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Benin, Factor 5: Climate Volatility  
Impact of Flooding on Agricultural Productivity in Benin**

The Republic of Benin is a French-speaking nation in West Africa, where approximately 80% of the people earn a living from agriculture (“Integrated Production and Pest Mgmt”, n.d.). Most families in the country are subsistence farmers living on small family plots of land, growing crops to eat and sell. The father is head of household, the mother leads work in the house, and the children typically help with work. Education in the country is not widespread, and in 2012 only about 33% of the population of people over the age of fifteen could read (“Benin”, n.d.). There is little access to healthcare and malnourishment is common, as families rely on a few staple crops which lack micronutrients, particularly calcium and zinc (“A Recipe to Improve”, n.d.). Most farms are smallholder family farms, which commonly produce cotton, rice, cacao, palm products, soybeans, and maize (“USDA GAIN Report: Benin”, 2014). Crops are often planted in monocultural, non-diverse fields that are poorly managed (“Integrated Production and Pest Mgmt”, n.d.), causing a decline in farm profitability in the country. The typical family farm faces difficulty increasing agricultural productivity, earning a living wage, and accessing adequate nutrition.

Flooding is the most significant cause of food insecurity in Benin because it is the greatest barrier to agricultural productivity, destroying crops and equipment that smallholder family farmers cannot afford to replace. Flooding is persistent, ranging from rain runoff flooding fields for a few hours to large-scale evacuated events. Flooding will likely continue to get worse as climate change accelerates and changes precipitation patterns. Better flood control would yield more surviving crops, helping farming families eat and sell more, and would improve the economy by improving productivity. The possibility of an entire year of work being washed away and leaving farmers with nothing is a serious concern for farmers in Benin, and this insecurity decreases output and keeps farmers from making improvements to their farms. Management needs to be improved with education and planning, so farmers know how to protect themselves and their farms against floods. 80% of families are in agricultural work, largely growing food crops for themselves (“Integrated Production and Pest Mgmt”, n.d.), which makes earning a living wage very difficult for families. In addition to the volatility of food crops, families need money to buy additional food they do not produce.

Much of the food grown by families is consumed by themselves, and the rest can be sold or stored. If they wish to purchase food, families go to markets in their villages or cities. Stunting of growth in children is at 43%, above the sub-Saharan average of 39% (“World Bank to Help Benin”, 2013). There is a problem of malnutrition, with 30% of children in some areas considered malnourished (“A Recipe to Improve”, n.d.). In addition, 35% of surveyed children in the country did not meet minimum dietary diversity requirements, such as consuming foods from at least four different food groups (“A Recipe to Improve”, n.d.) Many crops sold in the country are sufficient in calories but leave a lack of access to specific micronutrients, such as calcium and zinc. (“World Bank to Help Benin”, 2013) There are enough calories for most families, but not enough specific vitamins and minerals. The lack of nutritional diversity is largely due to low incomes of farmers who cannot afford to buy varied, nutritious food (Rajendran, 2017) while on-farm diversity is positively associated with dietary diversity in Benin (Bellon, 2016). Protecting crops from floods through agricultural practices such as biodiversity, responsible soil systems, and water management structures and having the government help farmers by building better infrastructure, increasing communications access, and ensuring that farmers have a guaranteed buyer are essential steps to raise incomes and improve nutrition.

The floods in Benin and the poor management and farming practices that exacerbate their damage are the main barrier to increasing agricultural productivity in the country. Farms' products and all the time and money invested in them are easily washed away by a single flood, leaving them with no cash no food for their families. While the farmers have no control over the weather, improving practices by farmers and by the government to protect farms against flood damage is essential to overcoming this barrier and increasing agricultural productivity. Smallholder farmers struggle to make a living wage when much of their farm is destroyed, leaving them with nothing to sell. They are often unable to take necessary risks, such as switching to different crops and planting practices, because they do not have the money saved or the credit before planting season to afford changes. The inability to afford change is a barrier to progress and to saving more crops from floods and making a better wage, and the situation would be improved with greater access to credit and early payments through systems such as contract farming, with fair trade regulations by the government, as well as government efforts to ensure all farmers find buyers for their crops. The government should also fund better infrastructure to survive floods, train government employees in flood management, and increase access to digital communications and storm warnings in order to save farmers' crops. The poor farming practices that make flood damage worse, such as monoculture plantings and irresponsible soil and water usage, are a barrier to growing enough affordable, diverse and nutritious food in the country. When these practices are improved, agricultural yields and crop diversity will increase, allowing for more calories and more specific micronutrients to enter the diet. Better agricultural productivity through flood management would raise the amount of food available and would improve families' income and ability to buy nutritious food to fight vitamin and mineral deficiencies.

Educating farmers about practices that will protect them from floods, such as diversifying crops, using crops that can tolerate floods, are harvested before flood season, or are native to the country, using responsible soil practices, and building water management structures will improve both dietary diversity and agricultural productivity in the country. This sort of agricultural education will allow for farmers to grow crops more fit for flooded areas in various ways, as well as a greater quantity of different nutritious species, and will also minimize the damage flood water causes to farm yield. Educating government officials about flood safety and making the government commit to building flood-safe infrastructure, increasing communications access, and helping farmers afford the switch to other crops and practices will also help to increase crop yields and household income.

In order for flooding damage to be reduced, communities, the government in Benin, and independent organizations must all lend a hand. Integrated Production and Pest Management (IPPM) is a program designed to educate farmers in West Africa on issues relating to pest management, crop diversification, and improving agricultural practices ("Integrated Production and Pest Mgmt", n.d.). This local effort should be augmented to include a section on climate volatility and water management. This education would help farmers in Benin learn to better manage farms in the face of floods through a variety of practices they can then adopt in their communities. Other organizations, both new and established, can also disperse education about flood-safe practices to farmers.

The government in Benin can help by encouraging and incentivising responsible agricultural practices, ensuring farmers can sell their crops and make fair wages, building better flood-durable infrastructure, and increasing communications access and availability of weather forecasts and flood prediction services. Currently, the system of radio and cellular communication in the country is inadequate, and only 12% of residents have an internet connection ("The World Factbook: Benin", 2018). The government's dedication to technological spread through the country would give the farmers resources to predict and plan for floods. For this plan to have an impact, the government must improve cellular and radio connections in

the country and also survey citizens and ensure they all have access to storm warnings through radio, internet, or cellular connection.

The government should also encourage and regulate a contract farming scheme for the production of commercial crops, and particularly for rice. Benin consumes large amounts of rice, but between 70,000 and 380,000 tons of rice are imported each year to make up for a lack of domestically produced rice (“Benin’s Rice Farmers Urge”, 2017). Contract farming, which stabilizes markets and minimizes transaction costs, has been shown to be an effective method of improving the rice supply chain in Benin for smallholder farmers (Maertens, 2017). In these systems, buyers and farmers write and sign a contract before planting for the year, agreeing to have a transaction for a specific amount of rice. Because risks are shared and there is greater access to credit and technology, contract farming schemes are beneficial to the welfare of smallholder farmers. The government should enforce production contracts and keep buyers from participating in misleading or opportunistic behavior. Since contracts guarantee a buyer, they help farmers sell all of their crops, helping them improve their farms to protect against flooding. The government could also mandate, or economically incentivize, that operations such as schools, universities, penitentiaries, and welfare centers use only local rice instead of imports. Growing more rice in the country as a commercial crop would be beneficial to farmers if there were a guaranteed buyer and fair price terms, because rice survives floods much better than other crops do. This would encourage most farmers in the country to grow some rice along with their other crops; this will aid crop diversification and allow farmers to have surviving crops after a flood.

The local and national government also ought to provide permanent infrastructure improvements in major populated areas that will benefit everyone. The government should ensure that all local government employees are trained in disaster preparedness; this training should give the local government the responsibility of ensuring all families in their municipality are aware of emergency alerts, and should also teach government employees how to use climate data effectively to recognize unsafe areas and work to solve problems. Flood risk management should be an important consideration in both local and national government plans for infrastructure across the country, whether urban or rural.

Ultimately, however, it is up to communities to adopt the agricultural practices that will help them survive the floods. Once they have been educated on such practices, farming communities will be able to build water management systems in the neighborhood that will benefit everyone, starting with a flood plan that involves the entire community. All of these efforts should involve everyone, as the community’s pooled resources and expertise will more efficiently integrate new plans and build new structures. However, farmers will also be free to use their education on flood prevention to improve their own farms with better water management practices and the strategic planting of crops, trees, and shrubs. Once they are aware of general flood safety agricultural practices, the communities may adapt these practices or create their own to fit their own needs. This sense of identity, autonomy, and choice must be preserved by encouraging farmers to make their own decisions with the knowledge they have learned and to discover their own ideas and innovations to reduce crop damage.

A community’s plan for flooding may have a multitude of parts to minimize damage. Firstly, a section detailing agricultural practices that can minimize flood damage should be included. Soil practices such as no-till farming and more frequent soil turnover ought to be considered in relation to a specific area’s soil. Farming without turning over the soil prevents excess erosion and keeps nutrients and greenhouse gases in the ground (“Turning Soils into Sponges”, 2017). No-till farming is especially beneficial to water retention when a groundcover, such as radish, is implemented in the fields with the crops (“Turning Soils into Sponges”, 2017). The network of roots of this ground cover plant keeps the soil rich and absorbs

pooling water in the fields year-round, acting as a living mulch. According to one report, keeping fields untilled and covered with living plants increased the ability of the soil to absorb water in 70% of field studies (“Turning Soils into Sponges”, 2017). However, in other areas, tilling the soil more often or more strategically, such as after harvest, is a better strategy to absorb more water into the soil. These practices should ultimately be decided upon by farmers who know their own soil and have been educated about several systems of soil management. There should also be a plan for structural changes to water management in the area, such as building a set of dikes, runoff ponds, sediment traps, and irrigation channels that will redirect flood water away from farms. One particularly useful structure to implement in each community is a rain garden: a living piece of flood infrastructure that contains a variety of plants growing in a depression in the ground designed to fill with flood water. Rain gardens are easy to set up and maintain and help hold, direct, and filter flood water while also growing useful plants.

The plan should also include a dedication to growing a diverse set of crops, as plants survive floods better when surrounded by high-diversity communities containing many different species (Wright, 2016). Planting diverse communities of crops will protect them against flood damage generally, but farmers may also take advantage of semi-aquatic crops, quickly-maturing crops, and native plants that are easily culpable, nutritious, and will survive floods well. One main semi-aquatic plant that should be encouraged is rice, which is in high demand in the country and provides valuable calories. Quickly-maturing crops that are harvested before the flood season will ensure that families have nutritious food stored away. These plants have very short growth periods before they are ready to pick and consume, and can be grown before summer to avoid the flood season. Many nutritious vegetables fall into this category, such as radishes, salad leaves, spinach, carrots, and beans (Albert, 2018).

Most of all, a focus on neglected native species is essential, in addition to a focus on semi-aquatic and quickly-maturing crops. These native species of both plants and animals are found naturally throughout the country, and are therefore easy for poor farmers to begin cultivating without spending exorbitant amounts on seeds or livestock. Growing native crops will be less expensive for farmers, and will allow them to easily include a greater number of nutritious, hardy, flood-resistant plants and animals on their farms. The food groups listed in surveys of dietary diversity tend to include roots and tubers, legumes, fleshy foods, dairy products, eggs, grains, vitamin-A-rich fruits and vegetables, and other fruits and vegetables (“A Recipe to Improve”, n.d.). Edible and nutritious native species can be found to fit all of these descriptions, and should be included in the effort to diversify farms with a variety of crops with a variety of strengths. Native trees used in traditional agroforestry systems provide many benefits, being easy to attain and grow, native to the region, and useful in producing fruit, medicines, and other products. In addition, these trees are culturally important, leading farmers to feel an autonomous desire to protect these trees and cultivate them well. Agroforestry, or the incorporation of trees into crop fields and pastures, is essential in order to increase biodiversity and decrease erosion, simultaneously protecting crops from floods and providing more nutritionally varied food. When taught effective agroforestry practices, such as planting trees around fields and on upland areas to absorb flood water and decrease erosion and runoff, farmers may use these native trees to protect crops from floods. In a recent survey, 43 species of native wild fruit-bearing trees were found in agroforestry practices across Benin (Assogbadjo, 2012). One such tree is the ackee tree, or *blighia sapida*, which can be used as a part of a water management agroforestry system and also produces fruit and is a profitable cash crop used to make soap and medicines (Eckué, 2010).

Finally, a storage and hazard prevention plan ought to seek to minimize practices that can compound the impact of floods. This section should ensure that toxic chemicals and fuels are stored in a safe place where they cannot leak into flood water, and should also detail storage spaces such as high ground for

livestock, waterproof granaries for stored grain, and dry places for tools and equipment. This plan also must describe protocols to prevent loss of human life in the floods, keeping people indoors and making sure homes can survive a disaster. There should also be a plan for recovering the community after a flood. People who are displaced or whose farms have been damaged should be able to rely on their neighbors to feed them and help them rebuild. This builds a sense of trust and mutual dedication to improving flood infrastructure and management practices.

Flooding, and the poor management practices that exacerbate its damage, is the most immediate issue holding smallholder farmers in Benin back from producing more food, making better wages, and eating more nutritious diets. Literacy rates and nutrition would be greatly improved by better management of floods by communities, organizations, and governments, because farmers who produce more become wealthier and are able to afford more education and healthy food. Education of farmers and government employees about water management tactics is key to decreasing flood damage and increasing the quality of life of farmers and of all of the people in the country who eat food produced by the farmers. A flood management education system, as well as the government's dedication to flood-safe infrastructure, to increasing access to communications, and to ensuring farmers are paid fair prices and can afford to switch crops and growing systems, would dramatically increase agricultural productivity. A community-oriented education of farmers would help them learn responsible growing practices, and how to increase diversity on farms as well as dietary diversity. The diversification of farms should include the use of native, hardy, nutritious species such as ackee trees, use of quick-harvest crops such as various vegetables, use of semi-aquatic plants such as rice, and a general dedication to increasing crop diversity and growing flood-resistant crops. In addition to growing practices, communities and local and national governments ought to be taught how to construct effective water management systems of irrigation channels, runoff ponds, rain gardens and dikes. They should also be educated on different soil and planting practices to maximize nutrients and minimize erosion during floods, such as no-till farming with groundcover and incorporated agroforestry. Finally, communities must have a plan ensuring the safety of everyone in the community and the preservation of as much product as possible in the case of a flood.

Climate volatility decreases agricultural productivity and income, as well as the amount of nutritious food available for purchase in markets. Without reform, flood damage holds families back from saving up money and improving their lives, trapping them in a constant state of rebuilding. However, breaking the cycle of lost profit and productivity through improved flood management practices will ensure farmers make a more livable wage and have enough food to feed their family. The ability to keep some money each year allows farmers to improve their farms and communities, boosting dietary nutrition and quality of life as well as allowing for further education and agricultural innovation. In addition, the sense of autonomy and empowerment in finally earning a living wage and no longer fearing losing everything has a great psychosocial lifting effect on communities. The flooding issue in Benin needs to be resolved in order for farming families to move forward and improve their income and livelihoods.

Community-oriented, education-driven solutions that present a wide variety of practices to be adopted by everyone from farmers to government officials ensure that people in Benin will work together, fuelled by their knowledge, to come upon the best possible ways to implement solutions. Most of the changes recommended to protect crop yields from floods are low-cost, feasible adjustments that all smallholder farmers can take part in. Greater agricultural productivity in Benin will lead to a more opulent, educated country which will continue to rise internationally. Educating communities about flood-conscious agricultural practices and empowering them to design their own solutions is simple, yet extremely effective, and is necessary to let Beninese farmers out of the cycle of poor crop yields after floods.

## References

- Albert, S. (2018, June 15). Vegetable Harvest Times. Retrieved July 26, 2018, from [https://harvesttotable.com/vegetable\\_harvest\\_times/](https://harvesttotable.com/vegetable_harvest_times/)
- Assogbadjo, A. E., Kakaï, R. G., Vodouhê, F. G., Djagoun, C. A. M. S., Codjia, J. T. C., & Sinsin, B. (2011, August 24). Biodiversity and socioeconomic factors supporting farmers' choice of wild edible trees in the agroforestry systems of Benin (West Africa). Retrieved July 26, 2018, from <https://www.sciencedirect.com/science/article/pii/S1389934111001158>
- Integrated Production and Pest Management Programme in Africa. (n.d.). Retrieved July 26, 2018, from <http://www.fao.org/agriculture/ippm/projects/benin/en/>
- Bellon, M. R., Ntandou-Bouzitou, G. D., & Caracciolo, F. (2016). On-Farm Diversity and Market Participation Are Positively Associated with Dietary Diversity of Rural Mothers in Southern Benin, West Africa. Retrieved July 26, 2018, from <https://doaj.org/article/d2509de0d22e43e19cc2161bc3ceeb73>
- Benin. (n.d.). Retrieved July 26, 2018, from <http://uis.unesco.org/en/country/BJ>
- Benin's rice farmers urge compulsory consumption of local rice. (2017, May 23). Retrieved July 26, 2018, from [http://sk8es4mc2l.search.serialssolutions.com/?ctx\\_ver=Z39.88-2004&ctx\\_enc=info:ofi/enc:UTF-8&rft\\_id=info:sid/summon.serialssolutions.com&rft\\_val\\_fmt=info:ofi/fmt:kev:mtx:journal&rft](http://sk8es4mc2l.search.serialssolutions.com/?ctx_ver=Z39.88-2004&ctx_enc=info:ofi/enc:UTF-8&rft_id=info:sid/summon.serialssolutions.com&rft_val_fmt=info:ofi/fmt:kev:mtx:journal&rft)

genre=article&rft.atitle=Benin's rice farmers urge compulsory consumption of local rice&rft.jtitle=Xinhua News Agency&rft.date=2017-05-23&rft.pub=COMTEX News Network, Inc&rft.externalDBID=XI7&rft.externalDocID=A492556135¶mdict=en-US

Eckué, M. R., Sinsin, B., Eyog-Matig, O., & Finkeldey, R. (2010). Uses, traditional management, perception of variation and preferences in ackee (*Blighia sapida* K.D. Koenig) fruit traits in Benin: Implications for domestication and conservation. Retrieved July 26, 2018, from <https://ethnobiomed.biomedcentral.com/articles/10.1186/1746-4269-6-12>

M. M., & Vande Velde, K. (2017). Contract-farming in Staple Food Chains: The Case of Rice in Benin. Retrieved July 26, 2018, from <https://www.sciencedirect.com/science/article/pii/S0305750X1530276X>

Rajendran, S., Afari-Sefa, V., Shee, A., Bocher, T., Bekunda, M., Dominick, I., & Lukumay, P. J. (2017, October 21). Does crop diversity contribute to dietary diversity? Evidence from integration of vegetables into maize-based farming systems. Retrieved July 26, 2018, from <https://link.springer.com/article/10.1186/s40066-017-0127-3>

A Recipe to Improve Child Nutrition in Benin. (n.d.). Retrieved July 26, 2018, from <https://www.bioversityinternational.org/ar2016/a-recipe-to-improve-child-nutrition-in-benin/>

Turning Soils into Sponges: How Farmers Can Fight Floods and Droughts. (2017). Retrieved July 26,

2018, from

<https://www.ucsusa.org/food-agriculture/advance-sustainable-agriculture/turning-soils-sponges#.W1phc9JKiUI>

USDA GAIN Report: Benin. (2014, March 20). Retrieved July 26, 2018, from

[https://gain.fas.usda.gov/Recent GAIN Publications/Agricultural Situation\\_Lagos\\_Benin\\_3-20-2014.pdf](https://gain.fas.usda.gov/Recent%20GAIN%20Publications/Agricultural%20Situation_Lagos_Benin_3-20-2014.pdf)

World Bank to Help Benin Fight Widespread Malnutrition Among Mothers and Children [press

release]. (2013, December 20). Africa News Service. Retrieved July 26, 2018, from

<http://link.galegroup.com/apps/doc/A353484917/GIC?u=psucic&sid=GIC&xid=3d2e6a42>

The World Factbook: Benin. (2018, July 12). Retrieved July 26, 2018, from

<https://www.cia.gov/library/publications/the-world-factbook/geos/bn.html>

Wright, A. J., De Kroon, H., W. Visser, E. J., Buchmann, T., Ebeling, A., Eisenhauer, N., . . . Mommer, L.

(2016, September 15). Plants are less negatively affected by flooding when growing in

species-rich plant communities. Retrieved July 26, 2018, from

<https://nph.onlinelibrary.wiley.com/doi/full/10.1111/nph.14185>