risk of Colorectal Cancer: Analysis by Tumor Location and Modification by Time.” *PLoS One*. 10(8):e0135959.

³¹FAO, “The Future of Food and Agriculture: Trends and Challenges” published in Rome, 2017, available at <http://www.fao.org/3/a-i6583e.pdf>.

³²Rosamond L. Naylor, Rebecca Goldberg, Jurgenne Primavera, Nils Kautsky, Malcolm Beveridge, Jason Clay, Carl Folks, Jane Lubchenco, Harold Mooney and Max Troell, “Effect of Aquaculture on World Fish Supplies” *Nature* 405 June 2000:1017-1024. It should be noted that although this group questioned the sustainability of aquaculture at the time, they laid out a plan to enhance aquacultural sustainability, and many of the better operators now practice many or all of the suggested BMPs, leaving room for hope.

³³Stefano B. Longo, Brett Clark, Richard York, Andrew Jorgenson, “Aquaculture and the displacement of fisheries captures” *Conservation Biology* 33(4):832-841. Longo et al. modeled a hopeful case: aquaculture might displace wild fisheries enough to allow wild stocks to recover. Their findings suggest that although aquaculture now produces as much seafood as all wild fish capture in the world, it is not sufficient, and further increases in aquaculture (in a sustainable manner) may be needed.

³⁴Trond Bjorndal and Jordi Guillen, “Market Competition Between Farmed and Wild Fish: A Literature Survey”, Food and Agriculture Organization of the United Nations, FAO Fisheries and Aquaculture Center, Rome, 2016. Accessed at: <http://www.fao.org/3/a-i5700e.pdf>, 22 pp.

³⁵W. Ray McClain and Robert Romaine, “Crawfish Culture: A Louisiana Aquaculture Success Story. *World Aquaculture* 35:31-35 (2004). This article gives some history of how this system

developed into an ecologically friendly, robust system, where when either production or prices are down for one commodity, the other often makes up for it; and also allows a semi-intensive culture that can allow native species to thrive while still providing valuable food products.

³⁶Thomas A. M. Pugh, Mats Lindeskog, Benjamin Smith, Benjamin Poulter, Almut Arneth, Vanessa Haverd, Leonardo Calle. “Role of forest regrowth in global carbon sink dynamics.” *Proceedings of the National Academy of Sciences*, 2019; 116 (10): 4382
DOI: [10.1073/pnas.1810512116](https://doi.org/10.1073/pnas.1810512116) is one of a number of articles that acknowledge the role of forests in sequestering large amounts of carbon dioxide.