Erin Thomas
The Culver Academies
Culver, IN
Burma (Myanmar), 1

Burma: Marker-assisted Selection for Rice Improvement

Located in the heart of south-east Asia, Burma, also known as Myanmar, has a rich biodiversity with a tropical climate based on the monsoons. Dominated by over 135 different ethnic groups, the culture is deeply rooted in Theravada Buddhism practiced by 89% of the population. Burma is still suffering from the legacy of British imperial control and the rule of a harsh military regime from 1962 to 2011. The agriculture-based economy is still hurting from the decentralization of economic control by this regime during their power. The United Nations still claims Burma to be one of the least developed economies in the world today based on GDP, quality of life, and economic vulnerability. Despite this, Burma is rich in natural resources like oil and natural gas in addition to being one of the largest producers of illicit narcotics, exporting opium, heroin, and amphetamines. Although the population suffered from the oppression of human rights by the military regime, the revolution led by Aung San Sui Kyi is slowly working to rebuild Burma through reforms in the new government ("Burmese"). Since the creation of the country, the farm family has been at the center of economic development.

The typical Burmese family tends to live with other relatives outside of the nuclear unit with the husband as the head-of-household. The average family size in Burma is 5.2 people ("Integrated" 48). The wife wields considerable authority in this culture and is in charge of all domestic responsibilities. Rice is a staple of the Burmese diet. Other crops like millet, sorghum, and corn are grown in regions where rice does not grow. Rice is often accompanied by an array of salad leaves, fruits, and vegetables. Main dishes are seasoned with turmeric or chili, and supplemented with fresh tropical fruits like mango, lychee, and pomelo. In Burma, there still remains some dependence on traditional healing methods for healthcare, but the spread of Malaria and AIDS has caused many NGOs to intervene ("Countries"). Modern medical treatment is still in its rudimentary stages as there are only 703 hospitals in the entire country ("World Factbook"). Education levels are higher than many other developing countries because of Buddhist monastery schools. Still only 10% of household heads have received secondary education, and only 4% have reached the post-secondary level ("Integrated" 52). The agricultural industry employs 50.2% of the country, and 70% of the population lives in rural areas living off farmlands. The average family farm is 6.1 acres (48-52). A typical farm is constructed into a series of rice paddies. Water is collected upon a layer of impermeable soil through diverting river waters or collecting the monsoon rains. Livestock like oxen are raised to help plow fields while infrastructure remains mostly undeveloped. Fishing is also popular in the coastal regions ("Countries"). Looking to Burma's past, we see a nation left behind in a world of technological and industrial advancement.

During the power of the previous military regime in Burma, many economic barriers were constructed keeping Burma from being agriculturally productive and keeping Burmese peoples from having access to markets, sustainable income, food supply, and adequate nutrition. Prior to World War II and before the regime of the military junta, Burma was the world's "rice bowl". The military regime severely restricted trade and agricultural production in the country. *The Irrawaddy Magazine* blames the poor infrastructure, seed quality, and lack of technological innovation in the rice industry on the slow recovery from the half-century ruling military regime (Boot). There is also a major social barrier between the impoverished and the Burmese middle class. Rice is consumed mainly by the very poor because of its low nutritional content and respective price, while some high quality, imported varieties are becoming increasingly popular among the middle class. Since the country is mostly based off the agricultural industry, this is forming an impediment for ameliorating poverty. Regarding the entire issue of food insecurity, access and nutrition are major issues. Rural families survive off of their own land and neighboring farms, and when

dry regions are struck by drought, many of the traditional farming methods and seed strains fail to produce a harvest causing the family and neighboring regions to go hungry. Even when there is a steady food supply, the nutritional quality of the traditional Burmese diet is slowly deteriorating due to the lack of diversity. Rice is heavily relied on as a center-piece of Burmese cuisine. Problems associated with rice and food insecurity in Burma can be mitigated by the development of new rice strains that have higher nutritional and environmental-resistant qualities. Politically, the new government is slowly and steadily reforming old systems of control to be more beneficial for the people and the economy while taking advantage of the fertile lands of rural Burma. However, lasting issues regarding land rights from the transition of power and transparency between farmers and the government will continue to play a role in impeding the process of economic and agricultural improvement in Burma (Boot). New plant science holds some promise for addressing the problems of food production and nutrition that Burma face now and will likely face even more in the future. Lessons learned in Burma may also be applied to similar regions in the world.

Plant science in the world today has the potential to end world hunger. Currently, Burma has the potential to implement some of the new research regarding rice cultivation to improve crop yields, nutritional content of the rice, and drought resistance qualities of new rice strains. Agriculture research and development is already present in Burma, but the implementation of new processes in rural areas has yet to be fully explored and requires more experimentation. The factor of new plant science has had little consequential effect on most farms. Without this improvement, however, families will continue to suffer ("Rice Research"). Over 57% of the population in south-east Asia suffers from iron-deficiency anemia ("High-nutrient Rice"). Much of the iron in the Burmese diet derives from rice and meats, but on a large scale, the population is lacking this vital nutrient. This problem is being addressed by the International Rice Research Institute through the genetic development of rice strains. Internationally, research on the "Golden Rice", a strain with more vitamin A and other nutrients, is becoming more popular. However, inadequate nutrition caused by the lack of innovation in the agricultural industry of Burma is putting the country and its people at a disadvantage. Other factors like climate change, pollution, water scarcity, and population growth are also adding pressure to the need for new developments in the rice cultivation process. Climate change and pollution are narrowing the amount of space for rice cultivation. Coastal flooding can bring salinization to lands that are currently arable. Irregular rainfall could exacerbate the problem even more by causing destructive flooding that can also ruin water quality through pollution or by causing drought that could have the opposite effect and provide an opening for destructive insects or disease. Although these problems may seem distant for many Burmese families and farms, droughts and cyclones caused by abnormally changing weather patterns are having harsh effects. With population growth making more demands on agricultural production and water scarcity applying pressure to rural Burma's fertile lands, the need for change is evident. Burma has already opened up to using genetically modified, insect-resistant strain of cotton, and it has proved to be successful thus far (Choudhary). Plant science needs to continue improving on a larger scale in Burma in order to meet the needs of the population and adapt to climate changes.

To improve conditions of poverty, hunger, and malnutrition in Burma in accordance with Millennium Development Goal 1 with the target date of 2015, the system of marker-assisted breeding can be particularly effective. The process consists of selective breeding with the assistance of DNA fingerprinting for the desired allele that is traceable with a fully-mapped genome and the use of DNA microarray and electrophoresis (Gillis). Many biotechnological processes today involve the insertion of a gene into a recipient organism through the process of transformation, which would seem to be a simpler solution. However, this process does not allow scientists to specify to location in the genome that the gene will be inserted and therefore does not always ensure accurate or applicable results. The system of marker-assisted breeding is a more natural way of selective breeding, something that humans have done since the agricultural revolution 10,000 years ago. By streamlining the process with DNA fingerprinting, researchers are able to pinpoint the specific desirable traits in one plant to breed with another desirable

trait in another. Traditionally, the process was hit-or-miss because many of the desirable qualities did not produce visible phenotypes (Goff). In 2007 in Australia, the process was successful in producing a wheat strain with a higher yield and better taste qualities when baked into bread (Kuchel). Marker-assisted selection is a prime choice for Burma because of the close connection between traditional selection and the new biotechnical options. The process would be similar to that which farmers are already using to cultivate the best, most productive crops. The benefits certainly outweigh the cost considering the effects of improved technology in the developing economy. Although there are some short-comings, this system is applicable for Burma in particular because of their pre-existing infrastructure and the potential for innovation through agricultural research.

As a branch of the International Rice Research Institute, the International Network for Genetic Evaluation of Rice is present in Burma out of Yangon. The goal of this organization is to study the genotype of genetically modified or artificially selected rice plants and catalogs it in a research database for all scientists to access ("INGER"). Considering that one of the main concerns involving this type of agriculture is related to cost, the fact that this database exists in Burma provides a great starting point for new initiatives. Another concern involving this system of selection is the availability of researchers and scientists in the field. Burma has a relatively high literacy rate among developing countries, but the science and education systems have been seriously hindered by the previously ruling military junta. Plans for improvement are on the table, but the new government, voted into office in only March 2011, has a wide array of reforms to handle as well that may distract it from pursuing this important research and work. Opposition leader in Parliament, Aung San Sui Kyi, stated that "education reform will happen; [but] there's just too much for the government to do at the moment" (Ives). The country is looking at investments with large multinational companies, like Monsanto, for high-quality seeds, but the risks are high ("Myanmar"). Many worry about the implications of having such a heavy dependence on a large corporation that has motives beyond feeding a developing nation. There are also concerns with the genetically modified crops affecting international trade by turning away strict anti-GM countries, which could hinder the recovery of Burma. As the country is currently weaning away from the legacy of a totalitarian government, self-sustainability is the best option.

In order to improve food security in Burma, agricultural reformation is necessary. Marker-assisted selection can begin to be utilized at a national level through the Country Sector of the International Network for Genetic Evaluation of Rice ("INGER"). Working in collaboration with the International Rice Research Institute, new strains of rice can be developed with improved nutritional value like increased iron, high yielding varieties for productivity, and drought-resistant qualities. The process involves the backcrossing of wild-type specimens with an elite cultivar that has the desirable trait. Much of this science is already being worked on through the International Rice Research Institute, and Burma can become one of the central research locations because of the fertile land and existing infrastructure. This research and seed-production using the marker-assisted breeding system will also provide more job opportunities stimulating the economy further. However, the current education system is not ready to train a mass of biotechnological scientists. This will require support from the United Nations Educational, Social, and Cultural Organization in addition to investment by the national government and possibly by the World Bank's Innovation Funds for Higher Education (Saint). This World Bank Fund has had success in six countries including Ghana which received a $33 million grant to support their major polytechnic institutions. The effects have shown to improve the number of specialists in the country increasing the rate of technological innovation country-wide. With sustainable seed production through the marker-assisted selection process, patented seeds can be purchased from the research institution and cultivated in local communities. The country-based system is important to prevent cross-contamination and possible negative harmful effects for the environment. With regulation, the system is safe and can provide new avenues for productivity, health, and economic growth in Burma. Farm families would be involved in growing the newly developed seeds and distributing the new rice product in their communities through a

regular market process. Continual evaluation by the International Rice Research Institute and the Myanmar Rice Industry Association would be necessary.

In addition, non-governmental organizations are currently involved in mitigating food insecurity in coordination with the Human Development Initiative led by the UN Development Program which has been successful in its efforts to increase the Human Development Index. Their work at the grassroots level has been effective not only in improving livelihoods but also gender and human rights issues with the formation of Self Reliance and Microfinance groups led my mostly women ("UNDP"). This project, as well as others led by NGOs, is setting the groundwork in order for improved seed qualities to be distributed efficiently. They are also addressing problems in troubled regions where the new seed strains would be particularly beneficial. One troubled region is the Irrawaddy Delta which has also suffered from tropical cyclones which destroy the agricultural land for the year (Homer). With increasing natural disaster frequency with climate change, improved technology and education systems can also improve disaster preparedness and help to avoid the catastrophic effects on agriculture and the population.

Ultimately, Burma needs innovation. Most farms lack the technology to move past the use of oxen to plow fields. With innovation and a government dedicated to the reform of this once-broken nation, Burma can overcome the adversity of food insecurity. The typical family will be able to eat higher quality, nutritious rice that will sustain their lives and well-being. As the Burmese middle class continues to develop an interest in more high quality rice-based foods, social barriers will be broken as the lower class supplies for a growing demand. Iron-deficiency anemia will no longer cause problems across 57% of the Southeast Asian population because the staple crop will contain enough iron. Job opportunities will present themselves, and people will go to work. The research on marker-assisted selection has been available for years. Now with appropriate policy and government initiative, the next step will be to put it into action.

Works Cited

Boot, William. "Can Burma Become World Rice Bowl Again?" *The Irrawaddy Magazine*. Irrawaddy Publishing Group, 14 Aug. 2012. Web. 09 Mar. 2013.

"Burmese Community Profile." Commonwealth of Australia, 2006. Web. 11 Mar. 2013. <http://www.immi.gov.au/living-in-australia/delivering-assistance/government-programs/settlement-planning/_pdf/community-profile-burma.pdf>.

Choudhary, Bhagirath, and Kadambini Gaur. "The Status of Bt Cotton - the Silver Sixth in Myanmar." Diss. 2010. Abstract. *The Status of Bt Cotton*. India Environment Portal, 5 Jan. 2011. Web. 09 Mar. 2013.

Collard, Bertrand, and David Mackill. "Marker-assisted Selection: An Approach for Precision Plant Breeding in the Twenty-first Century." *Philosophical Transaction of the Royal Society*. The Royal Society, 12 Feb. 2008. Web. 09 Mar. 2013. <http://rstb.royalsocietypublishing.org/content/363/1491/557.full>.

"Countries and Their Cultures." *Culture of Burma*. Advameg, Inc., 2009. Web. 09 Mar. 2013. <http://www.everyculture.com/Bo-Co/Burma.html>.

Dapice, David. "Revitalizing Agriculture in Myanmar: Breaking Down Barriers, Building a Framework for Growth." Harvard Kennedy School Ash Center, 21 July 2010. Web. 9 Mar. 2013. <http://www.ash.harvard.edu/extension/ash/docs/burma.pdf>.

Gillis, Justin. "Rice Genome Fully Mapped." *Washington Post*. The Washington Post, 11 Aug. 2005. Web. 09 Mar. 2013.

Goff, Stephen, and John Salmeron. "Back to the Future of Cereals." *Scientific American* (2004): 65-73. Print.

"High-nutrient Rice." *International Rice Research Institute*. International Rice Research Institute, n.d. Web. 9 Mar. 2013.

Homer, Annabelle. "ABC Rural." *International Rice Research Institute Lends a Helping Hand to Burma*. N.p., 23 May 2008. Web. 24 May 2013.

Integrated Household Living Conditions Survey in Myanmar: A Poverty Profile. Tech. IDEA International Insitute; IHLCA Project Technical Unit, June 2007. Web. 9 Mar. 2013.

Ives, Mike. "Science Competes for Attention in Myanmar's Reforms." *SciDevNet Global*. SciDev.Net, 04 Oct. 2012. Web. 09 Mar. 2013.

Kuchel, Haydn. *The Successful Application of Marker-assisted Wheat Breeding Strategy*. Rep. Springer Science and Business Media, 19 Feb. 2007. Web. 9 Mar. 2013.

"Molecular Breeding." *Knowledge Bank: IRRI*. International Rice Research Institute, n.d. Web. 09 Mar. 2013. <http://www.knowledgebank.irri.org/ricebreedingcourse/Marker_assisted_breeding.htm>.

"Myanmar Seeks to Rejoin Top Rice Exporters." *Reuters*. Reuters, 08 Aug. 2012. Web. 09 Mar. 2013.

"Rice Research and Capacity Building in Myanmar." *International Rice Research Institute*. International Rice Research Institute, n.d. Web. 9 Mar. 2013.

Saint, William. "Innovation Funds for Higher Education." World Bank, May 2006. Web. 9 Mar. 2013.

"UNDP Myanmar." *UNDP Myanmar*. UNDP, 2011. Web. 24 May 2013.

United States. Central Intelligence Agency. *The World Factbook: Burma*. CIA, n.d. Web. 09 Mar. 2013. <https://www.cia.gov/library/publications/the-world-factbook/geos/bm.html>.

"Welcome to INGER." *Welcome to INGER - Home*. International Rice Research Institute, n.d. Web. 09 Mar. 2013.