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Mali: Employing infrastructural innovation techniques to combat water scarcity and improve agricultural efficiency

The dusty, parched earth beneath Sagamu Matinga's feet rose in small clouds of dust with each step that she took. She walked for miles, absently swinging the dented aluminum jug at her side. Ten-year-old Sagamu looked to the left and right as she passed, her eyes searching for signs of life among the fields of stunted crops. Seeing none, she moved on, towards the muddy river from which she drew water daily for her family. She wished that each morning she could join her brothers as they went off to school. But she was not a boy, and she had a job to do. Upon her arrival at the river, Sagamu immersed her jug in the sluggish water, waiting for the last bubble of air to rise from within it. Once done, she lightly splashed her face with water before hoisting the now-heavy jug upon her back and beginning the long walk home.

The Matinga family, typical of rural families in the West African country of Mali, has few possessions and is dependent on weather conditions for the presence – or absence – of an income. Six people is a common family size, usually with near-equal numbers of daughters and sons; however, grandparents and more distant relatives may occasionally live as a part of the family, boosting the number of people in a household to approximately 10 (Dimensions of Need). Each day a similar meal is eaten by the family; composed of sorghum, rice, or millet, a porridge is created and served with a meat or fish sauce (On the Line). Due to the lack of foreign economic interest in the region, profit margins are small and thus expansion of farms is rare. The majority of farms in Mali are small subsistence plots which are greatly affected by swings in the weather systems, especially in the consistency of rainfall.

Though education is theoretically provided by the government, many school-age children are unable to take part in formal schooling because of the prohibitive mandated pricing of uniforms, school supplies, and other school-related costs. Medical facilities are available in larger towns and cities, though the average person does not have access to affordable healthcare. If an ailing person locates treatment, it is likely provided through a foreign organization, as most of the Malians who study medicine move to foreign countries where they will find higher pay and increased opportunities. Lacking fertilizer and modern farming equipment, many rural Malians find farming difficult and crop yields reduced by primitive practices. These factors, in turn, reduce the opportunity for farmers to have a living wage. Sorghum and millet are crops grown for food and cotton is cultivated for export. Compounding these factors, there are international barriers to Malian growth and prosperity. One such barrier for the profitable exportation of cotton and for farmers to receive a living wage is the large subsidies provided by the United States government to its domestic cotton farmers, driving the global price down. Also, the lack of subsidies and supports by the Malian government for its own people inhibits opportunities for farmers to gain profit through their subsistence work. Lastly, and possibly most important, is the lack of internal infrastructure inside of Mali for the farmers to get their products to market.

Mali has a long history of debilitating dryness. Being situated on the edge of the Sahara desert, the northeastern district of the country receives a mere 218 millimeters of rainfall per year (World Weather Information Service – Gao). That is a normal year, one in which drought plays no role. This scarcity of water leads to dead or stunted crops and the death of livestock, diminishing agricultural productivity and decreasing overall profit from farming. The situation is severe, and the environment is currently being degraded through faulty water practices and deforestation for firewood, which leads to desertification (N'Djim and Doumbia).

There is little gender equality in Mali, which is directly related to both the education system and the climatic characteristics. Women and girls are disadvantaged in that they must stay home to make food, collect firewood and draw water. These activities preclude girls from attending school, which carries into the overall education of women. A shocking statistic results from this phenomenon: in Mali, 43 men for every 20 women are literate (CIA). Also, the rural poor are disadvantaged because they often do not have enough money to go to school. The trends for this factor are worsening. "In sub-Saharan Africa the number of food-insecure people rose from 125 million in 1980 to 200 million in 2000" (Water for Food, Water for Life). Droughts are happening with increased frequency and intensity (Dai et al. 1126). Trends are decided through the measurement of rainfall. Due to the decreasing rainfall, the trend is steadily getting worse for families in this region and major reforms will need to occur to prevent widespread poverty and possible starvation.

Climate change negatively affects water scarcity in Mali because of the unequal drying trends that are impacting sub-Saharan Africa (Dai et al. 1126). The Sahel regions are drying faster than other areas within Africa, and this directly impacts the Republic of Mali, a substantial portion of which is composed of the Sahel climate. This theme of increased desertification and drying reduces the amount of vegetation that can survive in a given area, reducing biodiversity and causing it to be harder for herds to forage. Population growth also puts stress on the water supply because of demand for increased usage. Mali's population is nearly 15.5 million people and is growing at a rate of 2.6 percent per year, centered especially around urban areas (CIA). Water rights will become ever more important for landowners, straining communities.

Mali has several infrastructural, environmental, and social problems which all tie in to the issue of water scarcity. Malians use firewood as the primary source of fuel, harness only approximately 1% of the total potential hydroelectric power, and have a paucity of infrastructure, not only for the transportation of water, but also for moving market-bound goods from the supplier to the buyer (N'Djim and Doumbia). Each of these needs to be addressed separately and effectively in order to conquer the overarching problem in sub-Saharan Mali.

Harnessing hydroelectric power through the rivers, some of which has been done, could affect more than just the heating, light, and air conditioning in African homes. Over 90% of the population of Mali relies on firewood as the principle fuel source, which quickly contributes to deforestation and ecological damage. Providing the capability to cook food and have light without the use of fires could greatly change the dynamics of a city like Bamako, the Malian capital. In a nation where just over 50% of the population is below the international poverty line of subsisting on less than \$1.25 per day (UNICEF), the effect of no longer having to haul firewood and spend time cutting down trees could increase the amount of free time that poor people have to work profitably. Additionally, as Integrated Water Resources Management says, "The sustainable management of the ecosystems that supply our natural resources should be integrated within political action plans" (IWRM 6). This intricately ties in to the availability of electricity in Mali: if the government in Bamako wants to prevent desertification, the prevention of which would offer longer-term solutions for agriculture and environmental stability, it needs to enact policy which more adequately provides an alternative fuel source to firewood.

Perhaps the most important use of electricity in Mali is the powering of electric water pumps in wells. Many farmers have to haul water by hand from its source to their fields or homes. Having readily-available water sourced from underground would be very beneficial for the people of Mali. In this way, a disaster could be prevented such as happened in 1973, when 40% of Malian livestock died due to an extensive drought. With a reliable supply of subterranean water, the water security of the region would be ensured.

Further environmental degradation as described by Hamady N'Djim and Bakary Doumbia:

Unfortunately, to this overuse of the environment [use of firewood as primary fuel] we must add the degradation of soil quality caused by common cultivation methods. One of the essential characteristics of Malian agriculture is its itinerant aspect, which is linked both to insufficient rainfall and to the need to feed a growing population. In fact, to compensate for the rainfall deficit, peasants till and cultivate the areas around permanent waterholes (backwaters, streams, and rivers). From this activity results the silting up and eventual filling in of river beds by the fertile soil coming from fields, with a consequent reduction in the life span of water courses.

To effectively address the lack of potable and usable water in the Sahel regions of Mali, several technological and practical changes need to occur. The soil in Mali is very dry, so when the annual or biannual rains come, most of them barely soak into the soil, and rather they flow over the top of the soil directly into rivers. Furrow diking is an in-field agricultural practice which changes the flow of water during rainy periods. The work required by furrow diking can be accomplished by hand with a shovel, which is a low-cost investment on the part of the farmer. The ramifications of creating small dikes in the field's furrows are great: water pools up in the field, giving it a chance to soak into the ground instead of rushing away directly to the rivers over ground with ineffective permeability. After rainwater has soaked into the ground, the roots of crops can utilize it, and the grounds retains water longer than when it flows off of the surface. Creating retaining ponds for the rains is another way in which perennial surface water can be yoked for the benefit of farmers. Working like a large-scale furrow dike, a retaining pond can supply water nearby to a farm, even months after the rains have passed (Thurow, Kilman 248). This consistency in supply is vital to the production of crops in parched regions.

Water scarcity is one part of the problem, but another is lack of water movement from its source to the farmer. Improving infrastructure would help this. The increased building of dams, irrigation canals, water pipes, and rainwater catchment systems would make a world of difference. Two major rivers flow through the country: the Niger River, which contributes approximately 46 billion cubic meters of water annually to Mali, and the Senegal River, responsible for about 10.5 billion cubic meters per year (N'Djim and Doumbia). Were these rivers to be outfitted for irrigation projects, potentially hundreds or thousands of acres could be irrigated successfully.

Despite these statistics [regarding substantial untapped subterranean water sources], daily life for Malians is much less bright. Water problems in Mali essentially take the forms of access difficulties and uneven temporal and geographical distribution. Less than half the overall population (46 percent) had access to potable water in 1992; the percentage is even lower (about eight percent) in the northern regions of Gao and Timbuctu. Agriculture, the cornerstone of the Malian economy, can only be practiced for a quarter of the year. (N'Djim and Doumbia)

Inventions by companies conscious of the plight of impoverished farmers have made significant impacts as well. Some technological options presented by KickStart International include a manual pump which is stepped upon to pump the water. To a great effect, this machinery was put to use in Kenya and transformed the life of subsistence farmer Peter Mutiso, as chronicled by Thurow and Kilman in *Enough: Why the World's Poorest Starve in an Age of Plenty*. After using this invention to pump water from a retention pond into his fields, Mr. Mutiso more than quadrupled his profit and was able to then buy a pump and generator, further improving his irrigation. Other mechanisms produced by KickStart International for this same purpose can be used by low-income farmers to completely change the way that they farm.

Harnessing water sources in ways other than irrigation could create drastic improvements in Mali. Watercourses throughout the region are relatively plentiful, and could be effectively used for hydroelectric power. Currently only 8% of Mali's population has electricity, and only 1% of the possible

hydroelectricity for the nation is being utilized, so there is great room, and need, for expansion (N'Djim and Doumbia).

A project which could be scaled up successfully is the Mali Rural Water Project, through World Vision. This project installed more than 260 wells in Mali in less than five years, among other water-related projects in the region. Additionally, plans for a five-year extension of the project through 2013 needed more funding yet had even greater and more ambitious plans in store, looking to drill 450 more boreholes for wells in rural Mali. That extension will positively affect more than 180,000 Malians, and a third phase of the project, especially with greater-scale funding, would be vital to reaching even more rural populations with clean, potable water from the subterranean sources under Mali. With increased funding, this project would truly provide reliable water to many communities and action on that front should definitely be pursued.

A commodity exchange would have profound impacts on Malian agriculture. Like the one brought to fruition through the efforts of Eleni Gabre-Madhin in Ethiopia, farmers would not have to worry about getting a fair deal on their crops, or having the possibility of complete failure after a bad year, and goods could be moved more efficiently throughout the country. Funding from overseas, private as well as public money, especially sourced from the World Bank, would be necessary for a project of this size, but the return on the investment would be profound as Malian agriculture took on a life of its own, unseen so far. A grassroots movement, led by a coalition of rural farmers and urban politicians, would need to happen there in order to build a commodities exchange to connect Malian farmers with the global market. If such an alliance could be formed, the true needs of Malian agriculturists would be represented in the government, necessary change would be instituted, and the face of Malian farming could greatly change for the better.

Organizations led by the people would be the way to institute change. Some former politicians, with experience in the development field and the situation in Mali, could formulate a group with a solid handle on the overall Malian situation and with knowledge of what would need to happen to improve the lives of subsistence farmers. These retired politicians from Mali or other Sahel countries would be backed by investors' funds. A board of trustees could identify the greatest needs and put into action a concrete plan for the execution of new reforms. Also, this form of spread-out power would ensure that the money was being used effectively and put toward the most necessary projects. Furthermore, the use of these experienced political figures would lend credibility to the organization. Assuredly, care would need to be taken to select board members with backgrounds clean of corruption or scandal and with a demonstrated heart for the people and their livelihoods.

Improving water movement in Mali would increase the yields of Malian crops, leading to fewer people going hungry and greater trade occurring. Once people have more financial resources, they will be able to buy electricity, which is mainly hydroelectrically produced, and this will contribute to sustainable environmental practices (less firewood consumption). Additionally, when Malians have more food and money, poverty will directly be reduced, allowing more girls to attend school and thus benefitting women and smallholder farmers especially. Additionally, these projects could be seen through to full completion by a group of people with experience in African political leadership, business, and agriculture.

Providing effective water conservation methods, new irrigation techniques and more widespread well technology would greatly increase crop yields and reduce women's labor. Having good crops would create food security and would boost income greatly. Additionally, it would lead to environmental rehabilitation and sustainability, necessary reforms for the continued healthy future of Mali.

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