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Max Alvarez

Alex Wiseman

Alex Welsh

Rashmi Sharma

Adedayo Ogundimu

See next page for additional authors

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Authors
Max Alvarez, Alex Wiseman, Alex Welsh, Rashmi Sharma, Adedayo Ogundimu, and Brian Woods

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Students: Max Alvatrez, Alex Wiseman, Alex Welsh, Rashmi Sharma, Adedayo Ogundimu, Brian Woods

Advisors: Peter Garretson, Prof. Don Flournoy, John Bowditch

ABSTRACT

As the global population increases, it's becoming more important for nations to be able to feed themselves. Unfortunately, while some developing nations may be able to produce large amounts of fruits and vegetables, they may lack access to facilities for food preservation. This problem is at the heart of food security issues across Asia and Africa. Working in consultation with Peter Garretson, an International Affairs Fellow in India, our Ohio University student team has designed a space-based solar power solution that addresses this need, with the potential to provide many secondary benefits. While our project targets the Indian subcontinent and its government, the ideas are broadly applicable globally and can offer insights for other nations seeking to meet critical food needs.

Intro from Brian Woods on Vimeo.

TECHNICAL BRIEF

India has the second largest population of any country on Earth. "Though India is the second largest producer of fruits and vegetables (about 180 million MT), it has a very limited integrated cold-chain infrastructure, with only 5386 stand-alone cold storages, having a total capacity of 23.6 million MT., 80% of this is used only for potatoes. The chain is highly fragmented and hence, perishable horticultural commodities find it difficult to link to distant markets, including overseas markets, round the year" (DIPP, 2010, p. 5).

Agriculture in India: The Indian agricultural sector is large and robust, but features several weaknesses that prevent it from reaching maximum efficiency. Worst of all, because this limitation is well known, when crops are in season, prices are very low, while only weeks after the season ends, prices climb very quickly. Not only does this deprive farmers of potential earnings at peak harvest, it also prices the poor out of the produce market as the peak season ends.

"Storage infrastructure is necessary for carrying over the agricultural produce from production periods to the rest of the year and to prevent distress sales. Lack of adequate storage facilities cause heavy losses to farmers in terms of wastage in quality and quantity of produce in general, and of fruits and vegetables in particular" (DIPP, 2010, p. 6). Crop storage is a huge issue, with tons of quality produce lingering on the vine because there is no effective way to store and preserve them.

According to Goswami, "The persistence of the food waste argument (and its 40% cipher) and its proffered technological answer takes on a new importance when the central government's 'mega food parks' plan is brought into the scene. The government has approved 50 such mega food parks for assistance across the country" (2011, p. 6).

The need for Farm Power is also rapidly increasing in India. "To meet the demand of food grain production of about 293.5 million tones by 2020 as projected by Indian Council of Agricultural Research (ICAR), the over all productivity of food grain production at National level will have to be increased from the present level of 1723 kg/ha (in 2001) to about 2300 kg/ha by 2020 for which, besides other things, the average farm power availability will have to be increased from the present level of about 1.35 to 2.00 kW/ha by 2020" (Srivastava, nd, p. 67). The increased demand for power in agriculture sectors and need for investment in cold chains calls out for more viable energy solutions in India.

Energy for Agriculture: We propose a pilot space-based solar power program for rural areas that will bring a 12-month growing cycle for agriculture, provide water for irrigation and, most importantly, put in place a large refrigeration system for agricultural produce preservation. Energy from space will also provide such secondary benefits as community storage of medical supplies. Using solar power satellites, energy collecting platforms orbiting above the Indian subcontinent will absorb the sun's rays where they are most direct and transmit them as energy to locations where they are most needed. This solution allows Indian officials to install receiving antenna (rectenna) sites in places that currently have no electrical service or are underserved.

The Ohio University team envisions a pilot 4 km2 rectenna that will convert microwave energy from space into terrestrial power. Such a rectenna will generate about 250 megawatts of electrical production, enough power to meet the additional energy needs of surrounding communities. Rectennas can be constructed from local materials such as wire mesh. Surface temperatures can increase at rectenna sites but can be managed by widening or narrowing the energy beam as transmitted via satellite. By sustaining a constant temperature, year-round growing cycles can be implemented.

Once the local rectenna is operational a large one-ton cooler is to be installed. This cooler will keep farm produce refrigerated, allowing the farming community to better manage the flow of produce into regional markets. Storage can be reserved for other applications. Medical supplies, for instance, can be safely stored to meet vaccination needs.

Deep water wells could provide fresh water and be used in conjunction with new irrigation channels to distribute water to parched areas. Water towers could be erected and used in lieu of batteries for power storage; that is, water allowed to seep from tanks could generate power for the refrigeration unit while the satellite directs its transmission to alternate sites.

The ability of a single satellite to power multiple locations is a major benefit and cost-saving measure. As the Indian government has its own space program, launching of appropriately equipped satellites is within reason. A pilot program could be implemented quickly if the government perceived a need.
India is not the only country for which this space-based solution is applicable. Nigeria features a climate well suited to agriculture but is also badly in need of a storage solution for its agricultural produce. China’s farmers could be empowered to better feed themselves and their neighbors while reducing the country’s need for imports. The effects of Russia’s devastating wildfires in 2010 could have been mollified if their earlier harvests had a longer storage life.

Our team proposes that, as our global population continues to increase, now is the time to begin implementing such alternative energy solutions as space-based solar power.

SSP in Agriculture Team at the International Space Development Conference in Huntsville AL in May 2011

BUSINESS PLAN

Our Ohio University team tailored its energy-from-space proposal specifically for India. India's government is forward-thinking, it possesses a strong sense of social justice, and it has the technical knowledge and capability to make a food preservation project like this a reality. The country is well aware of its problem with food storage and, as a space faring nation, is positioned to become a global leader in innovative solutions for sustainable food production.

Illustrative Examples

In 2008, the Food Corporation of India reported that the country had spoilage of 1.3 million tons of food grain. Activist Dev Ashish Bhattacharya stated, "This amount of food grain could have fed over 10 million people in a year" (Bhattasali, 2008, para 6).

In 2011, the Department of Industrial Policy and Promotion (DIPP) stated that 57% of the Rs.1 trillion in food loss is directly attributable to food waste and problems with food storage. DIPP also reported that with a production of fruits and vegetables that reaches 180 million metric tons annually, there is storage for only 23.6 million metric tons, and of that, 80% of that storage is used for potatoes (DIPP, 2010 p. 6).

During the last 50 years the average farm power availability in India has increased from about 0.25 kW/ha in 1951 to about 1.35 kW/ha in 2001. Over the years the shift has been towards the use of mechanical and electrical sources of power. While in 1951 about 97.4% of its farm power was coming from animate sources, in 2001 the contribution of animate sources of power reduced to about 18% and that of mechanical and electrical sources of power increased from 2.6% in 1951 to about 82% in 2001. (Srivastava, p. 57)

During 2000-2001, the country produced about 45 millions tonnes of fruits and 80 millions tonnes of vegetables. It was next to China in production of vegetables and topped China in production of fruits. However, growth in post harvest sectors have not kept pace with the production. Even a decade ago, there were only 6,000 fruits and vegetable units in the country, growing from a figure of about 1,000 during 1950-1951. (Kachru, p. 57)

Installation of cold storage units cost about US $24,000. But without a means to power these units in rural locations, this isn't a realistic option. Space-based solar power provides a long-term solution that can help amortize the electrical costs of these facilities over the entire country instead of on a community-by-community basis.

View SSP for Agriculture's interactive website here.

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