



# Food insecurity in relation to governance in Uganda

KATONGOLE TAUFIQ, SSALI ISMAIL\*

<sup>1</sup> Department of Islamic Banking and Finance, Islamic University in Uganda (IUIU), Mbale

<sup>2</sup> Department of Development Studies, Bandung Institute of Technology, Bandung, Indonesia

## Abstract

**Aim:** The study's overarching objective was to examine the causes of food insecurity in relation to governance and suggest ways to combat the problem and better the population's lives.

**Method:** Documentary review is used as a qualitative research method in this exploratory study to glean information about food insecurity and governance laws already on the books in Uganda. Data is analyzed using both descriptive and interpretive approaches.

**Findings:** Deforestation and land disputes are two examples of government failures contributing to food insecurity. Increased refugee movement is a costly problem for the country, but it benefits a select few within the relevant institutions. Financing alternatives that generate new jobs for people and boost the availability of healthy, nutritious food are the key to solving all of these problems. There have been several studies done on how to best improve food insecurity and governance ethics in Uganda, and this is one of them.

**Implications/Novel Contribution:** This research adds to the body of knowledge on partnering to increase government revenue, enhance governance, combat food insecurity, and decrease unemployment.

*Keywords:* Food, Insecurity, Governance, Uganda

**Received:** 4 May 2020 / **Accepted:** 6 July 2020 / **Published:** 29 October 2020

## INTRODUCTION

Oh, Uganda, my home country, "for magnificence, for variety of form and color, for a profusion of brilliant life bird, insect, reptile, and beast for vast scale Uganda is true "the pearl of Africa" by Winston Churchill 1907. Is Uganda still the "pearl of Africa," as it was once dubbed, in light of its current food insecurity, or could this be due to governance issues?

Uganda, a landlocked country in East Africa, gets her name from the mighty Buganda kingdom, the largest of its kind in the region, which once ruled over a sizable swath of the country's southern half. Uganda is a landlocked country between 40 120 North and 10 290 South, longitude 290 340 East and 350 00 East. Uganda has the Democratic Republic of the Congo to the west, Rwanda and Tanzania to the south, Kenya to the east, and South Sudan to the north as its neighbors. Approximately 200523 square kilometers of that island, giving it a total area of 241551 square kilometers (Apolonio, 2020; Uganda Bureau of Statistics, 2014).

Uganda enjoys a modified equatorial climate with two distinct wet and dry seasons due to its location within the Nile basin. The Nile River, whose source is Lake Victoria, the third-largest lake in the world and located in southern Uganda, gives the region its name. The Nile River begins in Uganda and continues through South Sudan and Sudan before entering Egypt and, finally, the Mediterranean Sea in northern Africa. So these bodies of water have helped the agricultural sector, Uganda's mainstay economic activity.

Tourism, mining, forestry, fishing, small-scale industries and businesses, and agriculture are all vital to Uganda's economy and society. Due to its significance in the economy, agriculture employs roughly 70% of the active population. Farmers raise and sell various products, including crops, animals, honey, poultry, and fish. Subsistence farming is practiced by the vast majority of the population, while only a minority engages in commercial agriculture. Uganda is a major commercial producer of coffee, tea, and vanilla.

\* Corresponding author: Ssali Ismail

† Email: [Ssaliz.mnz@gmail.com](mailto:Ssaliz.mnz@gmail.com)

Nearly half of Uganda's total export earnings come from its agricultural exports, specifically coffee, tobacco, and fish. Uganda's primary foreign income source comes from selling the coffee it grows, which is shipped to countries like the United States and others (Mizirak & Altıntaş, 2018; Uganda Bureau of Statistics, 2014; Williams, 2018). This explains the rationale behind the National Coffee Bill of 2018, which will become law on August 5, 2020. Parliament has set a target of 20 million bags annually by 2030, and this bill is meant to replace the Coffee Development Authority Act, Cap. 325, which was passed in 1991. Despite this, Uganda is home to an estimated 40 million people, and its population is growing at a rapid 3.6% annually (Uganda Bureau of Statistics, 2016). Uganda's high population growth rate and reliance on farming for subsistence mean the country constantly needs more farmland and food. As a result, people have resorted to environmentally harmful practices like deforestation and swamp drainage to acquire more land for housing and farming. Due to the physical and natural effects of poor governance, the country's climate has changed in a way that has not been beneficial to agriculture, resulting in a rise in food insecurity.

## LITERATURE REVIEW

### Overview of the Current State of Food Insecurity in Uganda

Food insecurity is a phenomenon that exists whenever the availability of nutritionally adequate and safe foods or the ability to acquire acceptable foods in socially acceptable ways is limited or uncertain (Aguilar-Toalá et al., 2018; Balan, Alin, Tiberiu, Gabriela, & Camelia, 2020; National Research Council, 2006).

On average nearly half of all Ugandans consume less calories than they need every day. One in three school children have no food to eat during the school day. Inadequate diets are a root cause of persistent nutritional problems which undermine the health, growth and development of Ugandan children world food programme Uganda.

Uganda is listed among the 29 African countries with populations likely to suffer from hunger or a lack of access to sufficient food (Ministry of Water and Environment, 2015). The total population in Uganda stressed due to minimum adequate food consumption amounts to 13% with regions such as karamoja 35%, east central Acholi 17% and central 16% being ranked as having the highest stressed population. This population has ever widening food consumption gaps with deteriorating dietary diversity and high malnutrition rates (Integrated Food Security Phase Classification, 2017). The deteriorating food security situation especially in Ugandas north eastern region of Karamoja could affect an estimated 1.2 million people (Integrated Regional Information Networks, 2013).

## METHODOLOGY

Most of the deliberations undertaken at policy and institutional levels to combat food insecurity indicate potential success in Uganda. However, there is currently a huge research gap in literature that could link this potential success to reality due to poor governance. This study is an exploratory analysis done qualitatively using documentary review. The findings of the study would have implications for governance, agricultural and financial development as well as for researchers. The study reviewed numerous documents such as relevant statutes (National Research Council, 2006; Uganada Legal Information Institute, 2000, 2001) among others.

To analyze data, the study made use of analytical and interpretive analysis. Data collected were classified proportionately as data relating to the legal governance of institutions that deal with combating food insecurity. After that, the data were analyzed in comparison of different reports and making relevant observations of what exactly happens with the populations innutritious feeding.

## RESULTS AND DISCUSSION

Food insecurity is as a result of various causes in Uganda which include following things.

### Climatic Changes

This has been as a result of environmental degeneration in the form of air, water and land pollution, swamp reclamation and deforestation. These have exposed Uganda to new and unpredictable weather patterns characterized by prolonged droughts, floods which have threatened to worsen food insecurity in the various parts of the country as well as lowering the fertility of the soils leading to low crop yields.

This has stressed the population of all regions with the highest being in Karamoja 35%, east central 17%, Acholi 16% and central 16%. The households in these regions all suffered the effects of prolonged dry spells that stressed most of the crops and reduced yields from both the first and second seasons. The prolonged dry spells also created a conducive environment for the army worms that attacked and destroyed cereals mainly maize, sorghum and rice yet some areas also suffered livestock disease outbreaks ([Integrated Food Security Phase Classification, 2017](#)).

The weaknesses in the National Environment management Authority (NEMA) and the National Forestry Authority (NFA) which operate under the supervision of the Uganda government have created the prevailing conditions that have boosted climate change human causing activities. This has been because these institutions have failed to closely monitor their environment protection programs such as campaigns against deforestation which has been attributed to inadequate funding from the government and their inability to high skilled and competent personnel needed in the implementation of their programs. From 1990-2015, Uganda has been losing an average of 122000 ha/year of forest. The NFA reports the annual greatest forest loss in the country estimated at 250,000 ha for the period 2010-2015. This has created an imbalance with the 7000 hectares of forests planted on a yearly basis in the last 15 years which is attributed to factors such as weak institutions, uncoordinated implementation of policies between different sectors of the economy and insufficient funding ([Ministry of Water and Environment, 2015](#)).

Further corruption scandals in these bodies have also greatly affected their operations as this has turned them into environment destruction authorities whereby some officials in these authorities have been involved in environment destruction activities such as deforestation. These authorities have also failed to help Uganda transit from using environment polluting energy sources like diesel, kerosene which emit a lot of greenhouse gases like carbon dioxide that destroy the Ozone layer in the atmosphere leading to adverse climatic change effects like drought which facilitate food insecurity in the country to clean energy sources that have zero emission rates such as the solar energy and wind energy.

### **Ever Increasing Population Growth Rate in Uganda**

This has been brought about as a result of poor or no family planning methods being used by the people leading to unplanned births, failure of family heads to provide the required basic needs for their families including nutritious foods. The ever increasing population is attributed to poverty and increasing unemployment which is evidenced with a large number of people failing to adopt modern birth control measures as they tend to be expensive thus increasing the countrys population.

The governments inefficiency to create more employment opportunities for the youth has resulted into many young people engaging in unlawful sexual behaviors as a form of leisure since they are redundant thus enhancing the population growth. Despite Uganda having one of the youngest populations in the world of 78%, it would be facing a significant opportunity to flourish socially and economically however it has often forgotten the need to invest in young people to achieve the desired targets ([United Nations Population Fund, 2017](#)).

According to the World Food Programme, Ugandas growing population is expected to reach 100 million people by 2050 and the presence of the world's third largest refugee population pose further challenges to the Uganda's ability to achieve Sustainable Development Goal 2 on zero hunger. As a result of this ever increasing population, there has been a shortage of land needed to cultivate crops to feed this population because of the ever increasing demand for more land to settle the growing population thus making the available food too small to meet this high demand. Majority of the population has therefore abandoned nutritious foods and instead opted for unhealthy foods which have also contributed to their malnourishment. The government through its ministry of health and agriculture has also done very little to make sure that people eat nutritious foods hence leading to nutrition food insecurity. They have also failed to improve and modernize the agricultural practices from the poor farming methods currently being used by majority of the population.

### **Land Fragmentation**

This stems from the high population growth that has made families to divide land into large partitions so as to settle and practice a little of subsistence agriculture. Therefore majority of the land which would have been

used for crop cultivation is eventually settled on. According to [Kashambuzi \(2012\)](#), land fragmentation is practiced culturally and sentimentally whereby when the head of the family passes on it becomes incumbent every son; every daughter and widow(s) to get a piece of the land. The more members in the family the smaller the piece each member gets and given low agricultural productivity (low yielding traditional seeds and absence of organic and inorganic fertilizers and irrigation technology) .

The tiny pieces of land do not produce enough to maintain a family for food and cash, pushing that family into deeper poverty if there are no alternative sources of income. The Ugandan judiciary has also failed to settle land dispute cases that are before court, coupling that with the governments introduction of a land inquiry and review commission that has not yet been effective. This has left a lot of land not cultivated since the matters are before courts and the commission waiting for the overall ruling about the disputes.

### **Political Instabilities both Within and Outside the Country**

Instabilities have also worsened the country's state of food insecurity. The country at times finds serious opposition due to its poor and undemocratic governance policies such as corruption and increased crime among others. The population has therefor resorted to striking in the different parts of the country thereby hindering agricultural production. The energetic youth who would have been carrying out farming join these strikes while other people remain indoors for fear of their lives hence leading to low or no agricultural production.

The instabilities outside Uganda for example in countries such as Burundi, Congo and South Sudan have resulted into an influx of thousands of refugees into Uganda who have mounted pressure on the existing few resources like land that would have been used for agricultural production to increase on food availability. This refuge problem has also contributed too many land wrangles with the local population which has resulted into destruction of agricultural farms, forceful eviction of people from their lands and farms something which has also increased food insecurity within the affected members of these communities. According to the World Food Program, this fast growing population and the presence of the worlds third largest refugee population pose further challenges to the Ugandas ability to achieve Sustainable Development Goal 2 on zero hunger.

### **Improper Farming Methods**

These have been characterized by over cultivation of the same piece of land for a very long period of time which has left the land infertile as a result of reduction in soil nutrients leading to poor or low crop yields. The weaknesses in the Uganda National Bureau of standards (UNBS) to regulate the inflow of fake agricultural products has exposed many Ugandan Farmers to fake dangerous fertilizers, spraying chemicals and improper genetically modified seeds that have left the land barren generally leading to soil exhaustion in most parts of the country accounting to the low or poor crop yields that are less nutritious.

The fishing sector has also been greatly affected by poor fishing methods being used by many of the Ugandan fishers including the continuous use of unlicensed fishing nets which have wiped out majority of the young fish from the lakes and rivers there by hindering fish farming an act which has denied many Ugandans access to this nutritious food. There is little monitoring and control by the Ugandan government through its Ministry for Agriculture, Animal industry and Fisheries as well as the Uganda Revenue Authority on the kind of fishing nets being imported into the country.

In trying the resolve the issue, the Uganda government instead transferred the management of water bodies to security institutions and also a few private individuals who are not easily supervised but rather aim at exporting fish to maximize the profits. There has also been insufficient agricultural development where by most people in Uganda use the traditional technologies in growing crops and rearing of livestock for example people still practice shifting cultivation and bush fallowing instead of using fertilizers. This has led to low yields per hectare in a season leading to low production levels for human consumption hence worsening food insecurity in Uganda. This is coupled by lack of storage facilities where by a lot of crops such as maize is grown in plenty and if not eaten at physiological time maturity, the maize is left to dry and wasted in the field. If harvested, there are only few households with storage facilities therefore this maize is left to dry on verandahs and is consistently hit by rain, eaten by birds, animals or stolen by thieves. This has led to the absence of food in times of scarcity leading to food

insecurity ([Tumwebaze, 2011](#)).

The above problem was worsened by the irresponsible government privatization policies, which resulted into the selling off of national granaries that used to store food to be used in times of hunger and drought. The National Cooperative Bank which was sold to the Standard bank group from the republic of South Africa used to fund farming activities and also help farmers market their agricultural produces both locally and internationally hence enabling them earn good income to sustain their needs. This bank also used to subsidize agricultural produces and give them to farmers at a reduced or no price which boosted their agricultural production hence leading to food security at that time. Currently granaries are no longer in existence to support agricultural activities among the local and poor famers leading to food insecurity in these farming communities in Uganda.

### **Policies to Address the Challenges**

The Ugandan government in cooperation with both local and international partners has put up a number of policies aimed at reducing on the impacts resulting from the causes of Food insecurity in the country among which include;

The dry lands integrated development project launched in June 2015 to address a swath of challenges which fuel the population's vulnerability to hazards. This project was aimed at complementing and strengthening the existing government projects in Karamoja to address food insecurity, improves crop and livestock production, health coverage, education, and develops business and infrastructure. This program is also aimed at strengthening the capacity of the local population by developing weather resistant and fast maturing crops to improve on food security, improve livestock, train people on health and hygiene, engage people in income generating activities through creation of markets (United nations office for disaster risk reduction ).

The national land policy for Uganda was approved by the cabinet chaired by President Museveni on February 7th 2013. This policy provides a framework on how land will be managed and used in Uganda for the next 30 years. The land policy seeks to introduce fundamental reforms, paving way for the resolution of the country's land problems. It provides a basis and further strengthens the already existing land laws on issues such as illegal evictions, inadequate land use planning, land fragmentation, destruction of ecological systems, encroachment of private and government land, land conflicts and injustices, informal settlement and the poor land information management ([David, 2013](#)).

The National Agricultural Advisory Services program is an innovative public private extension service delivery approach put in place by the NAADS act 2001 to improve rural livelihood by increasing agricultural productivity and profitability, promoting development of farmer organizations, empowering them to procure advisory services, manage linkage with marketing partners and conducting demand driven Monitoring and Evaluation of the advisory services and their inputs. Government is reintroducing food banks as well as establishing agro based industries in districts like Luwero, Nakasongola and Bushenyi among others.

It aims at processing agricultural produces in a way that they gain value and quality. This will help to keep these foods for longer periods especially after the harvesting period for example Matoes in Bushenyi district is being turned into flour which has added value to it thereby leading to its exportation and longtime storing. Various perishable foods have been prevented from rotting through such mechanisms and in turn stored in safer places to be used during periods of food insecurity.

Regional stabilization policy through engaging in peace keeping missions and various peace talks with regional members should be carried out. Uganda is among the African nations that deployed troops as part of the African Union mission in Sudan established in 2004 to provide for security and peacekeeping in the Darfur region. Also in March 2002 Sudan and Uganda signed an agreement aimed at containing a Ugandan rebel group called the Lord Resistance Army (LRA) active along a common boarder while in March 2007. Ugandan peace keepers were deployed in Somalia as part of the African Union mission to help stabilize the country ([British Broad Casting News, 2018](#)).

The major aim of these policies is to reduce the inflow of refugees into the country as well as reducing on the land disputes that arise as a result of an influx of refugees into the country. This will later help to create more space for cultivation and in turn improve on food security in Uganda.



## **CONCLUSION, RECOMMENDATIONS AND IMPLICATIONS**

The Government of Uganda in 2015 tabled in Parliament the Financial Institutions (Amendment) Bill. This Bill contained at least 50 clauses and sought to amend a number of provisions within the Financial Institutions Act, 2004. It sought to introduce Islamic banking, banc-assurance, Agent Banking, special access to the Credit Reference Bureau, and sought to reform the Deposit Protection Fund among others. Hence, the amendments were passed and the president signed the bill into law in January 2016 thereby legalizing Islamic banking in Uganda.

It would therefore be proper to embark on this ethical alternative banking to improve agriculture and livelihood development thereby reducing food insecurity and improving governance issues in Uganda. The Governor Bank of Uganda, Prof. Mutebile suggested that Islamic banking has gained prominence internationally due to its exponential growth and resilience to financial crises as well as sharia compliant finance models and practices which include risk sharing among others (Lujja, Mohammad, Hassan, & Oseni, 2016). With respect to these practices, engaging in Islamic finance has several ethical conditions that must be upheld and these conditions help change the behavior of the borrower or the agent. Case in point, involvement in the Murabaha (model) agreement is thought to reduce the rate of crime through binding the youths to ethical practices which would ultimately reduce crime rates especially among the youths (Grewal, 2013).

Food insecurity in relation to governance can be combated through agricultural development using various models such as Bai-salam agreement which is a trading transaction involving advance payment for future delivery since majority of the population lacks capital for startup. Salam financing is involves value added activities leading to material output. The customer receives funds, procures several inputs and adds value to the produce. Value addition may come in form of production among others. It has various shariah requirements which involve offer and acceptance, specification of nature, quality and quantity along with delivery date, setting of the price payable in advance as well as settling the transaction with delivery of goods not on the margin.

It was traditionally used for agriculture however today its used even in non-agricultural transactions such as industrial activities like sugar production for instance (Sayyid, 2013). This can lead to value addition on products hence improvement in food quality, industrial development as well as employment generation to various nationals. Food production shall increase in turn thereby combating food insecurity as well as improving governance and monitoring issues in the country.

### **Recommendations**

There should be proper accountability for government expenditures. A lot of money has been invested into agricultural modernization through projects such as NAADS and Operation Wealth Creation agricultural projects and the output is below average. It would be easier to monitor the development in these projects, however the administrative systems of these projects has not offered any accountability. The government should therefore consider providing accountability to the general public, for proper assessment of its projects. Corruption is a serious disease affecting every government institution.

The government established a crime divisions court with its main objective of fighting corruption as well as monitoring the judiciary however it has not yet yielded better results. The president in 2019 participated in the anti-corruption walk however he was embarrassed when they failed to properly account for the items such shirts and services used during the procession. Stricter laws should be enforced on corrupt government officials especially those who engage in land disputes like judicial officers who have sat on land grabbing cases. A lot of land that would have been used for agriculture has been grabbed thereby hindering the progress of agricultural services and when the issue is raised to the courts, they have not labored to solve the land grabbing issue.

As a result of corruption, Government bodies like the UNBS, NAADS and URA among others have enhanced the importation of poor quality agricultural inputs into the country. This has greatly contributed to the low development of agriculture since these agricultural products such as seeds, agricultural chemicals among others have yielded low output thus the government should fight corruption in all institutions connected with agricultural development to pave way for agricultural modernization and development.

The government should increase on the funds put in the agricultural budget. Agriculture being the major backbone of Uganda's economy, it's so a shaming and alarming that the government allocates only 4% of its budget

to the agricultural sector, it will therefore be very hard for agriculture to develop in a country where its given limited funding .The government should as well restore farmers' cooperative societies in a way of developing the agricultural sector.

The government should control the influx of refugees into the country as well as controlling its population growth rate. The government should improve its foreign peace keeping missions within the region whereby its major aim should be settling these countries rather than economic gains from these countries and that will help in reducing the unnecessary refugee migrations. This should be coupled with sensitization of its nationals about the negative effects of population growth rate as well as aiming at improving the welfare of its people through creation of more employment opportunities.

### **Acknowledgment**

First and foremost we would like to thank Gods grace and wisdom for keeping and strengthening us throughout AMEN. With gratefulness, we would also like to thank and appreciate the management of Journal of Advanced Research in Social Sciences and Humanities for this great opportunity they have offered us to publish our work which opportunity has constructively molded our academic experience. We would also want to thank all the participants in this study both on record and off record for their constructive criticisms during the course of writing this paper.

### **REFERENCES**

- Aguilar-Toalá, J., Garcia-Varela, R., Garcia, H., Mata-Haro, V., González-Córdova, A., Vallejo-Cordoba, B., & Hernández-Mendoza, A. (2018). Postbiotics: An evolving term within the functional foods field. *Trends in Food Science & Technology*, 75, 105-114. doi:<https://doi.org/10.1016/j.tifs.2018.03.009>
- Apolonio, R. A. (2020). Behavioral and demographic antecedents to household food waste. *International Journal of Humanities, Arts and Social Sciences*, 6(1), 32-43. doi:<https://doi.org/10.20469/ijhss.6.20004-1>
- Balan, I. M., Alin, C. P., Tiberiu, I., Gabriela, P., & Camelia, T. (2020). Food safety versus food security in a world of famine. *Journal of Advanced Research in Social Sciences and Humanities*, 5(1), 20-30. doi:<https://doi.org/10.26500/jarssh-05-2020-0103>
- British Broad Casting News. (2018). *Uganda profile-timeline*. Retrieved from <https://bbc.in/3kEOKHj>
- David, M. (2013). *The national land policy will strengthen land laws*. Kampala, Uganda: Fountain Publishers.
- Grewal, B. K. (2013). *Overview of the Islamic financial landscape: Globally and in Europe*. Kuwait City, Kuwait: Kuwait Finance House.
- Integrated Food Security Phase Classification. (2017). *Uganda: Acute food insecurity situation for November 2017-February 2018*. Retrieved from <https://bit.ly/3e60HU2>
- Integrated Regional Information Networks. (2013). *Food insecurity threatens 1.2 million in Ugandas North East*. Retrieved from <https://bit.ly/3e9SYnS>
- Kashambuzi, E. (2012). *How to address land fragmentation in Uganda*. Retrieved from <https://bit.ly/34Faeyp>
- Lujja, S., Mohammad, M. O., Hassan, R. B., & Oseni, U. A. (2016). The feasibility of adopting Islamic Banking system under the existing laws in Uganda. *International Journal of Islamic and Middle Eastern Finance and Management*, 5(7), 567-578.
- Ministry of Water and Environment. (2015). *State of ugandas forestry: National agricultural advisory services act 2001*. Retrieved from <https://bit.ly/35IdvMB>
- Mizirak, Z., & Altıntaş, K. (2018). The nexus between governance factors and foreign direct investments: Evidence from panel data. *Journal of Administrative and Business Studies*, 4(1), 1-18. doi:<https://doi.org/10.20474/jabs-4.1.1>
- National Research Council. (2006). *Food insecurity and hunger in the united states: Assessment of the measure*. Retrieved from <https://bit.ly/37TscPQ>
- Sayyid, A. (2013). *Alternative structures for financing by Islamic banks* (Working paper No. 5). The Islamic Research and Teaching Institute, Jeddah, Kingdom of Saudi Arabia.
- Tumwebaze, J. (2011). *Food insecurity brief in Uganda* (Unpublished master's thesis). Makerere University,

- Kampala /Uganda.
- Uganda Legal Information Institute. (2000). *Constitution of the republic of Uganda, 1995*. Retrieved from <https://bit.ly/31Z0uxe>
- Uganda Legal Information Institute. (2001). *National agricultural advisory services act, 2001*. Retrieved from <https://bit.ly/3mw2dSy>
- Uganda Bureau of Statistics. (2014). *National population and housing census*. Retrieved from <https://bit.ly/2Ty1vaL>
- Uganda Bureau of Statistics. (2016). *Uganda population and housing census*. Retrieved from <https://bit.ly/2Tyw1A2>
- United Nations Population Fund. (2017). *Youth enterprise model, education, empowering and employing Ugandas next generation*. Retrieved from <https://bit.ly/3kLbGVK>
- Williams, R. A. (2018). Opportunities and challenges for the introduction of new food proteins. *Annual Review of Food Science and Technology*, 12, 75-91. doi:<https://doi.org/10.1146/annurev-food-061220-012838>