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The Math Behind African Community Farms

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Less grazing, more farming makes sense.

Deep into the night, a herd of elephant pass by a family farm that is now ripe and ready for harvest. It is nothing fancy; perhaps a 1/2 acre of land, surrounded by a fence that consists of three strands of wire perilously strung up on acacia posts. The wires are possibly electrified, but not enough to deter an elephant who is drawn to the sweet smells of the fresh produce. Most single strand fence that has already been repaired will likely break at around 200 lbs of pressure; hardly anything for a 10,000 pound African elephant who can just lean into the wires causing them to break.

Once the fence has been breached, the farmer's hard earned labor is quickly destroyed. Most likely, this is not the first time. This garden is his family's work, life, and their subsistence. Of course the farmer will race out with his acacia stick in hand, rage in his voice as he attempts to stop the swift destruction of his precious crops. Most of the time, the herd will make a quick escape, and on a few rare occasions, the farmer is critically hurt in the exchange. This is just one episode of a human-animal conflict.

Given enough of these episodes, the farmer may quit his farm in frustration, especially if he is lured by the quick and easy money of poaching. After all, the elephants are no friend of his.

Too Many Small Farms

In many parts of Africa, small family farms are randomly dispersed throughout the bush. They vary in size, strength and quality. These farms impede the natural migration patterns of the wild animals because they are not designed to

facilitate the natural flow of animal movement. In fact, many times the animals have to detour around these farms or between them to move about.

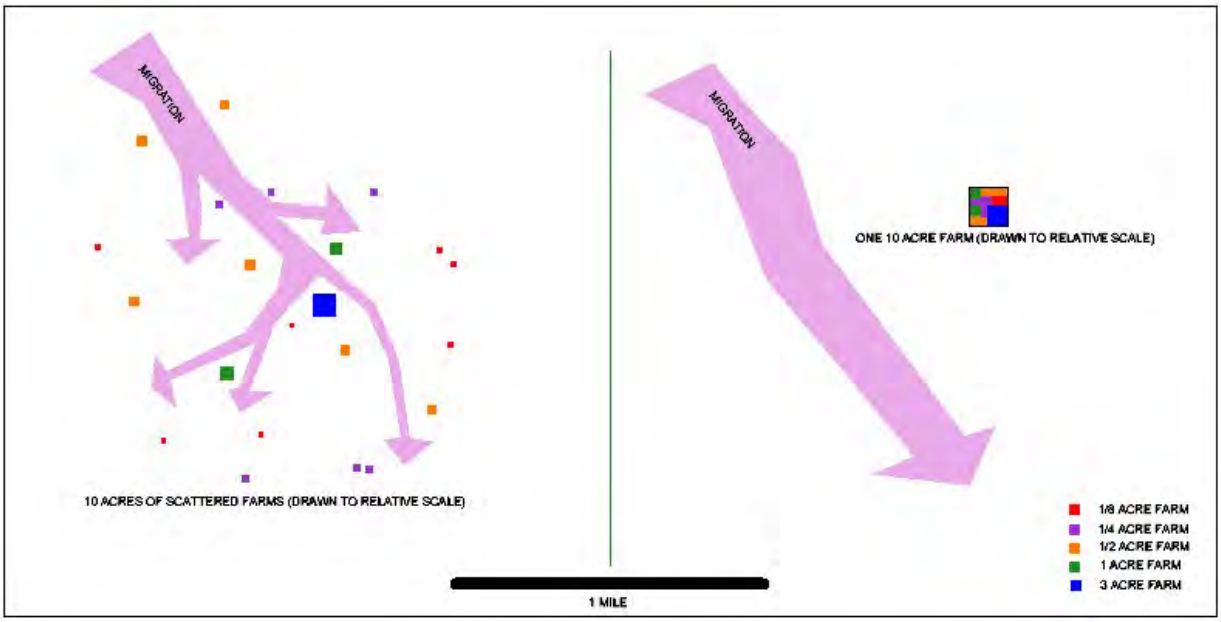

Figure 1: Two maps drawn to the same scale. On the left, multiple farms are spread out through the bush. On the right, the same farms condensed into one community farm.

There is also an enormous waste of human resources in these small plots. For example, based on a pure mathematical model, a random collection of farms will have an extraordinary length of fence line exposed to wildlife as the chart below demonstrates:

Farm Size (acres)	Total Perimeter Fence Length (feet)	Number of Farms in Area	Total Land Mass of all Farms (acres)	Total Perimeter Fence Length of all Farms (feet)
1/8	295	8	1.00	2,361
1/4	417	6	1.50	2,505
1/2	590	5	2.50	2,952
1	835	2	2.00	1,670
3	1,446	1	3.00	1,446
SUBTOTAL:		**22**	**10.00**	**10,933**
10	**2,640**	**1**	**10.00**	**2,640**

Note that there is a 76% decrease in the fence length for the same land mass.

76%: That is how much fence line can be *saved* by having one square farm instead of 22 small farms! That is 76% less cost, 76% less maintenance, and most importantly, 76% less exposure to wildlife migration. Other benefits include the ability to build better, stronger electric fences that would be impervious to animals such as elephants, hippos and baboons.

These are all good reasons to consider the consolidation of these family farms into farm co-ops that can be better protected and maintained by a community. These co-ops must be strategically located where there are adequate water resources and good soil. Of course such a proposal would require the community to work together; either as sub-parcels within the farm, or together as one co-op. The benefits could be extraordinary.

A Working Example of a Community Farm

Figure 2 is a photo of a farm located in the lower Zambezi of Zambia. This farm is a community based farm located on tribal lands that was designed and constructed by Direct Impact Africa[1] hereinafter referred to as DIA. The area is full of elephants, buffalo, baboons and other critters interested in good farm food. The fence is powered exclusively by solar power. The irrigation is a low pressure surface drip system that is also powered by solar power.

Figure 2: Direct Impact Africa farm located in the lower Zambezi, Zambia.

DIA has built about 6 of these farms in the lower Zambezi area to date. Some of these community farms also include tilapia fish farms within the confines of the fenced

area. These farms have been so successful that the challenge today is how to sell the surplus produce to major urban markets.

DIA has funded and constructed these community farms under the expressed and written agreement that the local community will fully self-enforce no poaching in the area. Otherwise, the major components of the farm will be removed.

Grazing

13 x: The carbon footprint of cattle grazing is 13 times greater than that of farming broccoli or beans[2]. It is the second highest carbon footprint for any food source.

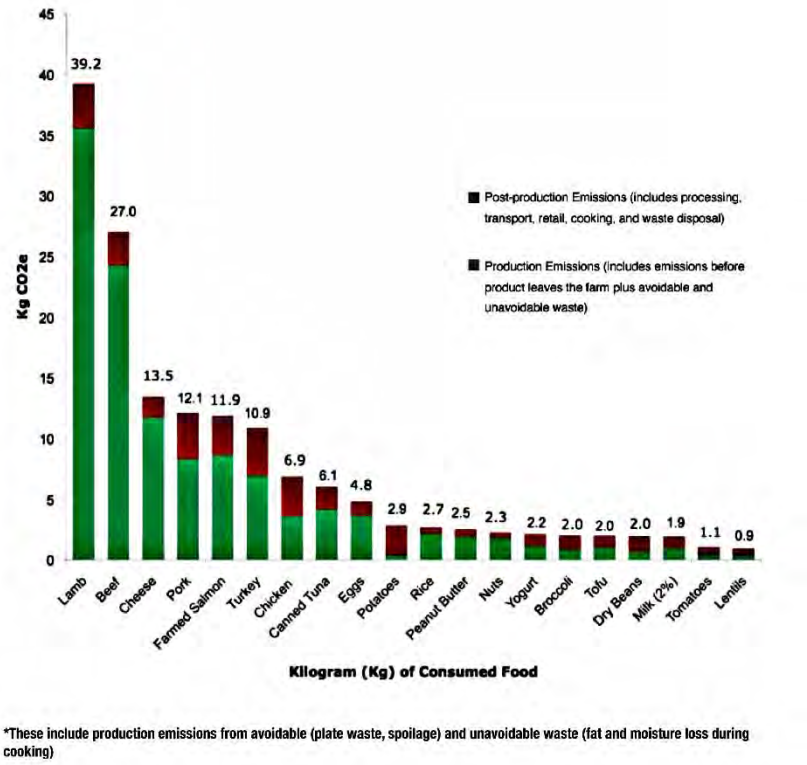

Figure 3: Carbon footprint of various food sources.
[1]http://static.ewg.org/reports/2011/meateaters/pdf/methodology_ewg_meat_eaters_guide_to_health_and_climate_2011.pdf

In many parts of Africa, cattle are a means of culture, wealth and subsistence that is so entrenched that it would seem impossible to change. However, success in fish, poultry and vegetables via a community farm could modify the need to rely solely on beef. After all, civilizations have modified their behavior when a food source becomes reliable and abundant. Solar power is allowing the world to make that change. Never before have we had the ability to domesticate wild rangeland into crop land with minimal solar powered infrastructure.

The academic and research publication, *The Conversation*, recently shared an interesting article that described the many reasons why we desire to eat meat; "Why cutting meat from your diet could be revolutionary".[3] The article breaks down a variety of cultural factors that help explain why we are drawn to be meat eaters even though our bodies are quite capable of reduced meat diets. Furthermore, the trend to eat meat appears to be growing worldwide. If this is indeed the case, then it is even more important to provide dependable, abundant meat and vegetable food sources from efficient farms in order to minimize the need to graze cattle.

Tilapia, Chickens & Guinea Fowl

Community farms are also good candidates for tilapia farms. This is another protein source that has a much smaller carbon footprint than cattle and is reasonably easy to construct. All it takes is an adequate water supply, an impervious pond lining (like clay), fingerling fish and fish food. The fish food can be purchased from a metro area, or it can be grown and processed locally given the proper equipment.

Figure 4: DIA chicken coop in Lower Zambezi area, Zambia

Chicken and/or guinea fowls can also be introduced into the community farm although the ability to construct varmint proof cages in or near a village is also effective since these coops are relatively small. Like fish, chicken feed must be purchased, or it can be grown locally with the proper equipment. Chicken manure can then be used to naturally

fertilize the farm. Both egg layers and roasters are another good replacement for beef.

Solar Power

272 watts: The amount of power a new 40” x 40” solar panel can generate.

Never before have we had the ability to run camps and farms using solar power. The technology is here today; it is no secret. And best of all, it is affordable. Some companies are even offering 25-year power warranties on their products which means that this product is here for the long term. Solar can be used to power electric fences, water pumps, sensors and security cameras. Many companies all over the world are able to design and implement the proper setup for just about any need, anywhere.

Electric Fences

20,000 volts: A static discharge from carpet is about 20,000 volts. It is not lethal due to its extremely low joule count. A Taser uses about 50,000 volts that pulse about 20 times per second. Each pulse is about ½ joule. This blend of voltage, joules and pulsing is certainly enough to incapacitate a human.

Voltage is what penetrates the skin, joules are what pushes the voltage through the wire. Various literature cites that the effective voltage to deter an elephant is between 5000-10,000 volts. Energizers vary in their joule delivery from .1 to 20 joules. Consequently, fence voltage must have the proper energizer that provides the correct amount of joules *and* voltage along with an intermittent charge so that the animal has time to remove itself from the contact zone before another charge is sent down the wire. Nobody wants an elephant or human to be

injured. There are a number of international vendors who are experienced in this matter and who are able to design a proper fence based on its total wire length, soil type and animal behavior.

Figure 5: DIA electric fence, Lower Zambezi, Zambia

Some elephants have been known to use their tusks to penetrate an electric fence. In case you are wondering, the resistivity of an elephant tusk is 2×10^8 ohm-cm.[4] This number is similar to the resistivity of a damp piece of wood[5]. That is why it is important that the fence be constructed not only with electric wires, but also with proper poles and wire fabric which will also deter the smaller animals.

As the old saying goes, "a chain is only as strong as its weakest link." The same rule applies to a community fence; it only takes one breakthrough at a weak point to compromise the entire crop.

Water

1.5 inches: The approximate amount of water needed to irrigate small vegetable crops per week via a subsurface drip system[6]. Other systems include low-pressure surface drip, live water ditch systems, surface sprayers, and pivot irrigation. The beauty of drip systems is that the calculation for necessary

Figure 6: Low pressure surface drip irrigation, Zambia

water flow is relatively easy. If there is an adequate flowrate, then the most critical element of a drip system is to get clean water to the drip nozzles. If not, then clogging of the orifices will become a big problem. Of course, the cleanliness of the water depends on its source. Well water is usually very clean but may not be productive enough to run a farm. These are all very tangible problems that can be evaluated by experienced personnel.

As shown in Figure 6, DIA is using a low pressure surface drip system because of its affordability and visibility. The drawback is that the drip lines must be removed before any tilling. Another interesting option are the thin-walled drip systems that are buried 14-16" deep on 40" centers that have been proven successful in other areas of the world. Netafim (www.netafimusa.com) is one international vendor that has proven the success of these buried lines. Their website has good information regarding the general success and layout of a farm with underground irrigation[7]. Although more expensive at installation, the subsurface drip systems are below plow depth so they provide easy management of surface disturbance like tilling, planting and weeding.

Water is another natural resource that needs to be carefully exploited because many successful farms could permanently damage an aquiver or live water resource. Hence, as good stewards of this planet, it would behoove us to install the most efficient irrigation techniques up front in order to set a good long term example of water conservation.

Maintenance

The local people must take ownership and responsibility for the maintenance of any project built in their territory. Without upkeep, the project will fail. There are examples all over the world whereby an innovative design was introduced, built and then successfully handed over to the locals. Soon thereafter, the project failed due to the lack of maintenance. It is critical that the local people have the leadership and training to conduct the maintenance themselves, otherwise, their dependency on outside help will only drag the founding organization down both economically and with continued oversight management. A wireless monitoring system would be able to track critical data on the farm, and that data could be sent internationally allowing the experts to diagnose and solve the problem without having to be at the site at all times.

Conclusion

100%: 100% success is the key. If a small trial farm is 100% successful, then it will open many eyes. It may not happen fast, but a series of successful farms will provide the food source to the community that is so desperately needed. With a full belly, the culture to hunt or even poach wild animals could be naturally extinguished. A successful farm will provide consistent food, even in droughts. After all, grazing cattle has its own environmental impacts and risks, including but not limited to, wildlife habitat impact, human/animal conflict, drought and commodity market risk.

Figure 7: Happy farmers, Zambia

A successful farm will not only provide food for the local community, but will also allow for the excess food to be monetized which in turn will give the community momentum to culturally convert to farming on a small footprint. And the carbon footprint of cattle grazing will be significantly reduced. Success is just a matter of patience, funding and good design.

About the Author:

Figure 8: Ed Trousil

Ed Trousil

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- Geological Engineer, Wildlife Habitat Enthusiast & Rancher
- All photos and graphics are those of the author unless duly noted.

Ed has always been a wildlife habitat advocate; "With some foresight, human infrastructure can be effectively minimized in its footprint so that wildlife corridors can remain open and unencumbered."

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[1] www.directimpactafrica.org

[2]http://static.ewg.org/reports/2011/meateaters/pdf/methodology_ewg_meat_eaters_guide_to_health_and_climate_2011.pdf

[3] http://theconversation.com/why-cutting-meat-from-your-diet-could-be-a-revolutionary-act-69904

[4] https://books.google.com/books?id=gKk_AAAAYAAJ&pg=PA299&lpg=PA299&dq=electrical+resistivity+ivory&source=bl&ots=f_XsyE_QoA&sig=W_hDWvcXp45f7w4mJHO7w6l-LAI&hl=en&sa=X&ved=0ahUKEwicpaqxq6nRAhWD7IMKHYrpDpgQ6AEIJTAB#v=onepage&q=electrical%20resistivity%20ivory&f=false

[5] http://chemistry.about.com/od/moleculescompounds/a/Table-Of-Electrical-Resistivity-And-Conductivity.htm

[6] http://extension.colostate.edu/topic-areas/agriculture/subsurface-drip-irrigation-sdi-4-716/

[7] http://www.netafimusa.com/data/media/2016/08/CORN-Drip-General-Brochure.pdf