

Technology Scan

Focus: Technologies for Rural Application

AFRICA KENYA

Software that assesses fruit quality and cuts fruit losses

A University of Nairobi (UON) post-graduate student has come up with a fruit-quality-assessing software that uses remote sensing to ascertain the extent of ripeness in tomatoes, oranges, mangoes, and other fruits. The software can be used to grade different fruits for their freshness and price them accordingly. "A blue light from a light emitting diode (LED) is shone through a fruit. In response, the fruit emits some light which is analyzed for fruit quality. This response comes from the skin of the fruit and has a direct relationship to the freshness of the fruit," stated David Muriuki Karibe, a master of science (MSc) physics student at the University of Nairobi. "For instance, some banana varieties will ripen but still retain the green color on their skins. Other varieties turn yellow on ripening. Rather than squeezing the fruit, which may itself lead to deterioration, the new technology will help measure the ripeness and freshness quickly and efficiently by randomly picking fruits." The research is a good news to fresh produce farmers, who lose over 45 percent of their produce to post-harvest losses that emanate from rotting, which is attributed to over-ripening, according to research conducted by the Kenya Agricultural Research Institute.

At the same time, the fruit market has increasingly become conscious to the freshness of fruit – demanding that they are harvested at the right time to improve their storage and quality. Accordingly, farmers would need to know the optimal time to harvest their mangoes, oranges, avocados, and tomatoes to stop losses that amount to millions of shillings. According to Mr. Karibe, a senior technologist in UON's physics department, the software is at prototype level awaiting mass roll out. So far however, the software development has cost Sh500,000 in purchasing the necessary hardware and intellectual input. Most of this funding has come from the university and personal savings. Mr. Karibe, however, laments that

local software developers lack the necessary backing from industry. "In developed nations, industry funds research projects at universities. Once a new product or software has been developed, industry takes up the product for the commercialization phase. In Kenya, the role of industry in research is missing leaving researchers and developers in the dark as they seek financiers for their ideas," he asserted during the recently concluded Nairobi International Trade Fair. In developed nations, industry spends a lot of money on research and development, which promotes innovation in local universities, according to Mr. Karibe. The software is suitable for all horticulture producers both large and small scale. Other users would be fruit vendors such as supermarkets and other outlets that deal with picky customers.

<http://www.standardmedia.co.ke>

ASIA-PACIFIC INDIA

Microbicidal technology for safe drinking water

Mumbai-based firm Livinguard Technologies Pvt. Ltd. has developed a filter designed to clean 100 L of water an hour. Not only does it remove the sand and odor from the water, but it also attacks the microbes in it. This microbicidal technology which uses treated textile was developed by Sanjeev Swamy between 2009 and 2011. He started Livinguard as a 100 percent subsidiary of Switzerland-based investment firm Green Impact Holdings in 2011 and a year later began manufacturing water filters. Since then, the company has teamed up with 16 non-governmental organizations (NGOs) and trust funds, including Swades Foundation in Maharashtra and the Jamnabai Trust for a project in Gujarat, to spread the use of these filters in rural India. Jayeshwar Gaikwad, a class II teacher, says the filter has made a big difference for the schoolchildren – for one, there is a steady supply of water. Then, there is also a marked improvement in attendance. "Food and water-borne illnesses, such as amoebiasis and diarrhea, were common among students and they would send mes-

sage through friends that they were taking the day off. That has stopped now," he says. Till a few months ago, Pagi and her schoolmates were among the 128 million Indians who do not have access to clean drinking water. According to a 2013 report by United Nations Children's Fund and Food and Agriculture Organization (FAO) of the United Nations, titled "Water In India: Situation And Prospects," around 37.7 million Indians are affected by water-borne diseases annually, and 1.5 million children die of diarrhea in a year. And, as per the Central Pollution Control Board's analysis of water quality monitoring results between 1995 and 2009, microbial contamination is the predominant form of pollution in surface water bodies such as the lotus-speckled pond where Pagi washes her plate. Livinguard does not have a distribution network and prefers to work through intermediaries such as NGOs and the corporate social responsibility arms of large corporations to reach schools, public health centers, even villagers' homes. In Jamsar, they teamed up with a local NGO Astiva, funded by Mumbai-based Ammada Trust, to provide two filtration systems – one to Pagi's school, another to the local primary health centre (PHC). "The results have been visible since Day 1," says Dr. Kiran Patel, one of the two medical officers posted at this PHC. "Every tap has potable water. Within the hospital too, we've cut our chances of suffering from salmonella or other bacterial infections that are prevalent in the village." Livinguard offers a discount of up to 35 percent to NGOs. For instance, the filter at the PHC cost Rs. 2 lakh, but the hospital got it for Rs. 1.3 lakh. Swamy adds that they regularly send samples of their filtered water to a government-approved water-testing laboratory to ensure all is well. "We've got no negative results so far," he says. Each filter has multiple cartridges to clean three impurities: turbidity (presence of sand, which says Swamy is the "biggest challenge"); chemicals such as arsenic, fluoride, heavy metals, and microbes. While activated carbon is used to attack chemical impurities and a special sand filter helps clean turbidity, their patent-pending textile technology is used to kill microbes. "When the bacteria touches the layers of fabric wrapped around a candle inside the Livinguard cartridge, a short circuit is created due to which a charge

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is released that destroys the bacteria,"Swamy explains.

<http://www.livemint.com>

Solar energy powers village economy

Thanks to National Institute of Rural Development (NIRD), several inaccessible villages are enjoying solar home lighting system and even the rural economy is looking up with transfer of technology. From a stone cutter to a solar light maker, the transition is swift and fast. Chenamma no longer works in the hot sun to eke out a living. She now sits under a fan and deftly fixes wires, batteries, and screws for the mini solar LED light. She makes 50 solar lights a day, earning Rs. 280.

Chenamma is among the several villagers making a fast buck in spite of their illiteracy. Thanks to the technology revolution unleashed by the NIRD, several inaccessible villages in the state are enjoying solar home lighting system. Even the rural economy is looking up with transfer of technology.

The solar light manufacturing unit at the NIRD's Rural Technology Park (RTP) here is abuzz with activity as a variety of solar lights are being made in partnership with the Thrive Solar Energy Pvt. Ltd. Some of the villagers who have been trained at the Solar Training Institute, Tiloni, Rajasthan are now gainfully employed. They now assemble solar-powered lights and also maintain the solar streetlights installed in their villages. "We will be manufacturing LED lights also in the coming days," said Mohammed Khan, consultant, RTP.

The solar mini light and study light, which are 30 times brighter than kerosene lamps, are being offered at just Rs. 150 by NIRD. In the 10 Telangana villages adopted by it, solar streetlights are being installed for Rs. 3,500 – exploding the myth that solar energy is expensive. By investing Rs. 27,000, one can have two lights, a fan, and TV running with solar power. Under the Jawaharlal Nehru Solar Mission, Government of India provides 40 percent subsidy, banks offer 50 percent loan while the rest is borne by the beneficiaries. "The only problem is that banks are not readily coming forward to offer loans," admits Dr. P. Shivaram, project director, RTP.

Solar energy is one of the 20 cost-effective technologies being promoted by the RTP for



Chenamma, a stone cutter, making a solar light at the NIRD's RTP in Rajdendernagar. Photo: J.S. Iftekhar

improvement of the rural economy. Recently, it has also developed solar lights and freezers for fishermen who go for fishing during nights. Nearly, 100 solar lights were supplied to 50 fishermen of Gopalpur on Sea, Odhisa. Other innovative devices manufactured are solar dehydration unit, solar pest manager, and thermoelectric cooking appliance.

<http://www.thehindu.com>

Innovative potable water treatment system

Regions of India will soon receive cost- and energy-efficient drinking water with an innovative European water treatment technology stemmed from a €2.2 million (\$3.0 million) Europe/India collaborative research project.



Cutting-edge integrated European systems for water disinfection (Trustwater ECO-Trio) and filtration (Dryden Aqua AFM, background) for installation at a rural community pilot site in West Bengal, India (Credit: Hume Brophy)

Called ECO-India, the 3-year project is co-funded by the European Commission's Seventh Framework Programme (FP7) and the Indian Department of Science and Technology (DST). It will run until August 2015 and is focused on developing innovative and sustainable approaches for producing potable water at a community level. The first rural community deployment is set for West Bengal, India.

Coordinated by the Tyndall National Institute in Cork, Ireland, the €1.7 million (\$2.3 million) FP7 consortium represents a world-class interdisciplinary research team from three research institutes – Tyndall-UCC, Danmarks Tekniske Universitet (DTU), Helmholtz-Zentrum für Umweltforschung GmbH (UFZ) – and four small and medium enterprises (SMEs) (Trustwater, Adelphi, Dryden Aqua, and AGM).

The FP7 consortium will develop energy-efficient systems for advanced filtration and disinfection of drinking water supplies from surface-water ponds and groundwater tube wells, which suffer from arsenic contamination using Dryden Aqua and Trustwater technology. In addition, UFZ will lead the development of field-deployable arsenic sensors for screening tube-wells, while an online system developed by AGM will enable remote monitoring of water quality. Tyndall-UCC will focus on the development of novel capacitive modules for the remov-

al of ions from brackish surface water and heavy-metal ions (especially arsenic) from groundwater as well as development of novel sensors for monitoring dissolved oxygen. The overall system will be solar-powered with mains/battery backup. DTU will also lead a feasibility study for assessing energy harvesting via biogas from wastewater.

The European Union team partners with the €500,000 (\$685,300) DST-funded ECO-India consortium, coordinated by Professor Asis Mazumdar from Jadavpur University. The consortium also includes the Indian Institute of Technology Kharagpur as well as an SME Super Technicians. Collaborating with Jadavpur University and Adelphi GmbH (the collaboration managers for the project), the European systems will be installed alongside conventional water filtration systems in order to demonstrate their performance in a harsh rural environment and to assess their potential for sustainable, cost- and energy-efficient treatment of potable water.

<http://www.waterworld.com>

MALAYSIA

New agricultural technology

The Malaysian Agricultural Research and Development Institute (MARDI) has introduced a new agricultural technology called the Vertical Farming Technology to prevent soil erosion and chemical leaching. Its director Datuk Dr. Sharif Haron said the technology

was practical, cost-effective, and suitable for use in the agricultural sector in valleys and hilly areas such as in Cameron Highlands.

“This technology can reduce water pollution and damage to the environment and the public. The advantage of this technology is that the crops can be planted in high density and it is most suitable for entrepreneurs owning small plots of land. The greenhouse structure is suitable for hill slopes without having to cut the land surface. The construction method and design can reduce damage to the soil as well as erosion,” he said.

Dr. Sharif also said the technology used cheap composite materials and the cost of making one set was only RM27. “The structure can take in 20 salad plants in one square metre of land with the selling price at RM80,” he said. The product will be sold on a large-scale commercial basis shortly. Dr. Sharif said the idea for the technology came about in view of the soil erosion occurring in Cameron Highlands following the cutting of hills to turn the area into agricultural land and for development.

<http://www.waterworld.com>

NEPAL

Improved water mill electrification

An improved water mill (IWM) is an intermediate technology based on the principle of existing mills that improves performance generating up to 3 kW. The improvement of traditional water mill is done by improving various components of the traditional mill but the most significant is replacement of traditional wooden runner with hydraulically better-shaped metallic runner having cup-shaped blades.

Besides agro-processing, IWM electrification is a very important end-use that can be coupled with Long Shaft Improved Water Mill (LS IWM) system. Depending upon the water resources available, the electricity up to 5 kW can be generated from the IWM electrification system. For this purpose, an induction generator with controller device can be added to the LS IWM by means of pulley and belt transmission system. The electricity generated from IWM electrification system can



Helpful endeavor: Assistant research officer Muhammad Shukri Hassan demonstrating the use of the new technology in Cameron Highlands. (Credit: Bernama)

be used for basic lighting purpose, mobile charging operation of TV and radio, small cottage enterprises, etc. To promote IWM electrification system, government provides subsidy up to 5 kW system only.

The short shaft IWM is limited for grain grinding only. To optimize the capacity of Short Shaft Improved Water Mill (SS IWM), a new technology Axial Flux Permanent Magnet Alternator (AFPMA) has been developed from joint research of CRT/N, Gramin Urja Tatha Prabidhi Sewa Kendra, and Kathmandu University. AFPMA can be easily coupled with SS IWM and electricity can be produced. The technology has been able to produce power up to 1 kW and it is under research for the system to generate power up to 3 kW.

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PHILIPPINES

Post-harvest technology package

The Philippine Center for Postharvest Development and Mechanization (PhilMech) is preparing a package of technologies for adlai, an alternative to rice which government wants to propagate. Adlai is grown in large quantities in Mindanao as a staple. Scientifically known as *Coix lacryma-jobi L.*, adlai belongs to the *Poaceae* grass family to which crops such as rice, corn, and wheat also belong. It is cultivated as a cereal crop in tropics and subtropics, like in India, China, Republic of Korea, the Philippines, Thailand, and Malaysia.

The department of agriculture recently included adlai in its mainstream research and development program, as one of the country's best-kept secrets and a potent weapon against hunger in a "climate-changed world." PhilMech is currently

evaluating two milling systems for adlai. Existing rubber-roller type mills can process 12 cavans of unmilled adlai per hour with a 60 percent milling recovery. Research showed that threshing harvested adlai should be in the early hours of the day, and the optimum moisture content should be between 15 percent and 17 percent during the process. Milled adlai grains are found to be susceptible to insect infestation and fungal contamination.

PhilMech tests showed that a moisture content of around 10 percent for milled adlai grains that are stored in hermetic containers can protect the grains from insect infestation for up to 1.5 months. The hermetic bag also minimized the proliferation of fungal infection. PhilMech also conducted cooking tests for adlai, which showed that water requirement for cooking is not different from that of milled white rice.

When it came to eating the cooked adlai grains, however, blind tests conducted by PhilMech in Nueva Ecija showed consumers still preferred rice to adlai because of the unfamiliarity to the latter. However, adlai and rice mixed at a ratio of 25:75 was also favored by consumers who took part in the blind.

The Bureau of Agricultural Research is currently coordinating 32 adlai-related projects involving state colleges and universities, and other research and development institutions across the country. Location-specific technology development of the crop is being implemented in areas identified with potential for commercial production like in Midsalip, Zamboanga del Sur, where vast areas are planted with adlai to produce seeds for distribution throughout the country.

During planting trials, 11 adlai varieties were identified: gulian, kinampay (ginampay), pulot (or tapol), linay, mataslai, agle gestakyan, Nomiarc dwarf, jalayhay, and ag-gey. Three of these varieties – gulian, kinampay, and pulot – are endemic found to be endemic to the Philippines.

http://www.businessmirror.com.ph

Coco water technology

The agriculture department recently teamed up with the provincial government

of Camarines Sur and Central Bicol State University of Agriculture to test the commercial viability of community-level coco water production using the technology developed by the Philippine Center for Post-harvest Development and Mechanization.

Agriculture Secretary Proceso Alcala signed last week a memorandum of agreement with Camarines Sur Gov. Miguel Luis Villafuerte and CBSUA president Georgina Bordado to carry out the coco water processing technology pilot testing and business incubation project. Under the agreement, an extensive study which will be carried out for a period of 1 year under the soon-to-commence Philippine Rural Development Project will come up with product and machine protocols that will serve as basis for the technology's commercialization nationwide.

It hopes to initiate supply chain linkages between coco water consolidators and possible small-scale processors. The newly-designed equipment allows hygienic extraction, storage, and chilling of coco water. With a capacity of around 2,000 mature coconuts per day, equivalent to more or less 600 L of coco water daily, the set-up is compact and portable enough to be transported and installed anywhere in the country.

http://manilastandardtoday.com

EUROPE

GERMANY

Innovative decentralized drinking water purification

A German start-up enterprise – AUTARCON GmbH – has developed a solar-powered decentralized water treatment plant. It is especially suitable for remote areas in developing countries. The young start-up enterprise AUTARCON, Kassel, Germany, has invented a sturdily built water treatment plant that can provide clean drinking water without a major effort, at a low cost and powered by solar electricity. The SuMeWa unit was developed by two young scientists at the University of Kassel, Florian Benz and Alexander Goldmaier, who are now the managing directors of AUTARCON. The first plants have already been installed in Brazil, Gambia, Ghana,

India, Laos, Pakistan, Tanzania, and Thailand in the context of German Development Cooperation (GIZ).

AUTARCON has already received two awards for SuMeWa. It won the Solar Award at Intersolar Europe 2011, the world's largest solar industry trade fair. Jurors said the award had been given to AUTARCON because the system impressed them with its "simple mechanics, which for the most part can be maintained using a toothbrush and citric acid." They stressed that the system could be produced on a large scale and used in developing countries. Now it is on the shortlist of the Deutscher Innovationspreis.

Two photovoltaic modules with an output of 120 W convert sunlight into direct current that powers a water pump. The freshwater is pumped out of a well, river, or pond and filtered, and turbidities are removed. Then the natural chloride in the water is turned into chlorine gas in an electrolytic process also powered by solar electricity. The chlorine remains in the drinking water, keeping it free of bacteria. This is why the water that has been treated can also be stored in a tank for a longer period or fed into water mains. When the sun is shining, the Die SuMeWa water treatment plant can provide 400 L of drinking water an hour. If a battery is used additionally, solar power can also be stored, enabling the plant to supply drinking water round the clock.

<http://www.rural21.com>



Microbes in a bucket

NORTH AMERICA USA

Waste cleanup for rural areas

Washington State University (WSU) researchers have developed a unique method to use microbes buried in pond sediment to power waste cleanup in rural areas.

The first microbe-powered, self-sustaining wastewater treatment system could lead to an inexpensive and quick way to clean up waste from large farming operations and rural sewage treatment plants while reducing pollution. Professor Haluk Beyenal and graduate student Timothy Ewing in the Voiland College of Engineering and Architecture discuss the system in the online edition of *Journal of Power Sources* and have filed for a patent.

Traditionally, waste from dairy farms in rural areas is placed in a series of ponds to be eaten by bacteria, generating carbon dioxide and methane pollution, until the waste is safely treated. In urban areas with larger infrastructure, electrically powered aerators mix water in the ponds, allowing for the waste to be cleaned faster and with fewer harmful emissions.

The WSU researchers developed a microbial fuel cell that does the work of the aerator, using only the power of microbes in the sewage lagoons to generate electricity. The researchers created favorable conditions for growth of microbes that are able to naturally generate electrons as part of their metabolic processes. The microbes were able to successfully power aerators

in the lab for more than a year, and the researchers are hoping to test a full-scale pilot for eventual commercialization.

The researchers believe that the microbial fuel cell technology is on the cusp of providing useful power solutions for communities. The work was funded by two National Science Foundation CAREER awards, the U.S. Office of Naval Research and Washington State University's Agricultural Research Center.

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Sanitation with food-grade materials

Fresh produce has been associated with microbial outbreaks around the world, thought to be caused in part by improper sanitation of fresh produce. Current disinfection methods rely on harsh chemicals which may alter the flavor of the fresh food or potentially cause an allergic reaction for some consumers. Furthermore, the chemicals employed in sanitation may have a significant environmental impact. Researchers at the University of California, Davis and Drexel University have developed a unique method for disinfecting produce. Unlike other methods of produce sanitation, this method combines treatment with ultraviolet (UV) light and a specialized wash solution to remove microbes from the entire surface of any fresh produce without leaving a toxic residue or impacting food quality and taste. Drexel is currently looking for partners for the further development of this technology.

Drexel University food scientist Dr. Rohan Tikekar, in collaboration with Dr. Nitin, of the University of California-Davis Department of Food Science and Technology, have recently proposed a novel solution to these critical limitations of UV processing: enhancement of UV-induced microbial inactivation rate within a solid food matrix via synergistic effects of a novel, food-grade photosensitizer, fructose, and UV light to improve the microbial inactivation rate.

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The benefits of these methods are not only the enhancement of the uniformity of microbial lethality, since fructose solution is in contact with the entire surface of produce but also the inactivation of internalized microorganisms since free radicals can penetrate through the intercellular spaces of fresh produce. However, further benefits over current methods include that oxidative stress from fructose is induced only upon UV exposure, in contrast to conventional oxidants such as hydrogen peroxide and hypochlorite salts, the residual fructose will not cause oxidative reactions in produce enhancing the product quality. Moreover, since these methods require only up to 2 percent fructose (w/v), which is only slightly higher than recognition threshold of 1 percent produce sanitized via these methods will also have a less offensive flavor and taste profile than current sanitation methods can result in. These methods showed a penetration depth of the antimicrobial effects of the activated photosensitizers up to 500 microns (0.05 cm) in agarose gel model system. As a further benefit, the free radicals generated by the photosensitizers of the present invention can also be destroying pesticides making them no longer harmful to humans by oxidizing them.

Drexel is currently seeking partners for the further development and commercialization of this technology.

<http://www.ibridgenetwork.org>

Solar-powered toilet

A revolutionary University of Colorado (CU) Boulder toilet fueled by the sun that is being developed to help some of the 2.5 billion people around the world lacking safe and sustainable sanitation will be unveiled in India this month. The self-contained, waterless toilet, designed and built using a \$777,000 grant from the Bill & Melinda Gates Foundation, has the capability of heating human waste to a high enough temperature to sterilize human waste and create biochar, a highly porous charcoal, said project principal investigator Karl Linden, professor of environmental engineering. The biochar has a one-two punch in that it can be used to both increase crop yields and sequester carbon dioxide, a greenhouse gas.

The project is part of the Gates Foundation's "Reinvent the Toilet Challenge," an effort to develop a next-generation toilet that can be used to disinfect liquid and solid waste while generating useful end products, both in developing and developed nations, said Linden. Since the 2012 grant, Linden and his CU-Boulder team have received an additional \$1 million from the Gates Foundation for the project, which includes a team of more than a dozen faculty, research professionals, and students, many working full time on the effort.

Linden's team is one of 16 around the world funded by the Gates "Reinvent the Toilet Challenge" since 2011. All have shipped their inventions to Delhi, where they will be on display March 22 for scientists, engineers, and dignitaries. Other institutional winners of the grants range from Caltech to Delft University of Technology in the Netherlands and the National University of Singapore.

The CU-Boulder invention consists of eight parabolic mirrors that focus concentrated sunlight to a spot no larger than a postage stamp on a quartz-glass rod connected to eight bundles of fiber-optic cables, each consisting of thousands of intertwined, fused fibers, said Linden. The energy generated by the sun and transferred to the fiber-optic cable system – similar in some ways to a data transmission line – can heat up the reaction chamber to over 600°F to treat the

waste material, disinfect pathogens in both feces and urine, and produce char.

Tests have shown that each of the eight fiber-optic cables can produce between 80 and 90 W of energy, meaning the whole system can deliver up to 700 W of energy into the reaction chamber, said Linden. In late December, tests at CU-Boulder showed the solar energy directed into the reaction chamber could easily boil water and effectively carbonize solid waste.

The CU-Boulder team is now applying for phase two of the Gates Foundation Reinvent the Toilet grant to develop a field-worthy system to deploy in a developing country based on their current design and assess other technologies that may enhance the toilet system, including the use of high-temperature fluids that can collect, retain, and deliver heat.

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Novel solar-thermal toilet developed by a team led by CU-Boulder Professor Karl Linden as part of the Bill & Melinda Gates Foundation. (Credit: University of Colorado)