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Industry Study

Industry Report
Agribusiness

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ABSTRACT: The Agribusiness industry is vital to the national security of the United States (U.S.) because food security directly influences stability. The U.S. is currently one of the world's agribusiness industry leaders. However, in order to feed a global population of nine billion people by 2050, the U.S. faces the daunting task of helping to implement globally sustainable and climate smart agricultural practices. Shifting consumer demand signals, water access, and a lack of investment in infrastructure at home and abroad increase the challenge. To influence stability around the world, the U.S. must continue to lead the industry by encouraging innovation, by sharing best practices between the public-private enterprise, and by investing in infrastructure to increase food security, environmental stability and economic opportunity.

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Figure 1: Agribusiness Industry Group Photo taken on Mount Veeder (Cardinale Estate)

Industry Study Outreach and Field Studies

On Campus Presenters:
USDA Economic Research Service, Washington DC
Center for Strategic and International Studies, Washington, DC
American Farm Bureau Federation, Washington, DC
Smithsonian Institution, Museum of American History, Washington, DC
University of Maryland, College Park, Maryland, MD
Chicago Council on Global Affairs, Chicago, IL
Bunge Limited, St. Louis, MO
Produce Marketing Association, Newark, DE
Land O'Lakes, Inc., Arden Hills, MN
E. I. DuPont, Wilmington, DE
Mondelez International, East Hanover NJ
AGCO, Duluth, GA
California Agricultural Leadership Foundation, Salinas, CA
RTI International, Durham, NC
Monsanto, St. Louis, MO
PepsiCo, Purchase, NY

Field Studies: Domestic
US Senate Committee on Agriculture, Nutrition, and Forestry, Washington, DC
Global Agriculture & Food Security Program, World Bank, Washington, DC
International Food Policy Research Institute (IFPRI), Washington, DC
Smithfield Foods, Inc., Smithfield, VA
2016 USDA Agricultural Outlook Forum, Arlington, VA
USDA, Beltsville Agricultural Research Center (BARC), Beltsville, MD
McCormick and Company, Sparks, MD
North Carolina State University College of Agriculture and Life Sciences, Raleigh, NC
Lake Wheeler Field Laboratory Tour, NCSU, Raleigh, NC
Advanced Animal Diagnostics, Research Triangle Park, NC
RTI International, Research Triangle Park, NC
NCBioTech, Research Triangle Park, NC
Bayer CropScience, Research Triangle Park, NC
California Institute for Water Resources, Oakland, CA
Roots of Change, Oakland, CA
Cardinale Estate, Oakville, CA
Seminis, Inc., Woodland, CA
UC Davis Agricultural Sustainability Institute, Russell Ranch, Davis, CA
UC Davis Sustainable Sourcing Initiative, Davis, CA
UC Davis Economics Department, Davis, CA
Rominger Ranch, Winters, CA
Foster Farms, Livingston, CA
Hilmar Cheese Company, Hilmar, CA
Clauss Dairy Farms, Hilmar, CA

True Leaf Farms, San Juan Bautista, CA
Ocean Mist Farms, Castroville, CA
Tanimura & Antle, Spreckels, CA
Cal Giant, Watsonville, CA

Field Studies: International
U.S. Embassy, New Delhi, India
Federation of Indian Chambers of Commerce and Industry (FICCI), New Delhi, India
Suri Agro Fresh, Azadpur Subji Mandi Market, New Delhi, India
INA Market, Sri Aurobindo Marg, New Delhi, India
Farm Operations in Narayanpur Village, District Aligarh, Uttar Pradesh, India
Olam Agro India Private Limited, New Delhi, India
Cargill India Private Limited, New Delhi, India
E. I. DuPont India Private Limited, New Delhi, India
PepsiCo India, New Delhi, India
Bill and Melinda Gates Foundation, New Delhi, India
Digital Green, New Delhi, India
Skymet Weather Services, New Delhi, India
Grain Farm Operations in Free State Province, Republic of South Africa
U.S. Embassy, Pretoria, Republic of South Africa
Council for Scientific and Industrial Research, Pretoria, Republic of South Africa
Mongena Game Reserve Operations, Gauteng Province, Republic of South Africa
AFGRI Agribusiness, Pretoria, Republic of South Africa
Monsanto SA Research Farm, Republic of South Africa
Irene Dairy Farm, Pretoria, Republic of South Africa
AfricaBio, Pretoria, Republic of South Africa
Johannesburg Stock Exchange/South African Future Exchange, Republic of South Africa

Figure 2: Agribusiness Industry Group Photo taken on a farm in Free State, South Africa.

Introduction

What is Agribusiness? According to the United States Department of Agriculture's (USDA) Economic Research Service, Agribusiness is "all economic activity that supports farm production and the conversion of raw farm products to consumable goods— for example, machinery, fertilizer production, farming itself, food processing and manufacturing, transportation, wholesale and retail trade, distribution of food, and eating establishments."[1]

Over the course of our Industry study, our group discovered that most Americans are familiar with only a small fraction of the industry and are unaware of how food gets from pre-farm to fork. Global consumers and some government actors are also unaware of the biotechnology involved in seed development or crop protection, or why the world needs sustainable precision agricultural practices to meet global food demand over the next century. Our Industry Study also found that consumers do not comprehend the vast global supply chain, sometimes referred to as the agribusiness value chain as depicted in Appendix A, which links food production, processing, storage, and distribution to retailers and food consumers. However, we discovered that the agribusiness industry has been a vital enabler of globalization. Furthermore, we realized that coordination across public-private enterprises, with world governments as well as within our own interagency, is complex but central to food security and influencing stability around the world. [2]

The most recent National Security Strategy (NSS), published in 2015, directly addresses food security and states, "we will leverage our leadership in promoting food security, enhancing resilience, modernizing rural agriculture, and reducing the vulnerability of the poor."[3] The NSS also addresses climate change as a threat to our national security, "contributing to increased natural disasters, refugee flows, and conflicts over basic resources like food and water."[4] And finally, the NSS includes efforts to end extreme poverty.

As the world population grows by two billion people and rising incomes in some areas support protein based diets, the world will face multiple challenges related to food security over the next three decades. How do we raise the standard of living for those who are malnourished due to poverty? Can we ensure food security as rural populations migrate to urban areas? How do smaller farmers in the developing world acquire the educational and mechanized tools to increase yields, and are not squeezed out of their livelihoods by large commercial farming operations? How do we guarantee that the next generation of farmers receives the education and resources necessary to make climate smart agribusiness decisions that could have economic implications for food security around the world? Pressure on existing infrastructure is growing, and in some places where there is no supporting physical infrastructure, ensuring access to food and nutrition is increasingly difficult. Throughout our study, we learned that the only way these challenges can be met is when innovation, technology, and climate smart agricultural practices are coupled with policies that do not inhibit economic growth.

Global Challenges Facing the Agribusiness Industry

Civilization and anarchy are only seven meals apart. This Spanish proverb highlights the catalytic effect that hunger, as well as the high cost of bread, had on the Arab Spring demonstrations in 2010.[5] The United Nations defines food security as a situation that exists when all people at all times have physical, social and economic access to sufficient, safe and nutritious food that meet their dietary needs and food preferences for an active and healthy life.[6] The world has over three-quarters of a billion people who are food insecure. However, as Appendix C shows,

the number of people who are food insecure has dropped from 1.9 billion in 1990 to less than half that today.[7] When governments increase food security, stability follows. Expert's estimate that as the world population grows to more than nine billion people by 2050 as shown in Appendix B, sixty percent more food than what is consumed today will be required.[8] Our on-campus presentations highlighted that the global food system must increase yields, production and consumer access, but climate change, water scarcity and infrastructures challenges could counter gains in food security that must be achieved in order to feed a growing world population.[9]

As populations continue to grow, mostly in the urban centers, there will be increased challenges to food security caused by rising incomes, loss of farmland to urban development, and a growing cultural divide between the urban centers and their food chain. While rising incomes help people escape poverty, they simultaneously challenge the global food system in three ways. First, greater income means people have the ability to purchase more food, increasing overall demand. Second, rising incomes change the type of food purchased, increasing demand for meat and dairy products. Since animal-based food production requires additional grain for feed, there will be even more pressure on the food system. Finally, rising incomes put additional pressure on the water supply. Uses for consumption, sanitation, industrialization, recreation and beautification compete with agricultural purposes that already use seventy percent of usable water. Land use can also be a point of contention. Urban sprawl claims 1.5 million acres of farmland worldwide for housing and industrial development each year. While some efforts to reserve or reclaim farmland have been marginally successful, the ability to produce more food on less land will be required to feed a growing world population and will continue to be a challenge to food security.

Over the next two to three decades, managing talent, continuing public investment in research and development, and taming politically-driven public policy will only get harder. Talent management is a growing concern for many in the agricultural industry as universities are not graduating enough students to meet the growing demand for educated agribusiness workers and professionals both on and off the farm. Support for public investment in agriculture has been on the decline for decades, quite possibly due to the lack of knowledge of the everyday challenges facing farmers, both domestically and internationally. In every segment of the agribusiness value chain where research dollars have been focused, we have seen productivity increases. The challenge in an increasingly urban-dominated society will be to maintain public support for the agricultural research necessary to meet future demand. Policies and regulations placed on the food industry are generally meant to preserve farms, increase food safety, or sustain the environment, but that is not always the end result. As urban leaders gain greater political power over their rural counterparts, the potential exists for policy and regulation to ultimately diminish the ability of the global food system to feed the world's population.

To be effective, the global food system must be able to efficiently move crops off the farms and into the hands of consumers. A robust infrastructure of roads, transportation, storage, processing and distribution must be in place, however much of the world is underdeveloped and lacks effective infrastructure. In Africa, only thirty-five percent of rural areas have passable roads. Rural areas without access to roads are often mired in poverty and malnutrition. Without adequate roads, investments in advanced farming techniques are unlikely to produce lasting results. The developing world has an opportunity to witness significant investment in their food security if private corporations continue to invest in infrastructure projects.[10]

Finally, climate change is slowly shifting agricultural zones toward the poles, impacting food security by reducing the land available for worldwide food production. Areas hardest hit, as shown in Appendix D, are the food insecure equatorial regions that must increase production year

after year to keep up with growing demand.[11] Farmers must balance increased yields, production and environmental considerations while meeting the challenges of global warming. Water scarcity will be an increasing challenge in many areas of the world as global temperatures rise and precipitation patterns change. Experts anticipate reductions in yields between seven and thirty percent as farmers adapt to changes in their local climates.[12] Temperature changes will enable plant pests and disease to migrate to new areas. Reductions in precipitation due to climate change can directly diminish crop yields, forcing farmers to adapt to the changing conditions by changing crops, investing in water management technology, or moving out of agriculture. Crop variation, soil fertility management, changing planting schedules, water conservation and improved irrigation infrastructure and management will be critical to meeting global food requirements.

After our 2016 Agribusiness Industry Study analyzed the global agribusiness challenges impacting our national security, we focused our research on shifting demand signals, water access, and finally the infrastructure required for the United States agribusiness value chain to operate effectively and efficiently. Our insights were gleaned from governmental and private industry on-campus presentations, as well as our domestic field studies to North Carolina and California. Helping us to understand the multifaceted U.S. agribusiness industry better prepared our group to further analyze whether India and South Africa's agribusiness value chains are postured to increase food security and subsequently, stability around the world.

State of the Agribusiness Industry in the United States

The U.S. agribusiness industry is robust and healthy, and provides health and nutrition for the American people. As the world's largest agricultural exporter by a factor of two, the industry is critical to the economic security of the country and accounts for nearly five percent or $835 billion of the nation's Gross Domestic Product (GDP). Ranging from companies in perfect competition to those demonstrating monopolistic tendencies, different market structures prevail throughout the industry depending on where a company sits in the agribusiness value chain.

The U.S. population is changing in ways that have important implications for the food security and health of the American people. The U.S. population is projected to increase steadily to 400 million by 2050.[13] Important demographic trends in the United States include legal immigration, changing ethnic demographics, changes in farming and the rural population, poverty and inequality, and demographics of food insecure households. Collectively, the trends show that population groups with higher percentages of food insecurity are among the fastest growing segments of the U.S. population. As a result, the United States is likely to invest additional resources to support the nutritional needs of a growing number of food insecure households, as well as increased healthcare costs for America's obese population. These changing demographics will also influence the future relationships consumers have with producers, as well as what farmers produce. In addition, a population decrease in America's rural farming communities will carry on an industry trend toward fewer and larger farms, and further limit the field of potential farmers for the next generation.

Shifting Demand Signals

U.S. consumer demands are increasingly based on changing values that "have led to new relationships between food producers, processors, and retailers."[14] An increasing number of consumers want healthy, nutritious food, and increasingly make decisions based on production

and distribution practices. The support for these practices is expanding the market for organic food and other niche food movements.[15] However, the majority of consumers do not have the access or the means to purchase these products.[16] And while some consumers are trying to make healthier, value-driven choices, consumers face complex and conflicting information that limit their ability to make informed decisions. Information on nutrition, the health benefits of organic versus conventional production, and the risks of genetic engineering are not well understood by consumers, and many concerns remain in question.[17] Many producers have publicly acknowledged the consumer demand for transparency, and have committed to meeting this preference. However, while many businesses support labeling, they do not support separate policies from state to state.[18] The food industry advocates uniform federal regulations to avoid potentially conflicting state rules.[19] In addition, food companies are concerned that consumers will incorrectly interpret a label as a warning.[20] Nevertheless, these consumer choices will have a significant impact on the direction of the agricultural industry. To protect the health of the American people and the agricultural industry, consumers need to be better informed and educated about the health and nutrition of food products.

Producer demand signals include the significant issues and opportunities affecting agricultural input producers, farmers, food processors, packaging producers, and distributors. The coming decades will be a time of transition between farming generations. Policymakers need to support this transition for those who are retiring, and provide new farmers with access to the resources to maintain the agricultural industry. More and earlier outreach and education will help to develop future generations for the agricultural industry. Farmers need better access to land, financial resources, and a legal labor force. Incentives can help farmers transition to more sustainable and higher yield methods of production.[21] As a result of market pressures, both farmers and input producers have seen the structure of their markets move toward fewer, larger operations.[22] Free trade agreements could substantially increase agricultural income,[23] reducing some financial pressures on the industry. Increasing emphasis on food safety is enhancing the health of the American people and the resilience of the agricultural industry. Increased investments in the nation's ability to protect data could not only protect valuable intellectual property, but can also encourage farmers to adopt technologies that can increase productivity.[24]

These issues and trends have important implications for the future of U.S. agriculture and the health of the American people. Demographic trends are likely to result in a growing number of food insecure households, which will require more resources to meet nutritional needs and rising healthcare costs associated with the nation's obesity epidemic. Regardless of whether consumers have clear and accurate information on nutrition, the benefits of organic food, or the risks of genetic engineering, consumer choices on these critical issues will determine the future of food regulation and production. The U.S. must ensure the next generation of farmers has access to resources such as education, land, labor, and financing to maintain a productive, nutritious, safe, and sustainable agricultural industry.

Water Scarcity in the United States

In 2014, the Intergovernmental Panel on Climate Change, an international body established by the United Nations Environmental Program and the World Meteorological Organization, released its fifth Assessment Report. The report concluded that the earth's climate is warming as shown in Appendix E. The major impacts of a warming climate include rising sea levels, melting polar ice caps, and an increase in extreme weather events. These major impacts trigger secondary

impacts which are equally significant and damaging. For example, as global temperatures rise, renewable surface water and groundwater availability declines. As history has shown, tensions related to physical or economic water scarcity often leads to competition and conflict.[25]

Water scarcity, as shown in Appendix F, is truly a global issue that crosses cultural, religious, economic, and political boundaries. Although lack of freshwater can be a source of conflict, water scarcity can also serve as a medium for collaboration. Many international treaties, dispute resolution agreements, and regulatory policies have developed between parties who cooperate over water issues and use water's scarcity as a foundation for peace and stability rather than conflict and war. The U.S. is not immune to tensions over water but we have a history of collaboration in lieu of conflict. One such case involves the Hofer Dam in Walla Walla, Washington. Various stakeholders from farmers, to irrigators, to regulators, to land owners, to environmental stewards were at odds over the best use of the limited supply of river water. The Walla Walla County Conservation District was able to spearhead a project which brought together all stakeholders. The end result was a successful collaborative project which restored the flow of fish and provided more efficient water for the community's use.

Other western states are in a similar predicament to Washington. California, which is in the midst of a five-year drought, suffers from water scarcity perhaps more than any other U.S. state. Our field study to California allowed us to see the impacts first hand. The visit also brought to light two issues that had previously received little attention. The first is that the state's groundwater supply is equally, if not more stressed by the current drought. There is a direct link between groundwater and surface water and that link has been severed by the current drought. As most of the surface water has dried up, California's farmers have been digging wells to access the remaining groundwater supply. Many issues have resulted including ground subsidence and poor water quality. The crisis spurred state government action and resulted in the 2014 Sustainable Groundwater Management Act. This landmark bill regulates pumping and recharges the over-stressed groundwater supply throughout the state, and puts the management focus at the local level.

Though water is often seen as a local issue, the federal government does have a leadership role in helping to resolve water conflicts. Our field study also helped highlight how the federal government has collaborated with California to provide effective assistance. The Public Policy Institute of California points out that the federal government is the largest landowner, irrigation supplier, hydropower provider, and regulator in the West.[26] Therefore, it is critical that California and the federal government continue to work together not only during the state's current drought but also into the future as climate change will continue to stress the state's water supplies. Finally, during our visit we were able to see how the federal government leveraged its authority and resources. In 2014 alone, the federal government provided almost $3 billion to the west to respond to the drought and build local resilience. That money was spent in three main areas: water infrastructure, agricultural water and land stewardship, and emergency response.[27]

Moving forward, the federal government ought to collaborate with state governments to provide resources where they are needed most. However, the key to a successful assistance program, in our opinion, is understanding what the local water issues are and how best to support the stakeholders. The federal government could also encourage a replication of collaborative projects like the Hofer Dam in areas of the country that are experiencing water scarcity. Tensions over water scarcity will only increase in the future, especially since the effects of climate change are expected to exacerbate the problem.

United States Infrastructure Shortfalls

While effective and efficient agribusiness supply chains continue to promote the success of U.S. agriculture, America needs to begin investing in its infrastructure. The private sector, which owns and operates grain elevators, cold storage, and cargo terminals, continues to modernize to maintain a robust and profitable capability and capacity. In addition, America's transportation system has significantly contributed to the historical strength of U.S. agriculture. However, according to the American Society of Civil Engineers' 2013 Report Card for America's Infrastructure, sixty-five percent of the roads are not in good condition, twenty-five percent of the bridges need repairs or upgrades, the inland waterways haven't been updated since the 1950s, and the dams are over fifty years old on average. As our infrastructure ages and falls into disrepair, it will have a negative impact on U.S. agribusiness and consumers. Significant public sector investment in U.S. infrastructure is necessary to support the future success of American agriculture.

State of the Agribusiness Industry in India

Since food security is correlated with stability, our Agribusiness Industry Study group wanted to analyze what progress India, a developing and innovative democracy with the third largest number of billionaires, has made over the last decade to become one of world's largest agricultural producers. In addition, looking ahead to 2050, we also wanted to evaluate what political, economic and social reforms the country is now implementing to ensure food security for all its citizens, to include more than three hundred million undernourished men, women and children.

Shifting Demand Signals

Over the next twenty to thirty years, the U.S. and India will benefit from each other's economic growth. With a gross domestic product which has quadrupled over the last fifteen years, a capable military which includes the third largest army in the world, and a growing agribusiness industry which is a net exporter of agricultural commodities, India's stature on the world stage is rapidly growing. Opportunities abound for this growing democracy to include reducing bureaucracy between the federal and state governments, and taking advantage of public-private partnerships to improve health, sanitation, and malnutrition.

Four 'megatrends' expected to shape the world's future environment are individual empowerment, diffusion of power, demographic patterns, and the food/energy/water nexus. Over the last twelve years India has implemented national food and employment programs, halving its extreme poor in the process. Yet the country remains mired in deep cultural beliefs limiting individual empowerment, specifically with respect to how they treat women and their lower castes. Rightly so, the default demographic when discussing India is their population. In 2013, India stood as the second most populous country in the world with 1.25 billion people. With a moderate growth rate of 1.5 percent, India is expected to surpass China by 2022. A quarter of the world's food insecure population and a third of the world's undernourished children reside in India, placing

exorbitant demands on India and on the world to lift the country's poor from extreme poverty. Each of these issues also places extreme demands on India's food, energy, and water resources, all of which are government subsidized and inefficiently used.

While competitor nations are coping with rising healthcare costs and aging populations, India's youthful population is poised to take advantage of a massive labor dividend over the next thirty-five years (29 percent of their 1.25B population is under fifteen). The country has also seen a drastic decline in child stunting, malnutrition, and wasting, in large part to both green (crop) and white (dairy) revolutions over the last forty years. With national programs to ensure the threat of famine has been eradicated, agriculture remains vital to India's GDP. India is now the world's seventh largest agricultural exporter, due in large part to a significant increase in government subsidies. India is the top global producer of milk, trails only the U.S. in cotton production, and is third in beef production behind the U.S. and Brazil. Last year, grain production, especially rice, helped the country generate more than $39.3 billion in exports.

India's agricultural policies have made positive progress towards eradicating extreme poverty and feeding the population, but with looming macro-trends such as climate change and urbanization, the sustainability of social programs on such a massive scale must be questioned. Massive urbanization has led to a population density more than eleven times that of the OECD average, often pulling men from farms to urban employment, and leaving women behind with little power to improve productivity. Furthermore, the scale of those in extreme poverty also places a huge burden on the government's social programs as well as the health and sanitation programs.

India's Water Crisis

India is in the midst of a water crisis. Water scarcity and poor quality are significantly impacting the population's health and the country's overall food security. Even if water is scarce, it still needs to be safe for drinking, cleaning, and cooking to prevent illness and promote health. Unfortunately for India, the little water made available is of poor quality and has had devastating effects on the country's impoverished population. With a continued increase in urbanization and population growth, food and water demands will come under increased pressure to meet the needs of the Indian population. India's water crisis is rooted in three causes: total amount of usable water, poor water quality, and dwindling groundwater supplies.[28]

According to the United Nations, India's water quality ranks as one of the worst in the world (120th out of 122nd). Seventy percent of the country's water supply is contaminated.[29] The poor water quality can be attributed to: insufficient wastewater treatment facilities, inadequate infrastructure for sanitation and sewage, and pollution from industrialization and agriculture. India's main river, the Ganges, supports over four hundred and fifty million people in India every day. Of note, more than 12,000 million liters per day of sewage is dumped into the Ganges. Water treatment facilities exist, but they only have the capacity to clean 4,000 million liters per day. This lack of capacity impacts the millions of people who rely on the Ganges for water to cook, clean, drink and farm their fields.[30]

The inadequate infrastructure for sanitation and sewage further complicates India's poor water quality. The country's tanneries routinely release toxic levels of sulfuric acid, chromium, arsenic, and mercury into the Ganges. These industrial pollutants are believed to have caused higher rates of cancer and blindness in India's children.[31] In regards to agricultural pollution, the poor water quality can be linked to organic and inorganic contaminants such as dissolved contents of fertilizers, pesticide chemical runoff, and livestock manure that are creating dead marine zones

in the Ganges.[32] Due to India's industrialization and inadequate infrastructure, poor water quality impacts human health and food security. Diarrhea is the number one killer of Indian children and two hundred million days of work are lost each year from waterborne illnesses. Finally, the use of untreated sewage water on vegetable crops causes illness and disease outbreaks.

Clean water for all is a challenge that India must tackle in order to improve the health and food security of its citizens. The government will need to lead the effort by creating one agency to manage all water issues, as well as to work with partners to increase wastewater treatment centers, improve infrastructure for sanitation and sewage, and reduce industrial and agricultural pollution. Despite its challenges, India recognizes it must take steps to ensure clean water for all of its citizens.

Bureaucratic Reform to Increase India's Infrastructure Capacity

For India to continue its economic growth, it is important for the country to build its transportation infrastructure in order to enable its domestic economy and improve its overall global competitiveness, which will lower trade and transaction costs.[33] Transportation infrastructure requires strong planning, coordination, decentralization, private participation and commercialization of service providers instead of a top to bottom approach which has traditionally been practiced in India.[34] India's greatest challenge with transportation infrastructure has been slow implementation.[35] There are several reasons for this to include: a lack of public-private partnerships, a decrease in fiscal resources, a lack of coordination between the central and state governments, and finally, the government's land acquisition practices.

On the whole, public-private partnerships have not met the country's requirements for investment in transportation infrastructure. In India, public-private partnerships lack regulatory framework, information and guidance. There is not a single voice in the country that prioritizes investment projects, nor is there a clear framework for dispute resolutions. Although the government supports public-private partnerships, the lack of financial support and risk mitigation limits investment success.[36]

Financing is another area of challenge for India's transportation infrastructure. In the past, state governments initiated, owned, and managed all transportation projects. Today, the government faces fiscal constraints because of the enormous demand being placed upon nearly all modes of transportation requirements. Although India's economy is growing, it still faces budget constraints, debt obligations, and has to dedicate resources to projects other than transportation infrastructure. If India were to improve the way it finances infrastructure projects through loan incentive programs, such as a guaranteed special low interest rate for private firms that invest in transportation infrastructure projects, the private sector will step up their investment and fill the government void.[37]

The difficulty of coordination between the central and state governments is another big challenge for transportation development in India. Any transportation project initiated in India requires clearances from both the central and state governments. This is a very time consuming and bureaucratic process. The central government on occasion will try to reform policy, however, implementation happens at the state level and that is where the bureaucratic challenges most frequently occur.[38]

Finally, land acquisition is a major infrastructure challenge in India. Urbanization, economic development, and industrialization are putting pressure on small landholders. Citizens are protesting about being forced to sell their land and they are concerned that the government is

buying land at undervalued market prices.[39] Land acquisition reform in India could occur if a coordinated effort between all modes of transportation, the government, and the land owner could ensure proper compensation to land owners when the government acquires land for transportation projects.[40]

Opportunities exist to improve the speed of India's transportation infrastructure development. For example, an independent governmental organization for all transportation infrastructure modes could be empowered to get approvals for projects within a stipulated legal timeframe that binds the central and state governments. The government could also: 1) improve the framework for dispute resolutions when it comes to transportation projects; 2) provide guarantees and other forms of subsidies to private investors to ensure confidence in India's market; and 3) actively pursue foreign investment by allowing foreign ownership of transportation infrastructure projects. If the Indian government can reform its processes, it has a great opportunity to connect all modes of transport and create a world class transportation system that will enable its internal and external agribusiness supply chains.

A Supply Chain Investment in India's National Waterways

The Indian government understands that its food security issues, as they relate to undernourishment and malnutrition, are due in large part to a food access problem. But India's transportation infrastructure remains a burden to the entire economy. The road networks are severally congested, less than sixty percent are paved and access to rural communities is limited.[41] The railway system has significantly improved in quality and capacity over the last 10 years, but extension to the overall length was marginal. To address these and numerous other issues, the current Indian government continues to make infrastructure development a top priority, and their renewed investment in inland waterways shows the most promise for improving the lives of India's people.[42]

A national commitment by the Indian government to developing its inland waterway infrastructure will provide it with a more cost effective means of transporting agricultural commodities and will help improve the food access problem for millions of people. In 2015, the government announced plans to rededicate itself to the development of its inland waterways, and in March 2016, the Indian Parliament passed the National Waterways Bill. Unlike previous inland waterway legislation that nationalized one river at a time, the new bill placed 111 rivers under the federal government's oversight and dedicated $10.5 billion to the first phase of the revitalization project.[43]

There are two facts that highlight the untapped potential of the inland waterways. The first is that India has the ninth longest waterway system in the world.[44] India's current national waterways make up only 30 percent of the country's known navigable rivers, lakes and canals, but an additional 6,300 miles will now be available for commercial use. The second fact is that the renewed infrastructure investment in India's National Waterways will help the government reduce the cost of building and maintaining its transportation infrastructure and will help drive down transportation costs across all economic sectors.[45]

Specific to India's agricultural industry, an investment in their national waterways will have three primary benefits: (1) it will help reduce transportation costs; (2) it will help reduce food waste normally found at the beginning of the agribusiness value chain; and (3) it will improve people's access to food by increasing employment opportunities in rural communities.

There is little doubt that India has the capacity and the will to cement its position as a true economic world power. Many of its economic sectors already rank in the top percentile of global output, and India is the only member of the BRIC nations whose growth is projected to remain consistent throughout the second half of this decade.[46] However, India's rise must include every member of its society, especially the millions who are under and malnourished. India will undoubtedly reap the fruits of its labor well into the second half of the 21st century if they drive down costs with a more efficient transportation system, make more food available for distribution, and create a labor market in regions of the country where employment opportunities are limited to only farm production.

India Field Study Observations

Our research of India's water scarcity, poor water quality, lack of investment in infrastructure, and inefficient food storage systems was validated by our direct observations. Our field study demonstrated that improving government policies, investing in public-private partnerships, and divesting water subsidies is vital to India's food security. The Indian government should consolidate the independent organizations that are responsible for all infrastructure investment. Additionally, our field study confirmed that public-private partnerships are key to closing the technology gaps necessary for implementing sustainable water practices (including improved quality), enhancing agricultural yields, and improving the road infrastructure throughout India. Finally, the country should divest water subsidies in order to incentivize efficient water programs such as sprinkler systems, drip irrigation, plastic aqueducts and sluice linings, and or encourage farmers to utilize drought tolerant genetically engineered seeds.

After visiting Delhi's wholesale and retail food markets, it is clear that there is no incentive for the country to develop an internally focused cold storage logistics system. Our industry group discovered that farmers who sell their crops at the government subsidized markets sell 100 percent of their produce every day. The retailers only begin to lose money as the day ends and products begin to deteriorate. At this point, the retailers sell their products as animal feed at a reduced rate. While food waste is as high as thirty percent throughout the developed world, it appears that the wholesale and retail markets we saw effectively sell all crops either for human or animal consumption.

The field study also helped us to witness India's agricultural practices first hand. Inefficient water usage was worse than our research indicated. For example, our group visited a typical, but successful local farm and small landholder who used his groundwater to pump and flow water into a dirt based irrigation system. The water indiscriminately flooded the farmer's crops, watering both product and weed alike. Since the dirt canals guided the water, the farmer often had to rush over and plug any holes with more dirt and rocks to prevent the water from seeping through to land that did not need to be irrigated. In addition, vegetables which had grown heavy on the vine drooped into the troughs, accelerating the mold and rotting process. Hence, inefficient water usage not only compounds the country's water scarcity problem but also exacerbates food waste during harvest and transport.

India is slowly developing its road infrastructure. This observation was reaffirmed as our seminar left the A11 expressway and drove along Aligarh-Palwal road (SH-22A) through the city of Jattari to the village of Narayanpur in the Aligarh District of Uttar Pradesh. We observed that the rural road was in very poor condition and that traveling on this road was very dangerous.

India's infrastructure is under increasing stress as the country grows economically and attempts to streamline farm to market access for its farmers.

State of the Agribusiness Industry in South Africa

As a newly industrialized country with the second largest economy in Africa, the Republic of South Africa is in a strong position to lead Sub-Saharan Africa's agricultural transformation and feed the continent's burgeoning population. Our final case study allowed our Industry Study to evaluate the productivity that one country's agricultural sector can have on an entire region. The South African Department of Agriculture's vision is to advance food security, job creation, and economic growth.[47] As a leader in Sub-Saharan Africa, the South African government is implementing policies and leveraging advancements in biotechnology to increase agricultural productivity. Furthermore, the government is investing in additional food processing facilities and breaking down export barriers to energize their agricultural sector. South Africa has the potential to take advantage of their own green revolution and help to guarantee regional food security if current drought conditions do not destroy their farming sector.

Shifting Demand Signals

The landscape of food production and consumption in the Republic of South Africa (RSA) has been transformed over the last two decades by government policy and a burgeoning black middle class. A broad environmental scan of the country's economy and agribusiness value chain,[48] along with demand signals from relevant stakeholders (i.e., consumers, producers, and elected officials) validates this assertion.

Despite the country's relatively high per capita GDP for Sub-Sahara Africa,[49] the economy is beset by widespread unemployment, income inequality, and poverty. South Africa's slow GDP growth and high inflation rate are hindering the country's long term potential. The country's GINI coefficient as of 2011 was 0.63 reflecting high inequality.[50] Yet agriculture is important to the country's socio-economic development. It makes up under three percent of South Africa's GDP ($19M), but is seven percent of the formal employment and its value chain contributes twelve percent to the national GDP.[51] The foundation of the country's food value chain is a dual farm structure that features a well-developed and internationally competitive sector of commercial farms alongside smaller-scale communal operations.[52] These small holder farmers must deal with climatic and soil conditions that are generally not conducive to high yields. Non-commercial agricultural households include 2.2 million small holder and subsistence farmers, while 40,000 commercial farmers make up the rest of the farming industry. Finally, out of thirty-five million acres of arable land, only ten percent is irrigated, making the current drought particularly damaging to most of the country's crops. South Africa is typically a net exporter of agricultural products (30th in the world). However, this year their yields are expected to be as much as fifty percent less, so the country's ability to export products to the rest of Sub-Sahara Africa will be severely affected.[53]

Due in large measure to post-apartheid reforms and a growing black middle class, South African consumers are in the midst of a "nutritional transition"[54] from cereal-based foods to those with higher protein, oil, and fat content. Household hunger rates have dropped from 29 percent to 13 percent in the past decade.[55] Per capita demand for chicken and eggs has gone up, while that

for fruit and vegetables has not changed, and beef, mutton, and pork has gone down.[56] With more grocery retailers out in the countryside, consumers now have more options, and their preferences are trending toward convenience foods.[57] The population is projected to grow from 54 million in 2015 to 65 million by 2050[58] and will age 40 percent by 2050.[59] Coupled with continued affluence for the upper and middle classes, these demographic factors will undoubtedly drive South Africa to complete its nutritional transition, necessitating the availability of more protein-based food products.

On the producer side, there has been a seismic structural shift since the mid-1990s. With the government's deregulation of agriculture which created dynamic market conditions, significant sector consolidation has occurred, resulting in larger farms, capital intensiveness, and declining employment in the sector.[60] Large producers are also shifting away from low-value staple crops toward high-value export crops.[61] As a result, the country's food trade volume and surplus have increased four-fold and six-fold, respectively, since 1995.[62]

Politically, South Africa's leaders view the agricultural sector as a primary driver for economic growth. The government's strategic plans and initiatives also seek to leverage the agricultural sector as a means of addressing rural unemployment and poverty issues.[63] A central policy lever is land reform, which involves land restitution, redistribution, and tenure in order to create an enabling environment for previously disadvantaged farmers.[64]

Climate Change

Climate change presents challenges to agriculture not only through increased temperatures, but also with more pronounced variation in rainfall and droughts and increased carbon dioxide concentrations.[65] Thus, climate change threatens global food security and studying its impacts on South Africa's agriculture can provide insights to global solutions.

South Africa has a diverse geography and climate, economy, and agricultural sector. It has desert, mountains, and high inland plateaus.[66] Over twelve percent of South Africa's land is arable and livestock farming constitutes the majority of the agriculture sector.[67] South Africa is ninety percent arid or semi-arid and has an annual rainfall of seventeen inches with twenty-one percent receiving eight inches or less. Comparatively, the global average rainfall is almost thirty-four inches.[68] South Africa is the thirtieth driest country in the world. Its fresh water is sourced from 8 percent of the surface land and of this, only sixteen percent is protected.[69] Water is the number one limiting factor to increasing farmer yields in South Africa, despite the fact that South Africa already allocates sixty-three percent of its fresh water to irrigation. However, the 1.5 percent of land which receives this irrigated water produces thirty percent of the nation's crops.[70] By 2030 there will be a seventeen percent gap between water demand and supply. Individual catchments will have gaps of twenty to fifty percent.[71] Likewise, population growth and urbanization will compete for the water needed for agriculture.

The country's average temperatures in the past fifty years have increased 1.5 times more than the global average of 0.65 percent. Likewise, the frequency of extreme rainfall and drought events have increased.[72] Continued rising temperatures will bring a drier climate and increased water stress, a change to growing seasons, and more considerable variations in precipitation and droughts. Areas of intense poverty and widespread inequality make South Africa particularly vulnerable to climate change.

South Africa must continue its efforts to reduce greenhouse gasses in order to minimize climate change. However, there are adaptive measures that it should take also. Extension services

must improve dramatically in order to bring technology changes to farming practices, to include drought resistant seeds. Crop variation, soil fertility management, changing planting schedules, water conservation and improved irrigation infrastructure and management will be critical to South Africa meeting its food requirements.

Water Management: Essential To South Africa's Food Security

Despite developmental progress over the last two decades, economic growth, poverty reduction, and combating climate change remain serious challenges for South Africa. In addition, the effects of El Nino are exacerbating the country's fragile ecosystems and water management practices. The South African government will need to continue to build institutional capacity at regional and local levels in order to capitalize on the region's economic growth potential. Furthermore, water infrastructure which supports human consumption and agricultural production is paramount to eradicating food insecurity in Sub-Sahara Africa.

Water is central to the food-energy nexus. While South Africa did meet their millennium development goal for access to clean drinking water, the country still needs to build water infrastructure to support further development. Like many African nations, infrastructure investment and maintenance is challenging due to large financial investment requirements, project timelines, management capacity, and regulatory hurdles. While South Africa boasts a solid infrastructure sector compared to the rest of Sub-Sahara Africa, the country's low investment in water infrastructure is worrisome for future productivity and economic growth.

South Africa's Department of Water and Environmental Affairs estimates that the demand for water will outstrip supply in the whole of South Africa by 2025.[73] Water infrastructure is a very sensitive issue in the face of climate change, local conflict, and dwindling supply. Nonetheless, South Africa is one of the few countries in the world that enshrines the right to sufficient water in its Constitution, stating that "everyone has the right to have access to sufficient food and water."[74] That said, they have yet to deliver this right to every citizen.

South Africa has a modern and progressive water governance system resulting from their 1996 Water Act. The act granted higher priority to human consumption and preferential access to smaller farmers, terminated the riparian principle of water rights, subsidized water prices, and encouraged greater cross-border cooperation between Southern African countries. Two decades later, the act's implementation has been slow.[75]

Innovative models of regional cooperation and public-private partnerships are key to ensuring equitable water access and quality management. The Southern African Development Community (SADC) is a regional inter-governmental body, with 14 member countries (Angola, Botswana, Congo (DR), Lesotho, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Tanzania, Swaziland, Zambia, and Zimbabwe). SADC member states acknowledge the importance of regional cooperation around water management issues. In addition to public-private partnerships, regional cooperation and joint collaboration among SADC member states is leading to the development of a number of large-scale transnational water management systems. For example, the Lesotho Highlands Water Project Phase II is a bilateral agreement with South Africa that will augment water supply to the Vaal catchment and serve the economic heartland and long term water demand for South Africa's Gauteng province.[76] Additional SADC cooperative initiatives include increasing intra-regional trade, agricultural marketing and research, and transboundary water management schemes. It is apparent from the region's current drought that intra-regional agricultural trade also fortifies the region's food security when one country is hit

harder by extreme weather events than another. The effects of El Nino are impacting the region's agricultural production and raise concerns for food security and livelihoods in multiple Sub-Saharan countries.[77]

Further support to small holder and subsistence farmers in the form of land, extension services, credit, and education will be essential if South Africa is to go the last mile of development. Innovations in irrigation, water harvesting, and other water management practices will be important to the country and its farmers as they prepare and adapt to a changing climate. Given the growing demands from industry, households, and the environment, managing the rainfall, river resources and conserving water are important in order to meet the food demands of future generations.[78] Given the large draw on water resources for agriculture, integrated and regional water management plans are essential.

South Africa's Investment in its Supply Chain

The Green Revolution sparked a sharp rise in food production globally and stimulated a global food supply chain which continues to feed an increasingly globalized and urbanized world. This supply chain will be crucial in the world's attempt to feed an additional two billion people over the next thirty-five years while adjusting to climate change impacts.

The government of South Africa is putting significant effort into developing their agricultural sector as part of a broader social and economic transformation. While all aspects of the agricultural supply chain are included in strategic plans, land reform, labor and specific crop and herd programs are targeting production. South Africa's agricultural strategy reminds us that agriculture is a critical element of national strategy. The country's future depends on its ability to feed its population. South Africa's regional and global influence is also linked to its ability to export needed agricultural goods. If land reform, labor issues and Broad-Based Black Economic Empowerment (BEE) policies are balanced in a way that does not undermine the value chain, South Africa's highly productive farms, robust infrastructure, and investment opportunities in the agribusiness value chain will be key to the region's future success.

South Africa's agricultural plan applies programs all along the general value chain as part of an effort to transform into a country with low unemployment, a net agricultural exporter, and a population with economic opportunities. South Africa has the highest developed transportation infrastructure on the continent which is an advantage to their supply chain. To increase exports, South Africa will need to add to its relatively small food processing capacity and continue to refine its biosecurity and food safety programs. Production related programs are directed at land reform, labor, selection of crops and herds, research, extension services, farm assistance, conservation issues and the development of markets.

South Africa has the ingredients of a bright agricultural future with productive farms, an opportunity to expand food processing with foreign direct investment, and infrastructure to support exports. Research, extension, food safety and biosecurity policies are comprehensive and continually refined. Conservation agriculture is encouraged to save soil and water for future generations. South Africa's future in terms of influence and meeting domestic development goals are linked to the success of the agricultural sector. Continued development in the agribusiness value chain must be carefully balanced and competing social policies must not be allowed to undermine the sector. South Africa's ability to create jobs and implement land reform within a modern productive agricultural sector will influence the future of Sub-Saharan African agriculture.

South Africa Field Study Observations

Our Industry Study's research into South Africa's severe drought, water scarcity, slow economic growth, and competing social practices were also validated by our field study observations. However, the situation is far graver than our group anticipated. As the bread basket of Africa, South Africa's inability to supply the region with grain could have an adverse effect on the entirety of Sub-Saharan Africa. The overarching question we encountered was whether instability is on the horizon?

South Africa is in the fifth year of reduced white maize production due to multi-year drought conditions. Surface water levels at multiple dams around the country are very low. We learned that one town near a farm we visited in Free State was expected to run out of water the following week with no solution in place to provide the inhabitants with water. The country has no ground water supplies to rely on during drought years. Grain crops are generally planted in October or November when the season's first rains are expected. The crops then rely on subsequent rainfall until harvest. This year the first rains arrived three months late. Since the crops were planted late and little rain was subsequently received, most of the grain crops have been lost.

White maize, the staple grain in southern Africa, is typically an annual export crop for South Africa but this year the country is importing non-genetically engineered white maize from Mexico. Even though South Africa grows genetically engineered white maize, they currently do not allow the import of the same product, which eliminates the option to import genetically modified (GM) crops from the United States. This trade policy is not normally an issue as long as South Africa remains a net exporter of white maize but the drought has created a need for South Africa to look to the global market to meet their needs and the needs of other SADC countries to whom they supply maize. Negotiations are underway with the United States to approve imported genetically engineered white maize from the U.S. This is important because white maize is only grown commercially in sub-Saharan Africa, the U.S., and Mexico. Because many other Sub-Saharan African countries depend on South African white maize, the impact of the drought, low yields and subsequent high white maize prices are expected to impact regional food security. This could easily lead to unrest in a population that spends up to forty-seven percent of their meager income on food.

Broad Based Black Economic Empowerment (BEE) drives every sector to develop policies to promote equality. Supplier creation is a term used to refer to the transformation of the racial profile of suppliers to develop black owned suppliers who are geared to the sensitives of local issues. As an example, Volkswagen is struggling to develop black suppliers so they can meet the 75 percent black supplier use metric imposed by the South African government. Agro-processers fall under the same policy and the development of black suppliers (farmers) is also driven by the same BEE policies. The government is also promoting BBE and redistributing white owned farms to black families who submit land claims. The vast majority of black families take the cash option rather than the land which is threatening the financial viability of the program. The current policy puts formerly productive land in the hands of non-farmers or the government, who now hold vast swaths of farmland. The unintended result is that productive farmland is being transitioned to non-productive land.

Policy Recommendations

To advance the 2015 National Security Strategy goal of promoting food security around the globe, several policy changes and initiatives are needed in both the public and private sectors. However, some strategic context is necessary to better understand how our recommendations could be implemented. First, the nation's political climate has created austere fiscal policies, especially at the Federal level. When government programs require more resources, the question of where the funds should be cut from often surfaces. In most cases, shifting resources from the Department of Defense to other agencies such as the U.S. Agency for International Development (USAID) often makes sense. Not just because DoD's budget dwarfs most other agency budgets, but because our industry group's recommendations could increase global food security which would decrease the prospect of requiring DoD resources to deal with future instability. Essentially, we are proposing several recommendations to help shape the environment and decrease the demand on the military to solve regional problems. Next, the USG should solve complex problems with a whole of government approach. The nation's vast resources and knowledge base are formidable when interagency cooperation is achieved. For internal efforts to improve U.S. food security, the U.S. Department of Agriculture (USDA) should take the lead while for external efforts USAID should reestablish itself as the lead. Other entities that have a role in food security should ensure their efforts are coordinated with both USDA and USAID.

Our group's first set of recommendations falls under the purview of education. Within the United States, it is our recommendation that USDA needs to work with the Department of Education to promote an understanding of how food gets from pre-farm to fork in the primary and secondary curriculum. Similar to *MyPlate*, which is run by the Center for Nutrition Policy and Promotion, the effort would also promote health and nutrition. Understanding the agribusiness value chain will raise awareness and support for the agricultural industry and may encourage our youth to join the agricultural economic sector.

Within our higher education system, Land Grant Universities (LGUs) need to build better educational pathways for future farming generations. Many next generation rural farmers are not granted admission to LGUs because they cannot compete with students in urban areas who have access to more advanced classes and greater extracurricular activities. It appears that LGUs are attracting and accepting undergraduate students who want to pursue life science degrees as a precursor for medical or law school. To counter this recent phenomenon, LGUs should admit a guaranteed percentage of next generation farmers from rural communities. Additionally, USDA could grant agribusiness scholarships/fellowships to students in exchange for a rural farming service obligation similar to scholarships given by the National Health Service Corps for future medical service in underserved rural areas.

The United States' LGUs are a tremendous asset to the nation's agricultural industry. Their direct education of future farmers, technical research, and extension programs reap tremendous benefits for American farming efforts. It is recommended that Congress broaden the scope of the LGUs to enable efforts beyond enhancing domestic production and allow for external extension services. This mandate would protect LGU funding and broaden their focus to enhancing global productivity. Building public/private educational partnerships between LGUs and private colleges could also leverage the strengths of both educational institutions. For example, many private

colleges have foreign campuses and overseas contacts. The LGU faculty could leverage these contacts to help broaden extension services in countries where agricultural challenges are the greatest. For example, a possible partnership between North Carolina State University's College of Agriculture and Life Science with Duke University's Women's Studies Department would be very beneficial for small holder farmers in China. Women grow most of the food consumed locally in food insecure countries.[79] Duke could integrate NC State's agricultural experts into their women's studies department at their Kunshan campus in China to aid in increasing food security in remote areas of eastern China.

Beyond talent management, the U.S. must maintain a labor force to harvest our nation's crops. Congress must pass immigration reform to make it easier for migrant workers to enter and leave the country legally during the labor-intensive harvesting periods. Some laws as currently written put unnecessary cost and infrastructure burdens on farming companies. An example is the requirement for farms to provide non-immigrant labor housing for their seasonal workers. Even when these areas are built in compliance with regulation, some local municipalities resist their construction due to political pressure from their constituencies. Smart policy reform and increased legal migrant worker populations will actually increase the tax revenue and help offset the price of some of the other programs to improve agriculture in the U.S.

To improve our nation's failing infrastructure, Congress should increase the federal gas tax to fund the 2016 Highway Bill and ensure projects affecting agribusiness, such as river locks maintenance and upgrading port facilities, are incorporated into the transit portion of the legislation. To enhance efforts on agricultural related infrastructure improvements, Congress could offer incentives such as tax credits or exemptions to private firms who invest in public infrastructure.

To leverage broader investment from the private sector, Congress can motivate private sector investment. In 2013, India's government passed the Companies Act, mandating corporations to devote two percent of their net profits to social responsibility initiatives.[80] While a social responsibility tax may not be politically viable in the U.S., Congress could incentivize corporations to invest in projects which tackle some of our own domestic food concerns. For example, projects to overcome the lack of healthy and affordable food options in inner cities for at-risk families, or safe and low-cost water reclamation projects in areas affected by drought, or potable water drinking solutions for areas devoid of appropriate infrastructure are just a few of the possibilities where private investment would benefit the public good. This type of incentive program leverages the innovation and rapid implementation characteristics of the private sector, while meeting the needs of the common good.

Without a change to current law, Congress can use the budgetary process to encourage greater information sharing and to increase global food security. USAID is the agency tasked with assisting developing countries to enhance their capabilities in areas of governance, education, and agriculture. In a new effort to harness solutions globally, USAID created the Global Development Lab (GDL) to "accelerate the transformation of the development enterprise by opening development to people everywhere with good ideas, promoting new and deepening existing partnerships, bringing data and evidence to bear, and harnessing scientific and technological advances."[81] We recommend that Congress earmark funding well above GDL's current budget of $200,000 in order to allow greater synergies amongst the agricultural industry, both domestically and internationally. Furthermore, future appropriations could also be allocated to facilitate coordination and food security projects between the Environmental Protection Agency, the U.S. Department of Agriculture, the Centers for Disease Control, and the Army Corps of Engineers.

Finally, Congress could also earmark funds for the Presidential Initiatives Partnerships for Growth (PFG), a State Department program heavily executed by USAID. El Salvador, Ghana, Philippines, and Tanzania were the first PFG countries, but the PFG initiatives were executed without line item funding and drew limited resources from other State and USAID efforts.[82] Fully funding PFG requests enables food insecure countries to achieve better development results through intergovernmental and private-sector efforts.

The Department of Defense can also aid countries around the world to address infrastructure and education issues related to food security. Periodically, the Secretary of Defense publishes the Defense Strategic Guidance (DSG). In the DSG, all Geographic Combatant Commanders (GCCs) are directed to develop a Theater Security Cooperation Plan (TSCPs). The TSCPs describe how each GCC will build partnership capacity and strive to maintain stability in their area of the world. The Secretary of Defense could also direct each GCC to focus training partnerships on efforts which aid with overcoming food insecurity. These types of activities could cover a wide range of efforts, to include: engineering projects to improve or increase infrastructure which allow for the better movement of food within a country and increasing civil affairs missions to elevate education on clean water and agricultural practices. These are some of the areas where the TSPCs could have an impact on food security when applied in a deliberate way. As stated before, any and all TSCP efforts should be coordinated with the State Department and USAID to ensure an integrated plan for aid to the foreign country's development.

Conclusion

The agribusiness industry is at the center of global security. Without food security, basic human needs are not met, and instability within a country follows. Stability and security depend not only on the actual farming of food, but this study observed first-hand the wide array of intersecting industries and policies that must be synchronized to ensure success: cyber technology, biotechnology, infrastructure, manufacturing, environment, and healthcare.

Common themes emerged during our field studies. Management of water resources is key to the security of agribusiness. Visits with farmers in the Salinas Valley, California, Narayanpur Village, India, and Free State Province, South Africa, all divulged a similar story. In order to ensure stability, further development of water source management by both central and local governments, as well as farmers must be a higher priority. Additionally, the U.S. must continue to educate the world's farmers that the benefits of biotechnology, no-till farming, and other climate smart precision agricultural techniques will increase yields as well as global food security. Finally, the studies observed as basic nutritional needs are met and incomes increase, the processing of food before it reaches the consumer also creates jobs in other sectors, even as farms get larger and more mechanized with fewer people working on them.

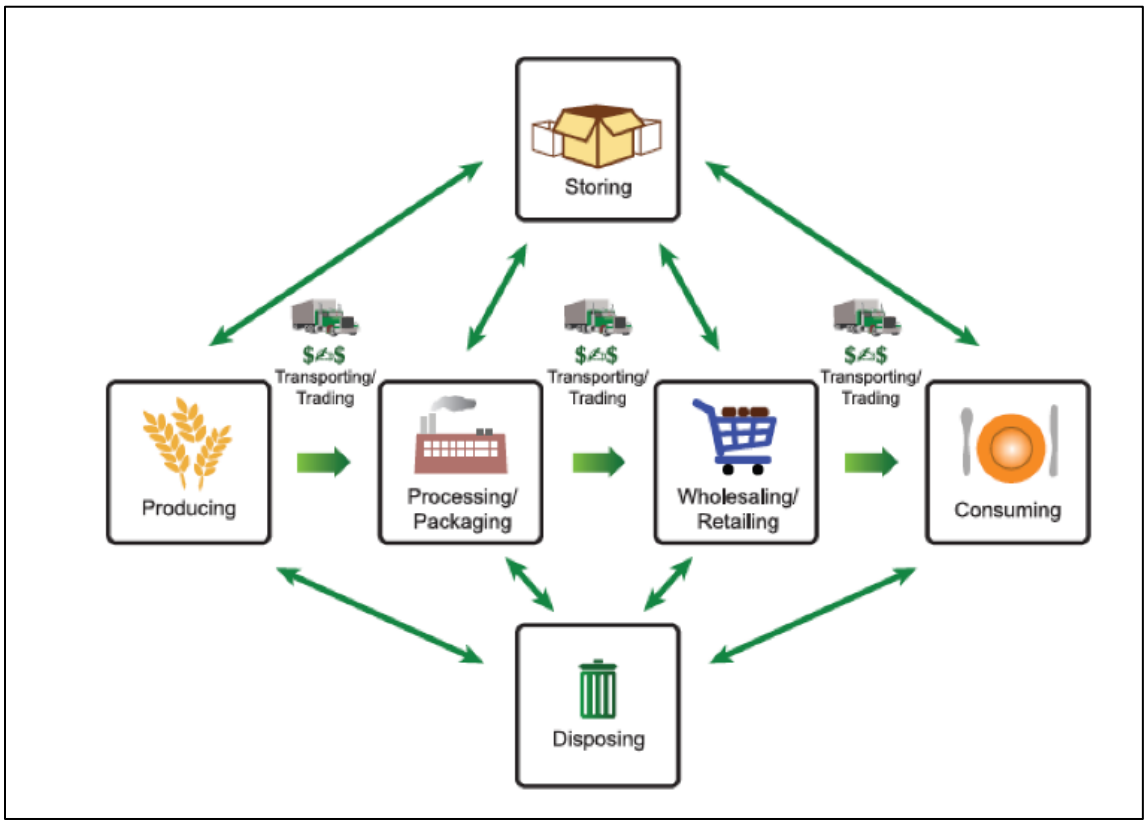
The technology to feed nine billion people already exists. However, a common understanding of the problem and how to address it does not exist. Global leadership is an imperative. The National Security Strategy directs the U.S. to "leverage our leadership in promoting food security, enhancing resilience, modernizing rural agriculture, and reducing the vulnerability of the poor."[83] To accomplish this mission, the U.S. must help other governments deliver educational extension services, policies, and infrastructure to pave the way for private companies to apply existing and emerging technologies to meet future global demand. When there is a financial incentive and a secure environment, private industry will invest in a developing country. Governments cannot provide food security without the support of private industry.

Private industry will not enter a foreign market without favorable market conditions and sound government leadership.

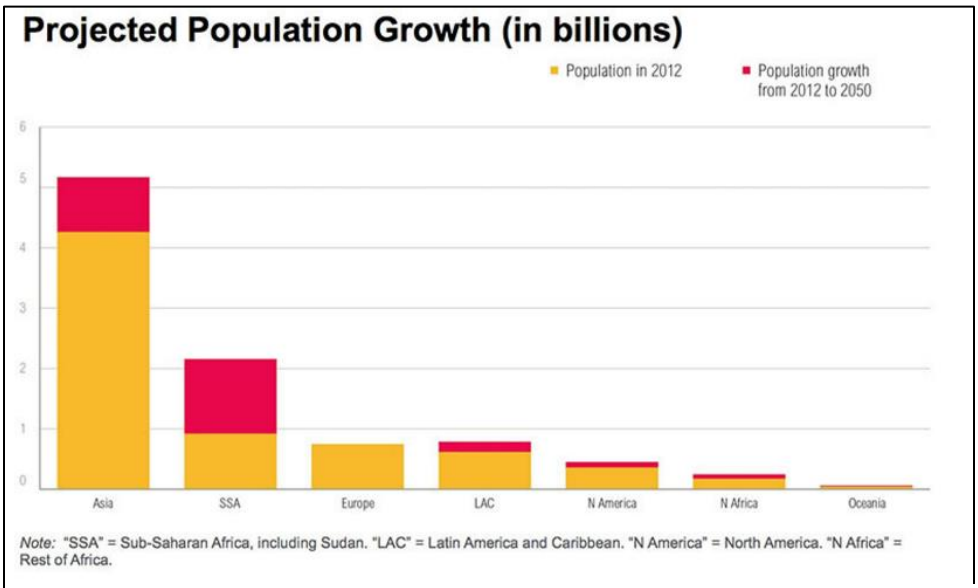
To make this even more challenging, there is not one single formula the U.S. can apply to ensure food security in every country. This study observed that the way that different industries invest resources varies greatly in the U.S., India, and South Africa. For example, the cold-storage supply chain which delivers an apple to a consumer in the U.S. is quite different than the one that delivers an imported apple via bicycle to a small vendor in India. Despite all of the differences in government policy and multiple country specific approaches to food security, the challenge of feeding an exponentially increasing population is a global one. Most of the increased stress on food security will be focused on areas that are already poor and food insecure, which poses very little hope for stability without partnerships between governments, NGOs, and private companies.

Finally, climate change will impact all aspects of global security, especially agribusiness, and will hit the most vulnerable food insecure regions the hardest. In those regions, crop yields will decrease and populations will move to urban areas when rural agricultural opportunities diminish. Compounding the problem further, access to water in the same areas will be extremely difficult, making this already wicked problem worse. Many regions will not have the capacity to make the necessary infrastructure and education investments necessary without assistance. It is in the interest of the U.S. to "leverage our leadership" [84] to help these regions. Emerging countries like India will be able to take steps in this direction, but assistance is still needed. Other nations, like those in Sub-Saharan Africa, will not be able to make any real steps without help, and will be extremely vulnerable to further instability without it. Despite all the challenges highlighted throughout this paper, our Agribusiness industry study is hopeful that the global food supply over the next century will exceed demand if the world "manages the land and loves the people."[85]

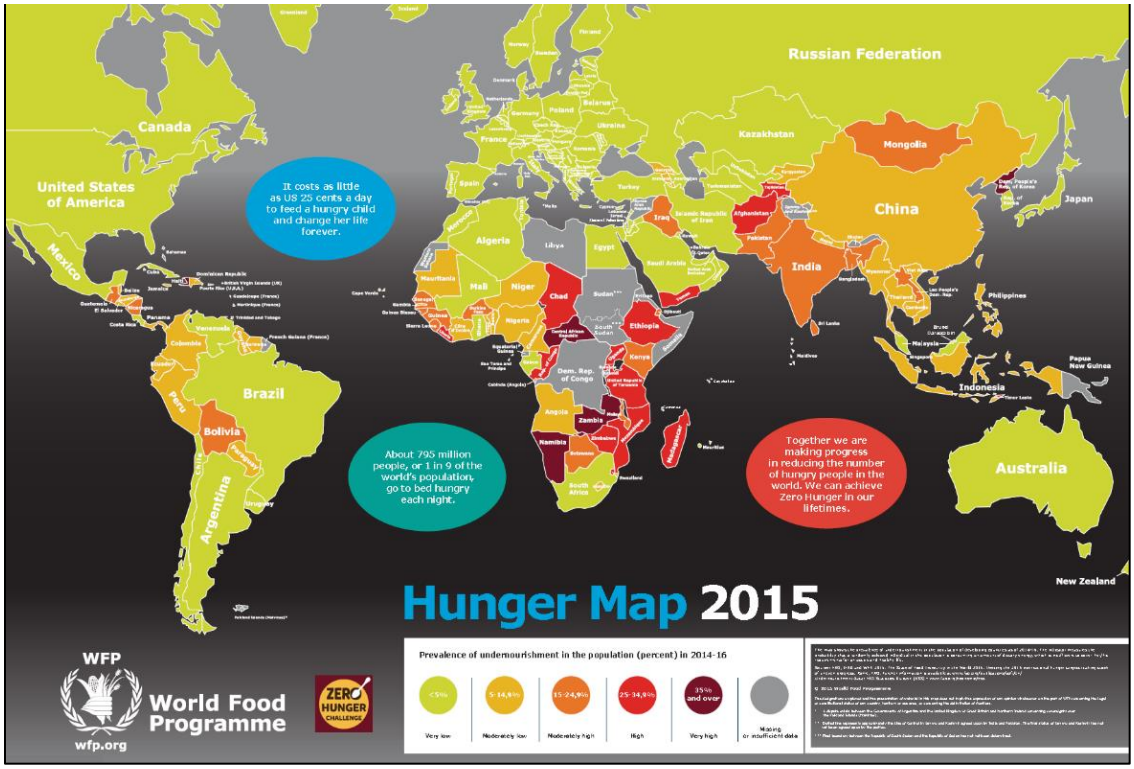
Appendix A: The Agribusiness Value Chain.



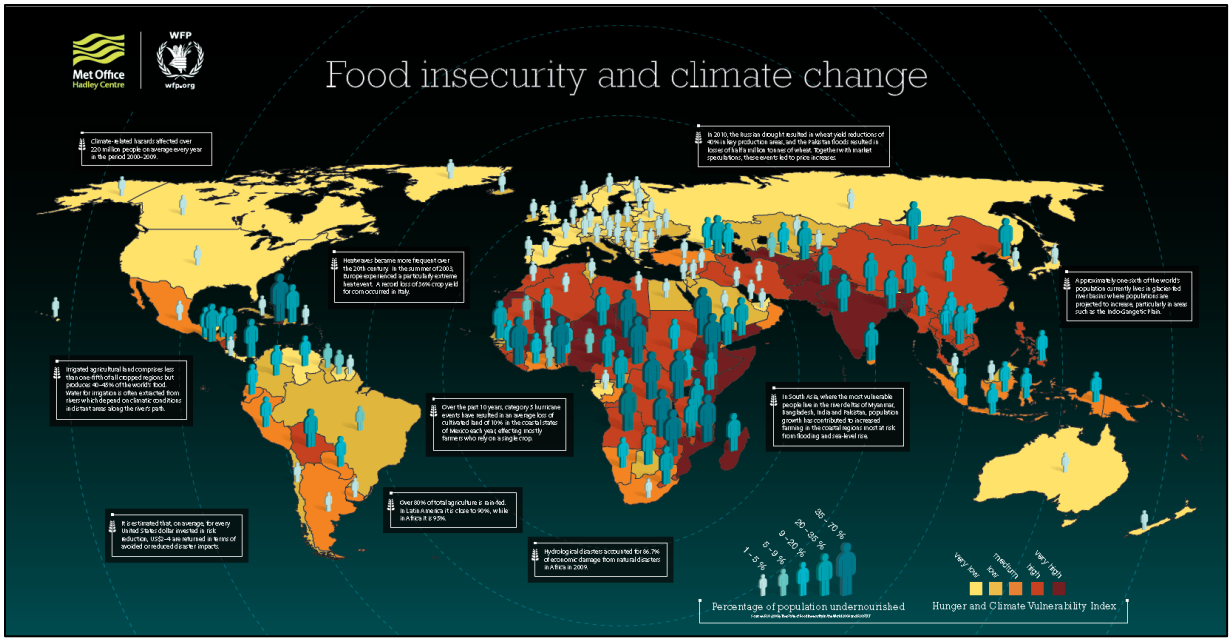
Appendix B: Projected Global Population Growth. Note significant population increase in Asia and Sub-Saharan Africa.



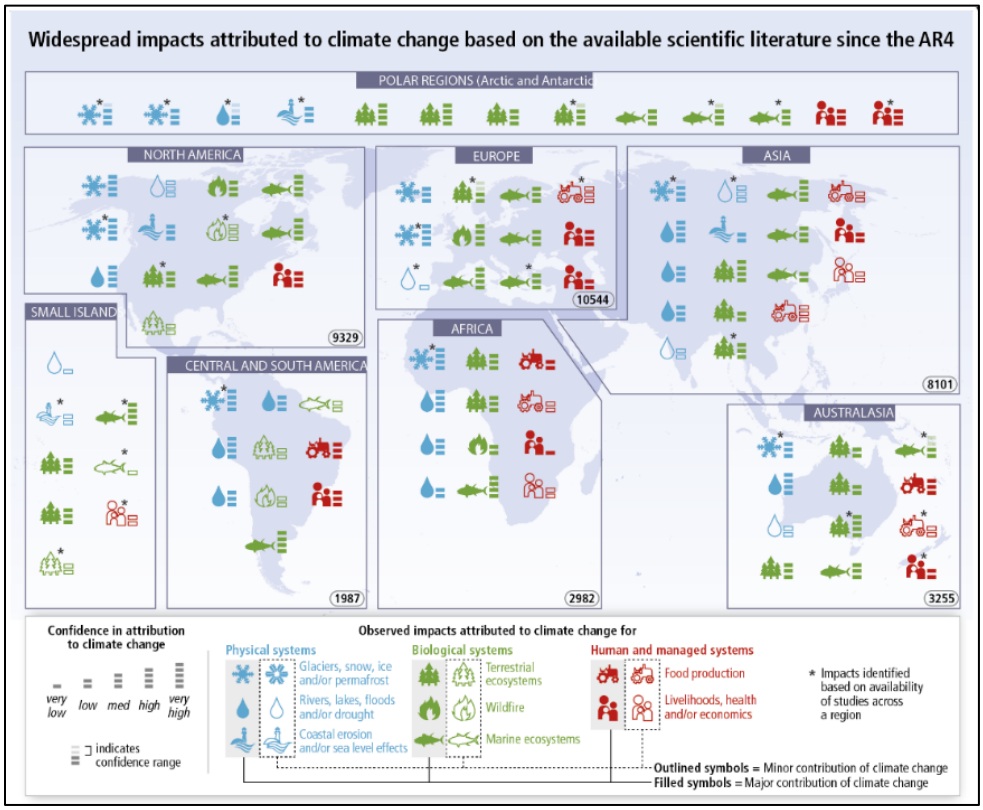
Appendix C: While hunger rates are decreasing, the 2015 World Food Program's Hunger Map depicts a striking correlation between developing countries, population growth and food insecurity.



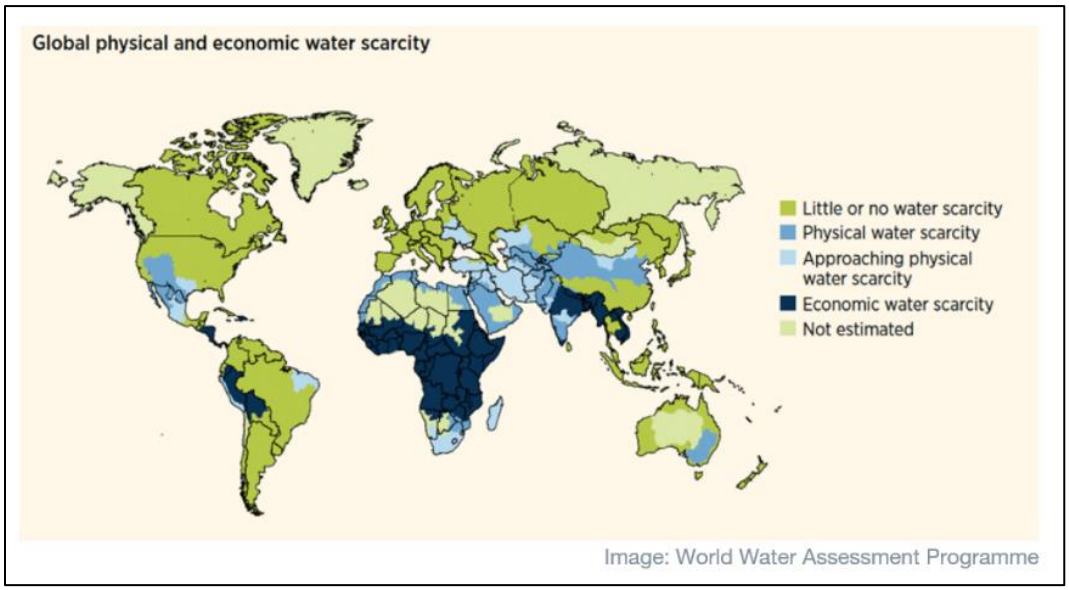
Appendix D: World Food Program diagram which links food insecurity with the regions of the world most impacted by climate change.



Appendix E: 5th Assessment Report highlights minor impact climate change has had on food production in Europe, Asia, Australia, and Africa. Note that according to the report, climate change has not impacted yields in North, Central or South America



Appendix F: Physical and economic water scarcity also exists in regions impacted by climate change, population growth, and poverty.



End Notes

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