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WINNER, GLOBAL ECONOMIC DEVELOPMENT CATEGORY

Integrated Policies for an Agricultural Revolution in the Sahel

By Greg Vaughan

ABSTRACT: The African Sahel has passed abruptly from a slash-and-burn system to the use of ox-drawn plows and modern chemicals in the past century. Using lessons drawn from the agricultural history of the West, this essay recommends changes in fertility management, equipment, and institutional policies to improve productivity and sustainability in the Sahel.

The African Sahel Belt is a climatic zone running in a band below the Sahara from Senegal in West Africa to Sudan in the East. It is characterized by a single rainy season lasting three to six months, depending on the latitude and the year, followed by no rain whatsoever the rest of the year. The Sahel is densely populated and has undergone explosive population growth in the past decades. Due to the fragile and variable climate, combined with the dense and growing population, the Sahel has been the site of many humanitarian crises in the recent past, including crop failure in Niger, and war in Chad and Sudan. These problems promise to continue in the future, possibly aggravated by climate change and continuing population growth.

Agriculturally, the Sahel is at a crossroads. In the past century, farming practices have changed drastically, but certain useful agricultural practices are not employed or mastered by Sahelian
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farmers. In Europe and the West, agriculture underwent an 8,000-year transition from slash-and-burn farming to light animal traction to heavy plows to the elimination of fallows to the mechanization of animal traction, until finally arriving at the present system of motorized, chemical agriculture[1]. In contrast, agricultural practices in the Sahel have jumped from slash-and-burn to the use of modern fertilizers and pesticides, all within the past century. As a result, many intermediate innovations and evolutions that could improve productivity and sustainability have never occurred in the Sahel.

Until well into the 20th century, Sahelian agriculture was based in large part on rotations with a long-term fallow, also known as slash-and-burn agriculture. A field was cleared from the natural brush vegetation and planted to crops for a number of years, often without crop rotation. When fertility began to decline, the field was abandoned to regrow native vegetation for decades, after which it was again cleared and cultivated. For centuries this system was sustainable. After a period of cropping, fertility was replenished with nutrients drawn up from the subsoil by the roots of new brush and forest vegetation. At any given time, the majority of land was left in this native vegetation. However, the system is only sustainable at a low population density. The arrival of modern medicine to the Sahel increased child survival and population density, which demanded that more land be cleared and left fallow for less time. The increased clearing of land was facilitated by the spread of animal traction. The introduction of new crops, modern pesticides and synthetic fertilizers improved productivity, thus allowing the population to grow even more. In a few decades, slash-and-burn agriculture was no longer possible because most of the land was in permanent fields.

This said, agriculture in the Sahel is not totally modernized. Because the new technologies were largely introduced from outside and in a very short time period, there was little evolution of certain practices critical to productive and sustainable use of the land. All the intermediate steps between Neolithic-style, slash-and-burn agriculture and modern, chemical agriculture were skipped, leaving in place many practices inappropriate for the present, high population density and an agriculture without long-term fallows. Use of oxen-drawn equipment is mainly limited to shallow plowing, with planting, weeding and harvesting done by hand. Even plowing is not

[1] See Mazoyer and Roudart's *A History of World Agriculture* for an in-depth discussion of these evolutions.

extremely efficient, requiring two young boys to drive the oxen and a man to guide the plow. There is little or very primitive crop rotation, a result both of the recently-used slash-and-burn systems and subsequent pressure from colonial and post-colonial governments to plant industrial monocrops, mainly peanuts and cotton.

There is little renewal of soil fertility because the traditional method of long-term fallows is no longer possible and has not been satisfactorily replaced by other methods. Use of synthetic fertilizers is somewhat common, but usually in suboptimal quantities because the fertilizers are expensive. Many governments in the Sahel region only offer credit to buy fertilizer to those farmers planting cash crops, such as cotton, which because of low prices are unattractive to farmers.

Furthermore, the Sahelian climate of alternating dry and wet periods and constant high temperatures rapidly decomposes organic matter in the soil. Use of synthetic fertilizers gives poor results without renewing soil organic matter. Incorporating manure in the soil would be an effective way of replenishing organic matter and fertility, and indeed this is the method that ancient Asians and Europeans employed when populations became too dense to allow long-term fallowing. There are many cattle in the Sahel that could provide this manure, and cattle numbers are growing. However, the current methods of animal husbandry involve transhumance, meaning herds are far away from cultivated fields during much of the year, making it difficult to use the manure.

Sahelian agriculture is thus an awkward hybrid of different agricultural systems. It incorporates the hand labor, slash-and-burn system, the shallow, inefficient plowing and sparse fertilization seen in classical Greece, with the synthetic fertilizers and pest control chemicals of the modern world, yet without sufficient state support to finance purchase of these modern inputs. However, this hybrid status and the system's openness to change are also an opportunity to fill gaps in knowledge and practice, and thus combine the best parts of different systems. To make this transition, changes are needed in three areas.

- Fertility management must be revolutionized by increasing the use of animal enclosure, hay-feeding, and soil incorporation of manure.

- A revolution is needed in such equipment as plows and harvesters.
- Institutional changes must occur to favor the positive evolution of Sahelian agriculture.

Increased and more efficient use of manure can be effected through a number of changes in animal husbandry. First and foremost, there must be a decrease in transhumance of domestic animals. Under the current system, cattle are herded north to unpopulated semi-desert lands during the flush of grass in the rainy summer, then herded south to wetter climes as the rains recede. This is an effective way of using seasonal grass growth for cattle production, but almost none of the manure produced is recycled onto agricultural fields.

To allow farmers to gather manure and spread it on crop fields to add organic matter and nutrients, it is imperative that more farmers tend their own livestock in enclosed yards, as opposed to entrusting their care to transhumant groups. This change allowed Medieval European farmers to double their productivity compared to farmers of Classical Antiquity. Many measures are required to increase manure production and soil incorporation. Unfarmed grassland near villages would have to be fenced as protection from transhumant herds and to allow harvest of the hay by villagers. The use of fencing and hay would be a drastic change in common practice. In some cultures, harvest and preservation of standing grass is even considered off-limits for legal or religious reasons.

Farmers would also have to include planted forages in their crop rotations. The combination of grass harvested from outside the field and forages from the field could be stocked and fed to cattle year-round, even in the dry season. The resulting manure would be a precious fertilizer, and the increased levels of organic matter in the soil would also permit more effective utilization of applied synthetic fertilizers. Changes in pasture and manure management can be encouraged by changing local laws to encourage enclosure, harvesting and hay storage, and through loans for buildings and equipment needed to handle cut forage and manure.

At the same time, some provisions must be made for transhumant groups, such as setting aside certain areas or certain times of year for the passing of their herds. Transhumant animal husbandry is an ancient custom in much of the Sahel, and certain specialized social groups

depend on it for their livelihood. Transhumance has its place as an effective use of marginal resources in the desert and the Sahel. It should and will remain part of the reality of Sahelian countries, but its presence must be readjusted to a level that makes efficient use of grassland resources and does not impinge on pasture and fertility management in agricultural zones.

An equipment revolution would be a great aid to Sahelian farmers. The changed practices of fertility management mentioned above would require numerous new pieces of equipment. Production of barbed-wire or electric fencing to enclose pastures and cattle yards, hay-harvesting equipment, barns for hay storage, and equipment for collecting, storing and spreading manure, are all necessary to implement new manure-management methods. Steel riding-plows using mechanical depth regulation would allow better incorporation of manure, and need only one person to operate. One-person plows and other labor-saving equipment, such as cultivators, harvesters, threshers, would improve work productivity and free more children to attend school.

This equipment should not be motorized, because gasoline represents an unnecessary extra expense that does not provide the manure oxen do. Much of this equipment can be adaptations of pre-existing equipment for animal-drawn agriculture, such as Jethro Tull's seeder or John Deere's steel plow, though there will also be a need for new inventions unique to the Sahel. Policy-makers in Sahelian countries and in donor nations can favor such innovation through realigning secondary- and university-level education to focus on designing solutions for local agriculture, providing grants and loans to innovative companies producing such equipment, or sponsoring competitions to spur the equipment ideas of thoughtful farmers.

The third and most far-reaching group of changes necessary for an agricultural revolution in the Sahel is a series of institutional measures favoring investment by farmers and better market conditions. Many of these measures were implemented by governments in Europe and the United States in the 20th century. Most important is the provision of credit, in cash or in kind, for farmers to obtain fertilizers, pesticides and equipment to increase productivity. This also implies a system for insuring crops, in case bad harvests prevent loan repayment. As in many developed countries, both the credit and the insurance systems could be a mix of subsidized government-run providers and private companies bound to honor certain rules and rates.

Another important credit measure is pre-harvest loans for the “hungry season.” In a seasonal environment with scarce economic resources, a family's stored food and money from one year often runs out before they harvest the next year's crop. In such a situation, many families are forced to borrow food from local merchants at loan-shark rates. When they finally harvest their crop, they must sell a large portion of it to repay the debt, precisely when crop prices are lowest. Government or NGOs can play a valuable role by offering low-rate loans during this “hungry season.” Traditional lenders may balk at such a loan, because it is for consumption and not directly productive. But if a family is required to pay less interest on such a loan than what they are accustomed to, there will be a high repayment rate. It may even be considered a productive loan, because the money saved by not paying steep interest to a loan shark could be used for other, more productive uses.

Sahelian governments and donors must promote producer cooperatives for storage of grain, milk processing and distribution, and other collective farmer needs. Such facilities and businesses allow farmers to better control production, quality and sales, and hence to receive better prices for a better product. Finally, loans for farmer investment in irrigation can contribute greatly to productivity and sustainability in the Sahel. Irrigation would raise production by doubling the length of the growing season, an important factor as climate change increases the variability of rains. There is another, lesser-known benefit to irrigation. Much of the Sahel is underlain by renewable aquifers. The level of these aquifers is actually rising due to increased deep infiltration of water due to the decrease in natural vegetation that slows and absorbs water. If this trend continues, these aquifers will eventually rise to meet surface water, salinizing the land and polluting wells, as has already happened in certain locations. Thus, increased irrigation will not only increase productivity, but is necessary to prevent a catastrophic degradation of land and surface-water resources.

Increasing the credit available to farmers who plant food crops would demand some difficult changes by Sahelian governments. Currently, credit is scarce in the Sahel, limited usually to farmers in certain vertically-integrated market chains, such as nationalized cotton industries. This is because in many cotton-producing countries in the Sahel, the government is the sole or

principal processor and exporter of cotton, which earns foreign currency. Many governments want to encourage production of cash crops. Locally consumed and traded food crops do not enter into this vertical state system, so do not directly benefit the governments concerned.

In light of increasingly poor prices for cotton and other exported commodities, it would make economic sense for such governments to make loans to those farmers growing food crops, since food crops encounter a sure market and good prices in local cities. The government could adjust its taxation structure to tax products sold internally, thereby receiving funds through a different channel than export crops, while at the same time promoting local farming and consumption. In a climate of unsure world commodity markets and burgeoning African cities, it is advisable for farmers and governments in the Sahel and the rest of Africa to focus more on national or regional markets, where prices are higher and transport is cheaper.

Many of the transitions recommended in this essay are already underway. Indeed, in such a time of changing needs and conditions, farmers evolve and create new ways of producing food. For example, the enclosure of cattle by farmer-owners and subsequent use of their manure is gradually replacing the entrustment of herds to semi-nomadic groups. However, spontaneous evolution of new agricultural systems involves long time periods and much trial and error. Many of these trials will not necessarily be productive or sustainable. This essay proposes the implementation of policies that would favor and speed the evolution of Sahelian agriculture towards more productive and sustainable systems.

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