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Algeria, Factor 6: Sustainable Agriculture

### **Algeria: A Comprehensive Plan to Halt Desertification and Raise Productivity**

A geographical and cultural collision occurs in Africa's largest country of Algeria. The Sahara meets steppes, the Atlas Mountains, and the Mediterranean coast. African traditions exist among Berber, Arab, and European ones. The People's Democratic Republic of Algeria is located in North Africa to the east of Morocco and the west of Libya. The southern extent of the country is occupied by the arid Sahara that composes 90% of the landmass, which is for the most part barren except for the occasional oases that dot the landscape. This turns into the Sahara Atlas mountain range to the north which gives way to the steppes known as the Hauts Plateaux, which has mostly natural vegetation used for pastoral purposes. Further north, the Atlas Mountains that isolate the coast keep it moister by blocking inward moving condensation, a region known as the Tell. The Tell region is home to most urban centers that have 73% of the population, and the entire Tell region has 90% of the Algerian population (Embassy of Algeria, Web). Only three percent of all land is arable, and only two percent of the land is forested. Algeria also has an interesting history of different people in control of governance. Early on, the region was held by Christian Berbers, who were then conquered by Islam's expansion under the Umayyad in 647 A.D., which brought forth an Arabization of the region. It passed into Ottoman hands, and was home to the Barbary Coast pirates who looted the naval trade of Europeans. Eventually this prompted an invasion by the French in 1830, who in turn made Algeria a department of their republic. Algeria remained in French rule until a post-World War II populace began calling for liberation; fighting broke out in 1954 and ended in 1962 with Algeria's independence. A socialist republic emerged that had started as an agricultural exporter (Embassy of Algeria, Web). Shortly after the revolution, utilization of the vast hydrocarbon reserves began, which coupled with agricultural malpractices, led to a decline in agriculture's importance to the national economy. Now Algeria has become food insecure since its imports are close to 75% of its total consumption. Reforms and privatizations have occurred over time in order to try to raise agriculture productivity, but most have had little effect. Algeria is a country advancing in the world with a healthy growing population, but teetering on an unsustainable agricultural program that can't support itself.

In the countryside, Algerian families remain attached to the more traditional family structure and lifestyles of Arabs. As such Algerians live in a male dominant conservative society that values group solidarity, desiring males to exhibit manliness and loyalty, and females to exhibit motherhood and tenderness. The population of Algeria is almost solely decedents of Berber-Arabs and are Sunni Muslims, only 1% of people do not fall within this grouping and are usually European Christians or Jews. The population was 37.1 million people as of 2010, and was expected to grow to 54.5 million people by 2050 (ESCWA, Web). Within rural settings, all 3 generations of a family will live in one house: the grandparents, married sons with their spouses each having on average 4 to 5 children. (Embassy of Algeria, Web). Rural families are also more likely to be under the poverty line because they've been affected by poor natural resources, high unemployment, and scars left from the civil war that ended in 2002 (IFAD, Web). The education system in Algeria, after having been constructed in 1963 after its independence from France, is well established in the daily lives of people and has led to high literacy rates. School is compulsory from the age of 6 to 16, with attendance being at 95% within the primary schools, but only 66% in secondary schools since many teenagers drop out in order to assist their families in making a living. This makes the literacy rate 92% among those under the age of 14, and for adults above the age of 15 it's at 73% (SOS Children's Village, Web). The healthcare network has also had tremendous strides in establishing a strong presence in Algeria, with 90% of individuals having access under the national publically funded system. However, those without direct access almost always are rural inhabitants and they still suffer from "poor country" sicknesses of tuberculosis and cholera that are

usually fixed by an extensive network of hospitals and clinics that the urban areas have (GlobalSurance, Web). The diets of Algerians have gone through extensive changes throughout time as an invading force has brought new crops and recipes. The staple starches for Algerians are both derivatives of wheat; people eat both breads made from durum wheat and couscous made from semolina wheat. People get their protein through beef, chicken, lamb, or seafood being put in couscous and in stews, or from eating tree nuts. Milk also plays a significant role in the Algerian diet with it making up 1/12th of all caloric intakes. Numerous different vegetables and fruits are consumed both whole and as components of salads, stews, and entrees (Edelstein, Web). In the end, Algerian's diet serves them well. They receive the nutrients they need, along with a sufficient amount of energy at 2400 calories a day, and only 5% of the population is undernourished (DuPont, Web). Overall, Algeria has a healthy and well taken care of population, especially for an emerging country, but has gaps in its rural populations who will have the responsibility of properly developing the country's future agricultural development.

The rural families that participate in agriculture vary depending on what they are contributing to the marketplace and their location, but two main categories exist. There are semi-sedentary pastoralists that operate in the steppes. They have herd movements between 10 and 50 km from their homes, usually consisting of less than 100 ewes and own less than 10 hectares to grow supplementary cereals; 80% of herders fall into this group of small pastoralist, with only a few herders reaching herds of 300+ ewes in size (Nedjraoui, Web). Long distance herding has now been mostly replaced by farmers intensively using their private land for the grazing of their sheep. Historically, all livestock were raised along migratory patterns designated by tribal agreements and led by expert shepherds; they would graze 4 months in spring in the steppes, spend 4 months of summer on the refuse of agricultural fields in the Tell region, and would then winter in the piedmont of the Saharan Atlas (Nedjraoui, Web). The other category of producers is row crop farmers that primary live in the Tell region. After the government reconstructed and distributed state farms, individual families held farms of 80 hectares in size. The primary crops grown include wheat and barley for a total of 63% of all cultivated land. Other major crops include citrus fruits, tobacco, olives, dates, sorghum, and corn (Metz, Web). Current agricultural methods include those initially adopted from the French, such as deep cutting tillage which promotes soil erosion (Cotthem, Web). Irrigation is presently active on 800,000 hectares and progressively made more available on some farmland by the government continuously developing 20,000 hectares each year through additional water resource structures, including 20 dams.

Several barriers exist that affect Algerians ability to increase their food security. First, the current reliance on imports as the major source of sustenance creates economic volatility. By not having enough domestic production and instead relying on other nations for foodstuff, Algerians are exposed to shifts in commodity prices. In a developing country like Algeria, these shifts can wreak havoc on the entire economy. According to the International Monetary Fund, after a price shock of around 10%, domestic inflation can be increased by 0.8 percentage points, 4 times higher than advanced economies (Gelos & Ustyugova, Web). This is particularly potent because food cost consumes 43% of the average Algerians annual income; with such a large percentage of total expenditures even small changes can cause financial strife for families (FAO Country Briefs, Web). Additionally, Algeria's unemployment rate is relatively high at 10%, but it affects those under the age of 25 disproportionately with their rate being 22%; people cannot be food secure if they possess no means of making a living (Gijón et al, Web). The government began attempting to mitigate the problem by subsidizing major staples including sugar, milk, oil and flour, after the disruption of a commodity spike in January of 2011 led to riots attached to the Arab Spring. Overall this still adds significant strain to the entire economy since enormous amounts of money are sent to foreign markets and government revenues are being used for support of foodstuff instead of development (Wooster, Web). Algeria cannot become completely food secure when it heavily depends upon other nations, which can be politically volatile. Second, their current production is very vulnerable to several factors, including malpractices, desertification, and climate change fluctuations. Overgrazing has demolished the integrity of Algeria's steppes in the way that the forage is grazed to a point beyond

immediate rebound to where come next season there is less to be eaten creating a positive feedback loop. Currently, there are 19 million sheep units on the steppes, but it has only a sustainable stocking rate one-tenth that size; current production is worsening the situation and is only possible from heavy concentrate feeding. Eventually there is not biomass to hold in the soil and it is slowly blown off by winds, leaving the ground bare and creating small dunes (Nedjraoui, Web). Poor farming practices including tillage and mismanaged irrigation leading to salinization which has destroyed cultivated lands. Each year in Algeria, 40,000 hectares are lost to encroachment by the desert. With this to continue would mean that food consumption would continuously be pushed off to imports thus exacerbating the economic problem of commodity spikes (Cotthem, Web). Furthermore, Algeria's only current resilience against food imports lies with its relatively large accumulation of wealth through hydrocarbons; however, these are expected to start running out by 2050, which would then leave Algeria with no safety net (Echarif, Web). Establishing self-sufficiency and diversifying the economy will create a new safety net for the future.

In order to combat the potential of desertification spreading, a four pronged approach is most appropriate, including: developing better grazing practices, integration of trees as a management tool, fostering a network of small greenhouse operations, and several best management practices to be used in order to strengthen the health of the soil. This would create a system that eliminates the driving force for desertification while protecting a foundational industry, holds the soil in place and imbeds a green barrier that would halt advancement of deserts, expands the amount of cultivated lands by integrating more marginal lands into agricultural production, and establishes strong soils that won't erode away and provide increased productivity in the future

The main cause of Algeria's desertification is at the hand of malpractices of the current livestock grazing systems that is destroying the steppes and rangelands of the country, attacking this issue will prove the strongest weapon against future desertification. The primary means of developing good practices would be to reestablish the nationwide rotational grazing, the system pastoralists had used for thousands of years of going from the steppes in spring to the Tell after summer harvest to the piedmont of the Saharan Atlas for winter. Rotational grazing is beneficial for several reasons: it allows times of rest and regrowth for the plants consumed, it more evenly disperses the nutrients created by the manure deposited, and it is shown to increase animal productivity. In order to ensure a good system is implemented, the country will need to call upon the experience of its pastoralists. They know the ability of the land, and how to move their herds properly, so the government should revert to the pastoral code of 1975 where all grazing land was state owned and run by locals administering communes, in order to put the experts in charge of the land (Nedjraoui, Web). In order to ensure optimized grazing, only 50% of the leaf mass should be consumed before moving on, if more is taken this can lead to root stoppage which also means a stoppage to leaf material growing back (Beef, Web). Additionally, all cereal operations in the steppes should be halted and converted back into pasture. They produce very low yields that don't really serve to feed the livestock herds and actually result in erosive conditions that lead to desertification; they were primarily used as a means of "improving" the land, thus giving them ownership rights. By doing this 2 million more hectares would be able to be grazed (Nedjraoui, Web).

The vulnerability of the steppes means additional protective measures need to be put in place in order to ensure their survival; trees as a management tool could be the solution. The primary use for trees is usually noted as them providing a live green barrier: this holds soil in place with the roots, it serves as a windbreak that reduces erosion, and it can trap traveling particulate matter that may otherwise be a spreading sand dune. This had been previously tried by the Algerian government with use of the military as the implementers, where they attempted to make a 1500 km wall of trees 20 km thick, running east to west within the 200 to 300mm isohyets zone. This began in the 1970's, but had limited success and eventually fizzled out of being a continued project; however, this was largely due to "ecological incoherence" since they cleared land before planting a monoculture of Aleppo Pine, along with there being logistical and managerial failure. With special care paid to these areas, the "Green Belt" could

become practical (SSO, Web). Another benefit that could be derived from installing more trees along the edge of the steppe is the use of silvopasture: where livestock is grazed among a thin stand of trees that still allow forage to grow. This system can be beneficial in a couple ways. First, it diversifies the economy of the farmers so they now have an additional product to sell, which also helps protect them against any fluctuation in one market since they have another to fall back onto. Second, silvopasture provides a greater financial turn since the two products produced don't inhibit the growth of each other. Having a variety of correct trees in place is necessary for the entire system to work. Diversity is important because it boosts productivity, and it shields against complete collapse if some disease, fungi, or insect was to come around and wipe out a single species (NC Envirothon, Web). Some trees that could be implemented include Juniper (*Juniperus thurifera*), Chaste Tree (*Vitex agnus-castus*), and Aleppo Pine (*Pinus halepensis*); all of these are suitable for the hot dry climate that Algeria has to offer (Cotthem, Web; Duke Univ, Web). All have additional economic uses: Junipers can be used for lumber and has an added benefit of a high resistance to decay; Chaste Tree has traditionally been used in medicine production; Aleppo Pine can also produce lumber and has a high production of resins that have industrial uses (WebMD, Web). By integrating trees the land of Algeria can have a level of protection and the people can have a greater source of making a living.

Great success in agricultural development has occurred across the Alboran Sea in Almería, Spain through a system of greenhouses, and this could be duplicated in Algeria. Almería currently has 35,000 hectares of greenhouses that produce 2.7 million metric tons of vegetable produce a year (Lucas, Web). The network of family run farms was able to take the barren landscape of Andalucía, which suffered from having 50% of the GDP per capita of the rest of Spain in 1960, and create an industry that added nearly \$2 billion dollars to the economy and raise the income of the area by 50% (World Bank, Web). This system could be placed on marginal land in Algeria, and thus only adds to the total food producing areas and doesn't take any away. Utilizing a Perlite closed drip irrigation system would be the best option of greenhouse for Algeria. Perlite is an obsidian based substance that serves as a soil medium for plant growth. This avoids the buildup of soil toxicity that the traditional Enarenado system of soil, clay, and manure experiences. It is also more efficient and productive compared to the same amount of open field cultivation: it used 50 – 60% less water for the food produced, and produces 8.5 times more food (Jovicich et al, Web). This system could be implemented in the rural areas and run by families through cooperatives since farms are usually small at an average of 1.5 hectares. It would then provide the poorest people of rural areas a means of economic development which can lead to further benefits of greater food security and medical care access (Giagnocavo, Web).

Developing a soil's health through proper farming practices can lead to countless benefits in most characteristics of a soil's performance, and the primary medium of increasing the health is to incorporate additional levels of carbonic organic material into its profile. One benefit includes the enhanced ability for the soil to form aggregates. Organic compounds decomposed by soil microbes form glue like residues that stick the basic soil particles of sand, silt, and clay together into larger particles. This allows the soil to have a greater available water holding capacity since the individual pore spaces are close knit; reducing drainage, increasing the water retention power, and making the soil act more like sponges. For every 1% increase of organic matter composition an additional 13,577 gallons of water can be held within an acre (Ehmke USDA, Print). This is particularly important in Algerian soils that have high sand content and thus rapid drainage which can leave the fields dry even shortly after a rain. Another benefit is that this reduces the potential of wind and water erosion. Single small particles are easy to move, since they require less energy, than the larger ones present with increased carbon binding soil into aggregates. In order to achieve such benefits, several different management principles need to be used including minimizing tillage, covering the ground, and having cover crops. When a soil is tilled and exposed the moisture within it can evaporate as well as the decomposing organic compounds can oxidize into carbon dioxide that gases off, so by reducing tillage the soil can grow its beneficial organic matter faster. In the arid region of Algeria, adopting minimized conservation tillage (over no till) is most practical since

hardpans can develop with arid soils and need to be broken up right before the sowing of seeds. Normally leaving the residual matter from the non-used parts of the harvested plants would be important for adding organic matter, but instead this serves a better purpose as fodder for the livestock operations of the country. Instead farmers should apply a cover crop in the place of a traditional fallow period in order to enrich the soil with organic matter. This provides organic matter that can later decompose into the soil profile that also when alive serves as a protective barrier that holds moisture in and stops wind and water erosion (Ehmke USDA, Print). These plants can also be very important for nutrient replenishment in the place of intensive fertilizer use, since the traditional crop of wheat and barley are high users of nitrogen. Cowpeas (*Vigna unguiculata*) and Sesbania (*Sesbania sesban*) have both been identified as cover crop legumes that fix nitrogen into forms usable by plants, while also not requiring a lot of water and thus suitable for dryland agriculture (Wang & Nottle, Web; Cotthem, Web). By adapting all these practices the cultivated lands for major crops and cereal crop production can mitigate the dangers of desertification while also improving their productivity and reducing Algeria's import dependence.

In order to incorporate all these suggested practices, an educational program will need to be established. The first step should be a national department that orchestrates local field offices where consultants provide the technical and scientific knowledge of proper grazing, silvopasture, greenhouses, and soil health to farm operators. The United States Cooperative Extension, as model program of this manner, has been able to increase efficiencies of the farm by having experts consult with farmers, as well as provide technical skills that make families more self-sufficient. The US Cooperative Extension operates continuously to improve the lives of farming families, but it also able to facilitate rapid increase in food production, as it did over a 5 year period during World War II that lead to a 38% increase of food capacity, which is needed for Algeria since it can't currently produce enough for its own sufficiency (NIFA, Web). The proper way to push improved, sustainable methods is just to provide the logic that farmers can extend the value and lifespan of their land as well as provide themselves with larger more secure incomes. Additionally, a second strategy of reaching out through local youth opportunities can be established like the United States' 4H and FFA, which provide students with agricultural skills. This is a particularly strong method because these individuals will grow into their parent's position of producers for the nation and thus a sustainable future is fostered. It can also pressure the current generation to adopt these practices once it's observed the children are able to beneficially produce more than their parents (NCCE, Web). Through local activism provided by the national government, local residents can be put properly in charge of enacting the changes that will lead to their decreases of food insecurity.

Most individual Algerians are currently food secure, with only minimized gaps of those not properly fed; however, they are doing so through unsustainable means. Their agricultural industry cannot meet the demands of the population and thus they currently rely heavily on imported food, particularly the staple of wheat. Importation is only economically viable because they have tremendous amounts of hydrocarbons to offset the cost, but these are expected to dwindle in 35 years then leaving them no safety net. To worsen the situation they are constantly losing more land to desertification. In order to assure Algeria will be able to properly feed its people, improving agricultural productivity and stopping the advancement of deserts is key. Reestablishing nationwide rotational grazing under the tradition of pastoralists will return integrity to the livestock operations of the country and stop the degradation of steppe land. Within this area, particularly along the southern edge of it, integrating trees can also serve to protect the land from wind erosion and desertification. This is also important because it would add another industry to the Algerian economy that could help eventually offset a subsiding oil industry. Introducing a vast system of family run greenhouses could provide tremendous amounts of vegetable produce while also economically empowering the rural poor on currently marginal lands. Lastly, increasing the capacity and health of all the soil on arable land would allow resistance to land depletion, while also increasing the yields of fields. Together these practices should leave Algeria with an adequate amount of land, and raise the productivity of that land, this in turn would shield them from the economic hazards of being dependent on food imports and only one economic factor to pay for it.

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