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Resource Efficient Agricultural Production

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Farming for the future in the Gambia

By C. Carpio, L. El-Ali and C. Ho Lem

The Gambia is located in West Africa, and is one of the most impoverished countries in the world ranking 151 out of 186 in the UNDP Human Development Index. It is challenged by food insecurity, poverty, an alarming rate of environmental degradation and the largest population growth rate in the world (4.2% per annum). Rainfall averages approximately 1020 mm annually with a long dry season from October to June. Gambia's economy remains underdeveloped because of its limited natural resources, a narrow economic base, and unutilized human capital. Nearly 75% of the rural population are subsistence farmers growing mostly groundnut, millet, corn, beans, rice, and sesame. Since the 1970's, world market prices for groundnut have rapidly declined leaving the Gambia's export industry in financial ruins. Because of this economic crisis, the Gambia has maintained a negative trade balance and continues to rely heavily on international aid organizations for its social and economic development.

Crop production is the predominant agricultural activity in the Gambia, followed by animal husbandry, rice farming, and small-scale vegetable gardening. Free range cattle rearing makes up the larger portion of animal husbandry. However, free range sheep/goat rearing is also found throughout the Gambia and is devastating to the integrity of the rural areas through the destruction of crops and permanent vegetation. On a national scale, approximately 91% of the houses reported as extremely poor were dependent on agriculture. The majority of women in the rural areas were also found in a constant energy deficient state, caused by poor dietary intake, heavy workload and a high disease infection rate. It is evident that women in particular have very difficult lives and the advancement of ecological agriculture is of paramount importance to improving their quality of life and restoring the natural resource base of their environment.

Local community members preparing a breakfast of ground millet. A diet lacking in diversity is a major problem in the Gambia.

The Gambia is in a major state of ecological decline. Farm practices contributing to declining soil fertility include peanut monocropping, planting down the slope, crop residue burning and fallowing fields after harvest. Lack of soil cover and erosion control is causing topsoil to be lost into watercourses during heavy rainfall events or by intense winds. The salinization of land within proximity of the river is rendering more and more lands unsuitable for cultivation. Forests are being heavily denuded by the growing need for fuel, livestock forage, farmland development and the burning of agricultural fields. Some women are forced to rely heavily on cow dung for cooking because of the scarcity of fuelwood. The reduced forest cover has resulted in a longer dry season and a 20% reduction in annual precipitation, resulting in significant decreases in crop production (farmers are reporting half the productivity of 10 to 20 years ago). Reduced productivity combined with increasing household size in the rural areas is leading to the early exhaustion of food supplies. Farmers are subsequently forced to search for income to

Local community members and REAP staff congregating in a community garden in the Lower Saloum District of the Gambia.

supplement household food requirements during the months leading up to the next harvest, a period commonly known as the "hungry season."

The Canadian International Development Agency (CIDA) supported an Exploratory Phase Mission to the Gambia and a corresponding Canadian Youth International Internship Program that will be ongoing for the next 3 years. As a result of this support and the exploratory mission in August 2003, partnerships were forged between REAP-Canada and the Njawara Agricultural Training Centre (NATC), Village Aid (VATG), and the Gambia National Agricultural Research Institute (NARI). NATC, is a local NGO established by the community for the purpose of training both male and female farmers in sustainable agro-forestry techniques. Village Aid is working with women to overcome economic and social barriers to securing livelihood and basic rights. NARI is the Gambia's principal agricultural research and development institute focusing on the advancement of livestock, horticulture, agronomy, and agro-forestry systems. The three organizations have previously collaborated largely on small-scale projects, but are now working together to complement each others' expertise on a large collaborative effort.

Conclusions developed through the Exploratory Phase indicate that a holistic and integrated development approach is required to respond to the interrelated challenges of soil infertility, environmental degradation, and lack of income generating opportunities in the Gambia. Introducing diversified ecological farming systems would not only increase the soil's fertility but also enhance crop production, suppress weed growth, inhibit pests and diseases, increase food security, generate more income, reduce use of chemical inputs and improve the health and nutrition of farmers and their families. Between the partners, two community development projects have been created and are now in the preliminary stages of implementation. The Gambia Ecological Agriculture Development (GEAD) Project and the Gambia Agro-Ecological Village Development (GAEV) Project have been developed to assist local communities in two different rural regions in the Gambia. As projects that require participatory approaches, local involvement of project beneficiaries was sought from the onset through village meetings conducted in late 2003. Villagers brainstormed on the objectives and design of the projects and outcomes were met with enthusiasm and a committed attitude towards the project.

The two projects aim to transform these local communities into Agro-Ecological Villages, those which have created self-reliant, integrated and ecological food and energy systems. They will involve four main activities: farm planning, farm implementation, farmer-to-farmer training and plant material improvement. These activities have been designed to both empower the local villagers and enhance the natural resource bases in their respective regions. In addition, some of the communities have committed to addressing regional issues, those which affect the landscape at a macro-scale, such as soil and water conservation or environmental deterioration as a result of the free-range livestock system. Thus, committees will be formed containing village representatives whose aim is to tackle these issues and develop a more global approach. Emphasis will be placed on agro-forestry techniques and semi-intensive livestock management, practices which both enhance farming and preserve the natural environment. The project will also support rural communities through the creation of self reliant, integrated and ecological food and energy systems. Overall, the Agro-Ecological Village (AEV) Development Model can provide the Gambia with an easily replicable approach to rural community development that meets the dual objectives of poverty alleviation and environmental sustainability. This strategy has proved to be the logical evolution for rural development programming in agrarian areas and could be successfully implemented on a wide scale with minimal resources to effect real change in desperately impoverished and degraded environments in West Africa.

Gambian Farmer showing off his Cassava plants. Farmers learn to sustainably produce a variety of crops and vegetables during the NATC Farming Systems Training Program.

THE MAYON TURBO STOVE: Fueling the Fight Against Poverty

C. Ho Lem & R. Samson

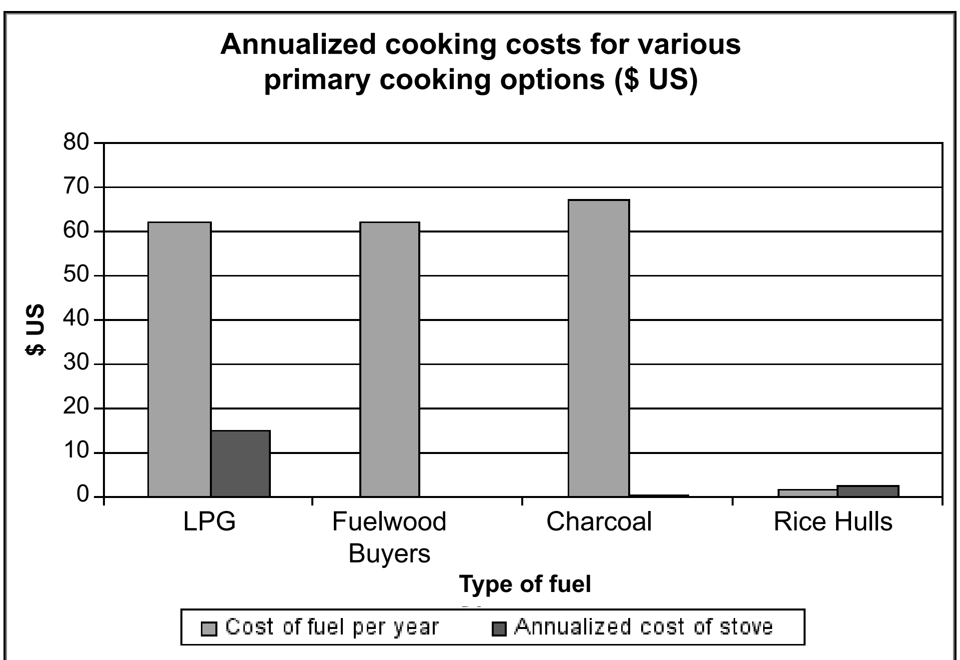
Inspired by the Mayon volcano in the Philippines, the Mayon Turbo Stove (MTS) has a near perfect cone design that allows the efficient combustion of crop residue produced by milling the worlds most important food crop. Low-income rural families can now utilize surplus rice hulls found throughout much of the developing world as a clean burning and low cost cooking fuel alternative. For $7 US per cooker, impoverished families are gaining access to this new stove to reduce their household cooking expenses and to improve indoor air quality. Over the past year, 3,000 rice hull stoves have been distributed in the Philippines by REAP-Canada and their local partners. We are now stepping up our efforts to introduce this simple technology both nationally and internationally. There is a pressing need to improve the extreme conditions faced by the millions of rural poor in the world.

A newly designed rice hull stove from the Philippines may be a breakthrough in sustainable household cooking systems that can reduce poverty and improve health in low-income rural communities around the world.

Household cooking is one of the most important energy issues in rural areas today and has a major impact on human health and the landscape ecology of developing nations. The vast majority of rural households in developing countries still rely on traditional biofuels for cooking, including firewood, charcoal and crop residues such as cereal straws, corn cobs, and coconut husks and shells. In countries like the Philippines, biofuels are often combusted in simple clay stoves or in crude stoves of steel bars over bricks. Chimneys are poorly designed and often absent. The incomplete combustion of biomass in the home can produce pollution levels exceeding that of the most polluted industrial cities. Inhalation of these products can lead to serious respiratory problems, directly impacting women and children. Fossil fuels, like LPG and kerosene are also used in the home, however, they are increasingly unaffordable for impoverished families. As the population grows and more land in tropical forests is converted into agricultural use, rural Filipinos are beginning to rely more heavily on agricultural residues for fuel. For these reasons, the development of a convenient, low cost cooking system using crop residues produced in a sustainable manner is of great consequence to many developing nations including the Philippines.

One of the most commonly available, low cost and easily accessible residues in the world is rice hulls. In the Philippines, there are more than 1.5 million tonnes of available rice hull that could provide sufficient fuel for 1 million households. Commonly, rice hull is discarded in waste areas and burned in smoldering fires that can create local air pollution problems and contribute greenhouse gas emissions to the biosphere. Using rice hull locally in simple household cookers is an ideal way to utilize this widely dispersed resource that is low in energy on a weight basis. Rice hull also has the natural advantage of being of a uniform and small size, which aids in the development of an efficient stove combustion system, in comparison to bulky wood or non-uniform crop residues.

REAP-Canada and the University of the Philippines at Los Banos recently completed a bioenergy assessment of the Philippines that identified the opportunity to develop a low cost household stove to utilize the rice hull resource. An economic analysis indicated that an improved rice hull stove could provide the lowest annual cooking cost amongst all purchased fuel systems available in the Philippines. In 2001, REAP-Canada received support for the project from the Canadian International Development Agency (CIDA) to introduce an improved rice hull



THE MAYON TURBO STOVE: Fueling the Fight Against Poverty

stove into households in the Philippines as a means to reduce both poverty and greenhouse gases.

A stove users study of 100 households in January 2002 in the upland areas of Negros Occidental found an improved rice hull stove (the LT-2000 –an enhanced version of the Lo Trau stove and forerunner to the MTS) dramatically reduced household cooking costs for impoverished families. The households in the survey had an average annual income of $756 USD and a per capita income of $126 USD. The stove was found to largely displace gathered and purchased fuelwood, as well as some charcoal and LPG use. On average, the introduction of a (US)$7 rice hull stove reduced the annual fuel expenditures for cooking (fuel and firestarter costs) from $35.58 to $13.17 (De Maio *et al.,* 2002). The annualized cost of owning the rice hull stove was estimated to be only $2.92. Additionally, the stove reduces the laborious task for women of fuelwood gathering, which typically requires 60-120 days per year of work in upland communities in Negros Occidental. The economic savings increased when the analysis projected the costs of stove users who were entirely purchasing their fuel supplies. Rice hull stove users were estimated to have annual cooking costs of only $4.87 US per year compared to $61.98, $67.54 and $77.32 for cooking with purchased firewood, charcoal, and LPG respectively. The projected savings from 100% displacement of rice hulls for other purchased fuels represented 7.6–9.6% of the total annual family income. For impoverished families suffering from malnutrition, these are critical household savings to improve family income and wellbeing. The rice hull stove user survey found on average the LT-2000 stove had a 76% displacement of conventional fuel use in households. The average per household impact was to reduce the quantity of firewood, charcoal and LPG used by 1734 kg, 54 kg and 7.2 kg respectively per year. It was projected that a more advanced rice hull stove could increase market penetration by increasing user convenience, reducing rice hull consumption and increasing the conventional fuel substitution impact of the stove in individual households.

Conventional cooking over crudely designed low efficiency wood stoves is smoky and consumes a lot of wood. Households need to provide 60-120 days of labour per year to gather two tonnes of firewood for these primitive cooking methods.

Local Villagers with Mayon Turbo Rice Hull Stove on Negros Island, Philippines

The Mayon Turbo Stove was developed by REAP-Canada in partnership with local workshop artisans in the Philippines in December 2001. It was designed as a low cost and clean-burning fuel stove to efficiently burn porous crop residues like rice hulls and coffee shells. Other available biomass residues like sawdust, corn cobs, peanuts shells and coconut shells can also be mixed in with rice hull as a supplement.

The Mayon Turbo Stove provides an unmatched combustion quality to any stove in its class by producing a non-luminescent flame from a low quality crop residue. It is simple technology that could be highly replicable because of its ease of construction, low production cost ($7US), and ability to significantly reduce household cooking expenditures. Considering the widespread abundance of low cost rice hull, this inexpensive household energy device could be widely used as a poverty reduction strategy for the rural poor in many of the world's rice producing nations.

References

(1) R. Samson et al. Strategies for Enhancing Biomass Energy Utilization in the Philippines. October 2001.

(2) De Maio Sukic, A., R. Samson and E. Guara., 2002. Impact of a rice hull stove on cooking expenses and greenhouse gases from rural households in Negros Occidental, Philippines.

March 2002. REAP-Canada, www.reap-canada.com.

The Evolution of the Mayon Turbo Stove

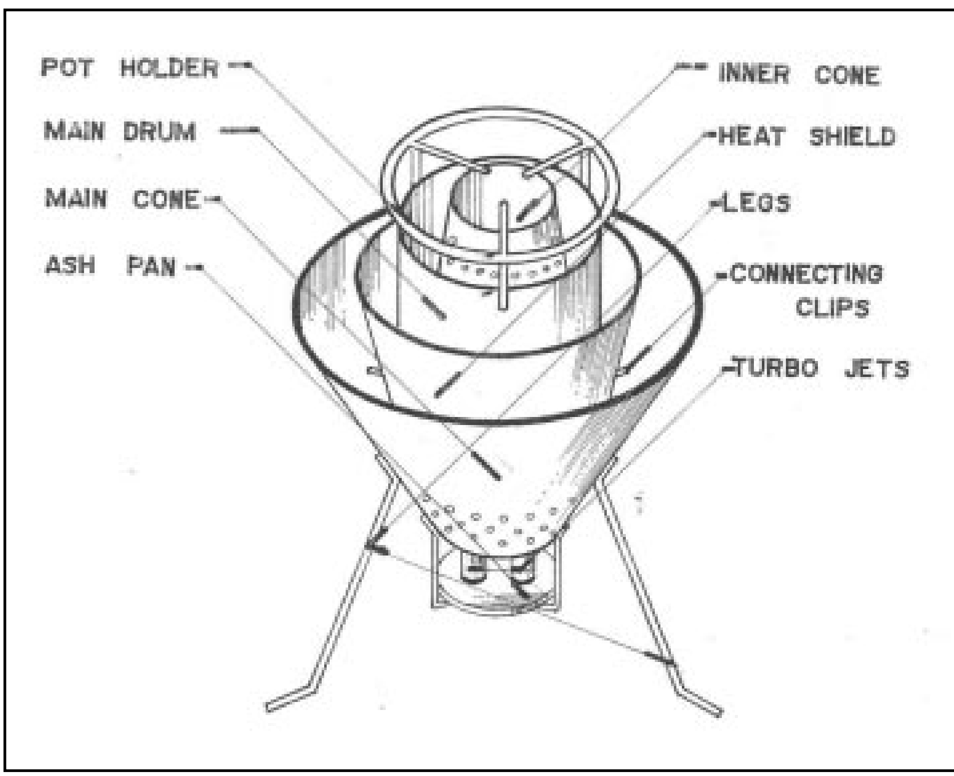
To develop the stove, all major rice hull stove designs available in the Philippines were analyzed including versions from the International Rice Research Institute (IRRI), PhilRice, the Central Philippine University (CPU) and compared to the Lo-Trau model developed in Vietnam. All stoves were functional but suffered from one or more deficiencies including incomplete combustion, excessive air, uncontrollable fuelbed fires, high rice hull consumption, constant need for tending and high production costs.

Through an intensive research and development program several innovations were made. The inner cone was lengthened by approximately one third to increase residence time of gases and concentrate the flame under the pot. To prevent smoke events (as the porous rice hull turns to ash it restricts the air supply), twin "air injector" pipes were installed through the ash pan to draw air into the combustion zone above the burning fuelbed. The twin pipes increased the turbulence inside the inner cone, creating a vortex and slowing airflow out of the stove. Secondary combustion air holes were also drilled into the inner cone to add additional air to more completely combust the gases as they circulated in the top of the cone. The innovations of extending the inner cone and the strategic reengineering of the air supply to create an adequate (but not excess) air supply with effective air mixing provided the breakthrough in clean combustion for such an unsophisticated appliance. After a 3-5 minutes start-up period, a blue or non-luminous flame is now present throughout the inner cone of the MTS. Maintenance of the stove is also reduced, with tapping required only after 10-12 minutes from start-up to introduce additional fuel. The stove is now thought to possess a near optimal air flow; there appears to be no excess air and no oxygen deficient areas of the cone or oxygen deficient periods during the entire burn cycle. Following start-up, smoke only begins to appear again when additional fuel is required to maintain combustion. There are no smoke events related to lack of air when adequate fuel is present. The ash is now a whitish-grey colour, indicating more complete biofuel combustion. Finally, to minimize fuelbin fires and eliminate smoldering of rice hull in the hopper, a heat shield was added around the centerpiece. This was formerly a major problem with all rice hull stove designs when the centerpiece would heat up and ignite the hull supply.

The next steps in the program are to undertake tests at several testing facilities. A smaller model of stove the MTS 6500 (having a 6.5 inch diameter fuelbed) has also been developed. The original MTS-7000 model (having a 7-inch diameter fuelbed) appears best suited to larger households or small commercial applications. There has been favorable feedback from the communities using the new MTS models with some reporting 100% substitution of conventional fuels. A new heatshield has also been added to the smaller 6000 model to prevent any fuelbed fires. The new MTS 6000 stove can allow a family of 6 to cook with approximately one tonne of rice hull per year. Households are experiencing up to 50% reductions in rice hull fuel requirements, less maintenance and less smoke. With a simple level of training, families are now enjoying a high quality non-luminescent flame cooker that is becoming locally known as "the poor mans gas stove."

The Mayon Turbo Stove developed by REAP-Canada is the cleanest burning low cost rice hull stove for peasant households in the world.

Illustrations and instructions on how to build and use the Mayon Turbo Stove can be found at www.reap-canada.com. For further information contact: REAP-Canada Ph:(001)(514)-398-7743, Info@reap-canada.com.



The Mayon Turbo Stove: One Interns Experience in the Philippines

By Candace Stryker

I was very excited to begin my overseas CIDA internship deployment in the Philippines for 6 months in 2003. My task during that time was to critically verify and improve the on-going Mayon Turbo Stove (MTS) Project with Sustainable Rural Enterprises (SRE) at the Philippine Central University (CPU) in Panay. Upon arrival to the Philippines I found that although being in distribution in the community, the user satisfaction of the stove needed further assessment after several years of use. Also, local engineers were indicating there were alternative bio-mass burning stove designs available that could potentially be superior.

To answer these questions, I first conducted 20 household surveys of families that had purchased some of the first MTS stoves sold as part of the Philippine Agricultural Climate-Change Project (PACCP). The results of the survey were quite encouraging. Most respondents purchased their stoves over 2 years ago and were using them 2.5 times a day. The respondents also predicted 1.5 years remaining for the life of their MTS, and all stated they planned on purchasing a new stove after their stove wore out. From the results of the survey (Jamin *et al.,* 2003) it became apparent that the stoves were lasting somewhat longer than the initial expectations. Respondents were highly satisfied with performance of the MTS especially when compared to conventional cooking methods. This indicated that the previous design changes to counteract difficulty in the establishment of combustion, and the initial smokiness of the stove upon ignition were successful (see *'Evolution of the MTS'* article).

Suggestions of the existence of a superior conical-grade rice hull stove stimulated us to investigate the validity of this claim. To do this, an experiment was conducted to compare the operating characteristics in terms of efficiency and usability of 2 different conical-grade rice hull stoves: the MTS to the Central Philippine University (CPU) design. The results of the experiments found that the MTS indeed had superior performance characteristics for its simple design and low cost. Results revealed that the MTS scored the highest in convenience, and had the fewest fuel bed fires and smoke events, while maintaining a high flame temperature and short boiling time. Additional, the stove only took 30 seconds to start and was able to boil a liter of water 8 minutes after ignition. Although the overall efficiency of this stove is slightly less than that of the CPU stove, the combination of high flame temperature and convenience make it an overall superior stove given that rice hull is largely a free fuel.

Candace Stryker and Yori Jamin in the Philippines with the Mayon Turbo Stove.

From the findings of the survey and the experiment it was determined that the design changes made to the MTS have produced a superior low-cost rice hull stove that delivers excellent combustion and convenience to its users while preventing deforestation and reducing indoor household smoke exposure. The wide-spread adoption of appropriate technologies such as the MTS can significantly improve the quality of life and the utilization of sustainable forms of energy in rice-producing nations around the world.

Reference:

Jamin, Y., C. Stryker, S. Jizmundo, M. Jizmundo and D. Renacido. June 2003. *Operating and Performance Characteristics of Conical Grate Rice Hull stoves.* Centre for Productive Uses of Renewable Energy (CPURE), main Campus, Aklan State University, Banga, Acklan, Philippines. 11 pg.

Operating and Performance Characteristics of Conical Grate Rice Hull stoves.

StoveStart up Model time (s)	Major fuel bed fires	Smoke events	Fuel replenishment (no. of times)	Avg. burn time (m:s)	Avg. time to boil water (m:s)	Avg. Flame temp (°C)	Avg. Fuel consumption rate (g/min)	Avg. % Ash: Char	Avg. Overall Combustion Efficiency %
MTS 28	0.7	3.7	10.3	24:26	8:16	334.9	23.8	28.4%	16.2%
CPU 39	4.3	6.7	15.3	22:46	8:54	313.1	22.0	28.8%	17.6%

Grass Biofuel Pellets:
An ecological response to North America's energy concerns

By R.Samson, R.Jannasch, T.Adams & C. Ho Lem

Unprecedented opportunities for biofuel development are occurring as a result of a combination of factors including: rising oil, natural gas and electricity costs, energy security in the US, and the need to reduce greenhouse gas (GHG) emissions. The 1.1 billion acres of farmland in North America could help mitigate these concerns if currently viable biofuel production systems were expanded. In most agricultural regions, warm season grasses can be grown for USD $2-$3/GJ. Much of this farmland can collect 100-250 GJ of energy per hectare with existing production technology and plant materials. Efforts have been made to produce power and liquid fuels from this material, but the development strategies appear not to be sustainable economically. Converting this feedstock into a viable energy option suitable for widespread application requires an energetically efficient, economical, and convenient energy transformation pathway to meet consumer energy needs.

'Energy farming' is a promising solution to help meet our Kyoto committments. Biofuel pellets made from prairie grasses can be used for space heating homes and buildings.

Finding Energy Farming's Comparative Advantage

The recent development of "close coupled" gasifier pellet stoves and furnaces capable of burning moderately high ash pelleted agricultural fuels, provides a completely new fuel cycle for energy farming development [1]. When burned in the gasifier stoves and furnaces, pelleted switchgrass provides fuel conversion efficiencies and particulate emissions in the same range as modern oil furnaces. Each GJ of grass pellet energy directly substitutes for one GJ of oil, and can be utilized on a large scale without significant air pollution. The pelletized grass biofuel systems builds on, and is likely to overtake, the existing wood pellet heating industry which is rapidly developing without any significant level of government intervention. Pelletized grass biofuel is poised to become a major fuel source because it is capable of meeting some heating requirements at less cost than all available alternatives. The cost-effectiveness of pelletized grass as a fuel results from:

⇒ efficient use of low cost marginal farmland for solar energy collection
⇒ minimal fossil fuel input in field production and energy conversion
⇒ replacement of expensive high-grade energy forms in space and water heating
⇒ minimal biomass quality upgrading which limits energy loss from the feedstock
⇒ efficient combustion in advanced, affordable, and user-friendly devices

Contrary to the prevailing wisdom that reducing GHG emissions will raise societal energy costs, pelletized biofuels can provide consumers with lower and more stable heating costs while dramatically cutting GHG emissions. Given that agricultural commodity prices are declining in real dollars, pellet fuels are likely to become cheaper over time. By contrast, wood-based pellets have been rising in cost due to ongoing improvement in industrial wood utilization, which is reducing the waste fraction of delivered roundwood. Furthermore, the development of a grass pellet biofuel industry has great potential to revitalize the rural economy of North America by absorbing the surplus production of the agricultural sector, and cutting on-farm fuel costs in heating intensive sectors like greenhouses.

The Potential for Energy Farming with Grasses

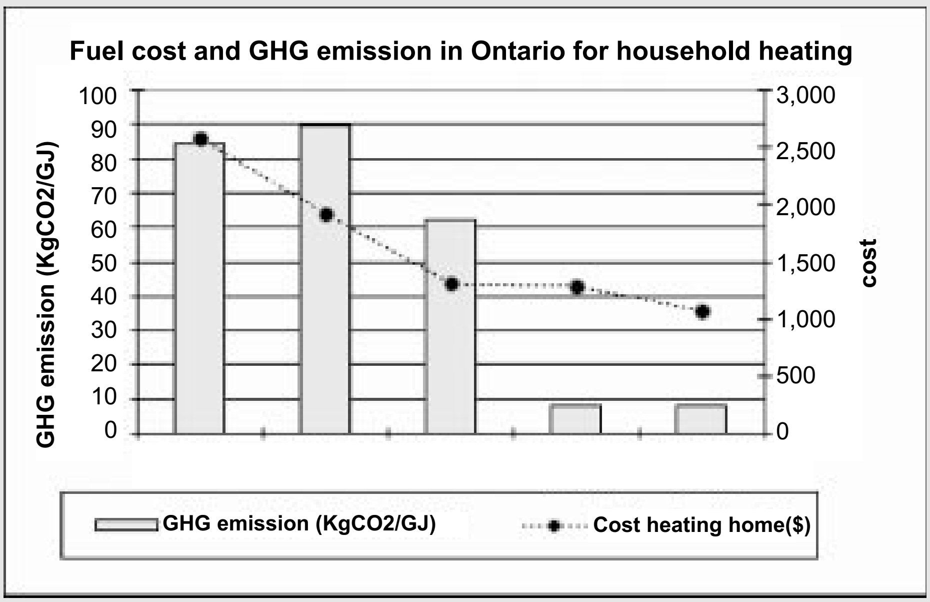
Of the farmland in North America (932 and 168 million acres in the US and Canada respectively), we estimate that 150 million acres could be dedicated to energy farming without appreciably affecting North America's food supply. Assuming biomass energy crop yields are 50% higher than the current hay yields, harvested perennial grass yields of 5.9 and 8.1 tonnes/ha in Canada and the US respectively can be expected. By energy farming 130 million acres in the US and 23.4 million acres in Canada, a total production capacity of 424 and 55 million tonnes could be achieved in the two respective countries. Assuming grass fuel pellets contain 18.5 GJ of energy/tonne, 8.9 billion GJ (an energy equivalent of 1.5 billion barrels of oil) could be produced each year from energy crop production on 14% of North American farmland. With U.S. crude oil imports of approximately 3.4 billion barrels per year, the U.S. could displace the equivalent of 39% of its oil imports by growing biofuels on 14% of its farmland.

> ***"8.9 billion GJ (an energy equivalent of 1.5 billion barrels of oil) could be produced each year from energy crop production on 14% of North American farmland."***

The Economics of Pelleted Biofuels

The most promising regions to develop a grass pellet fuel industry are those where hay production costs are low, and heating costs are high due to long winters and high fuel costs. Based on hay prices, land costs, relative winter heat costs, and warm season grass performance data in North America, the best opportunities exist in the states of North Dakota, South Dakota, Nebraska, Minnesota, Wisconsin, and the provinces of Manitoba, Ontario, and Quebec.

An ideal location for a biofuel pellet industry is the province of Manitoba. This largely agricultural province has amongst the lowest hay prices in North America and no indigenous fossil energy reserves. The spread between delivered heat costs of conventional energy sources and hay costs is rapidly growing. In real dollars, long-term hay prices remain flat at USD$2/GJ (USD35$/tonne) while delivered heat costs for natural gas, oil and electricity are rising and are now in the USD$10-$13/GJ range. With current pellet production costs estimated to be $2/GJ (USD$35/tonne) and a conversion efficiency of 80%, delivered heat costs for on-farm and residential grass pellet fuels are projected to be in the USD$5-$7.50/GJ range. There are major opportunities for Manitoba households to switch from electrical heating (used by 32% of households) to biofuel heating systems. Widespread implementation of this energy substitution strategy would enable hydro-rich provinces, such as Manitoba and Quebec, to expand electricity exports into the US market.



ASSUMPTIONS:

The heating costs of fuel types are unrelated and the dotted line connecting the different heating costs is for illustrative purposes only.

Electricity has an energy content of 0.0036 GJ/kWh, a delivered fuel value of 10.28 cents/kWh (tax included), a $C0_2$ loading value of 84.5 kg $C0_2$/GJ and is converted at 100% efficiency. The approximate electrical mix for Ontario is: 26.1% hydro-power, 40.3% nuclear, 33.1% fossil, 0.6% other (OPG, 2001 http://www.opg.com/envComm/SED2001Report.pdf).

Heating Oil has an energy content of 0.0387 GJ/l, a delivered fuel value of 67.45 cents/l (tax included), a $C0_2$ loading value of 89.67 kg $C0_2$/GJ, and is converted at 82% efficiency.

Natural Gas has an energy content of 0.03723 GJ/m^3 ,a delivered fuel value of 46 cents/ m^3 (tax included), a $C0_2$ loading value of 62.13 kg $C0_2$/GJ, and is converted at an average efficiency of 85%

Wood Pellets (bagged) have an energy content of 19.8 GJ/tonne, a delivered fuel value of $230/tonne (based on #1 pellet price plus tax), a $C0_2$ loading value of 8.17 kg $C0_2$/GJ, and are converted at 82% efficiency

Switchgrass Pellets (bagged) have an energy content of 19.0 GJ/tonne, a delivered fuel value of $184/tonne (based on current #2 pellet price plus tax) and a $C0_2$ loading value of 8.17 kg $C0_2$/GJ, and are converted at 82% efficiency.

[b] *Heat estimates made for a new detached 2000 sq. foot home with a 90GJ heat requirement (Natural Resources Canada, 1997). The analysis does not include capital costs associated with equipment.*

Summary

This paper makes the case that the easiest way to move biomass energy ahead in North America is to focus on the development of pelletized grass biofuels as an ecological substitute for high-grade energy forms such as oil, natural gas and electricity in heat related energy applications. North American energy markets could be profoundly transformed by the development of a large-scale pelletized grass biofuel industry. As prices continue to rise for high-grade energy forms, low priced biofuel pellets will increasingly become the heating fuel of choice for many North American energy consumers.

This paper was presented at the Tenth Biennial Bioenergy Conference September 22-26, 2002 in Boise, Idaho

Reference

Samson R, Drisdelle M, Mulkins L, Lapointe C, Duxbury P. The use of Switchgrass Biofuel Pellets as a Greenhouse Gas Offset Strategy. Bioenergy 2000 Conference, Buffalo, New York, October 15-19, 2000.

Growing Interest in Grass Biofuels

A market study REAP-Canada conducted on grass pellet fuels in Ontario, suggests that a promising new opportunity for farmers is on the horizon.

By Rupert Jannasch

The sharp increases in oil, natural gas, propane, and some regional electricity prices during the last ten years have demonstrated consumer vulnerability to fluctuations in energy supply. Farmers are particularly vulnerable because as primary producers they are often expected to swallow higher energy costs. These high energy prices combined with low food commodity prices represent a double threat to the prosperity of Ontario farmers.

One solution to resolve both problems would be to commercialize renewable, biofuel crops. By doing this, it would help diversify Ontario's farm economy, as well as allow farmers to increase their energy self-reliance and control their energy costs.

'Energy Farming' grasses, a new cheap indigenous energy source for Eastern Canada.

The need to find alternatives to fossil fuels and to reduce greenhouse gas (GHG) emissions has heightened interest in biofuels. REAP– Canada, has pioneered the development of biofuel pellets made from switchgrass (*Panicum virgatum*), a perennial grass native to the Great Plains and eastern North America. Switchgrass is a warm season grass adapted to marginal soils and arid climates with minimal fertility and management requirements. Switchgrass is best adapted to well drained soils and growing seasons with 2500 or more Corn Heat Units. Switchgrass has reasonably good frost tolerance and would be advantageous in areas that are risky for corn and soybeans.

Switchgrass pellets are used much like wood pellets. The goal has been to expand the pellet heating market from an estimated 10,000 wood pellet space heaters in Ontario by increasing the choice of fuels. The supply of surplus wood residues (sawdust, wood chips, etc.), for example, has declined by approximately 50% across Canada between 1990-1998. Over the past few years, many pellet processors across Eastern Canada have been unable to obtain enough sawdust to manufacture fuel, thus homeowners have experienced difficulty obtaining pellets.

Until recently, combustion of moderately high ash pellets made from grasses or tree bark was limited by a tendency for clinker (fused residues) formation in pellet stoves. Dell-Point Technologies and Grove Wood Heat Inc., however, have now developed technology to efficiently burn these materials in pellet form.

REAP-Canada conducted the first stage of a switchgrass pellet market survey for Eastern Ontario in 2001. Farmer surveys and land-based assessments were used to identify opportunities and needs for the industries development. More specific market data will be released later this year.

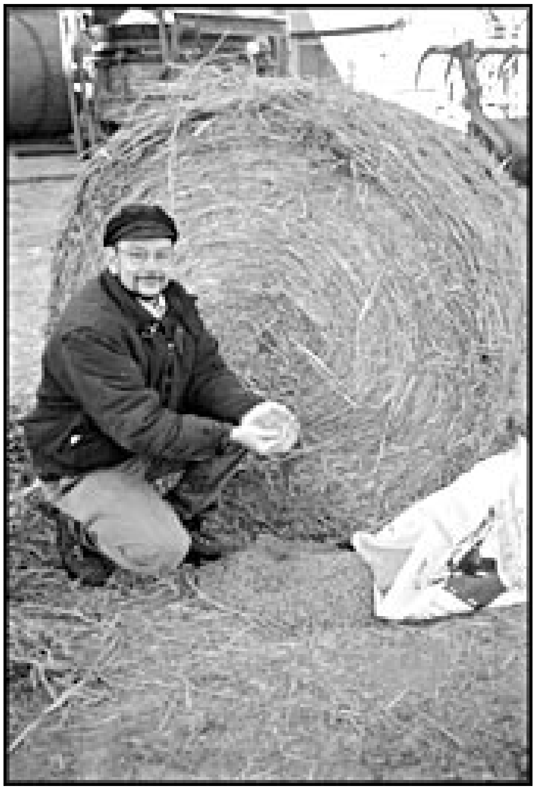
Farmers responding to the survey ranged from hobby farmers to large cash crop (over 2000 acres) and hog farming operations. The greatest risks associated with developing a grass fuel pellet industry were perceived to be: slow consumer uptake of pellet stove heating, low demand for pellets (initially), bale storage fires, and high transport costs.

Interest in pellet production and heating systems among farmers stemmed from a desire to: develop energy self-reliance and certainty of supply, control on-farm energy costs, diversify on-farm income, utilize marginal lands, and adopt more environmentally sound heating systems. Hog farmers saw a double role for switchgrass both as a sink for manure and as an alternate fuel for heating hog barns.

One of switchgrass' many advantages as a cash crop is its large quantity of potential markets. Farmers expressed interest in using pelletized switchgrass for heating barns, shops, houses, greenhouses, as well as for off-farm pellet sales. Others proposed using switchgrass for livestock bedding, garden mulch, mushroom compost and buffer strips on organic farms. The diverse uses for switchgrass help build confidence that farmers will find a profitable market for it as the pellet market evolves.

Prospective growers wishing to export switchgrass or switchgrass pellets from their farms expect a return similar to, or better than, a hay crop.

Growing Interest in Grass Biofuels



Baled switchgrass and pellets.

"New pellet stoves and furnaces are being developed by several Canadian manufacturers to burn grass pellets and other agrifuels. The Delpoint pellet stove has been tested to burn switchgrass pellets at 83% efficiency by the Canadian federal laboratory testing combustion appliances".

Land use assessment

Apart from soil and climate, one of the main factors affecting a region's suitability for biofuel crops is land costs. REAP-Canada estimates that an attractive land rental cost for switchgrass production, based on current switchgrass production costs and yields, would be \$60/Acre or \$15 per dry tonne harvested. Consequently, some sections of Ontario are not as well suited for switchgrass production, particularly high value cash crop growing areas.

Four areas in Eastern Ontario were identified with good potential for switchgrass production. These include: (a) Prescott and Russell County and the Alfred area, (b) Renfrew County ranging from Arnprior to Pembroke, (c) Lanark Highlands and (d) the Peterborough area ranging from Lindsey to Hastings. These regions were suitable due to soil type, sufficient heat units, and land availability.

Renfrew County has the advantage of an existing pellet mill that once processed alfalfa from over 4000 acres in the area. The Lanark highlands, in contrast, have very little infrastructure but a large underutilized agricultural land base with well-drained soils, low land rents (\$0-40 per acre), and little risk of competition for land from established agricultural enterprises.

REAP-Canada research trials have demonstrated that switchgrass will yield about 10 tonnes/hectare on both sandy and clay soil types in Prescott and Russell County. Total potential switchgrass production in the county is estimated at 127,000 tonnes, more than enough to supply a modern 100,000 tonne/year processing plant.

The potential for switchgrass biofuel pellet production therefore looks promising in Eastern Ontario. Early commercialization will depend on market factors and energy prices, as well as the willingness of farmers to take risks and innovate.

This study was supported by the Ontario Agricultural Council. It can be found on the REAP website (www.reap-canada.com).

References

R. Jannasch, R. Samson, A. de Maio and T. Helwig. Switchgrass Fuel Pellet Production In Eastern Ontario: A Market Study. December 2001.

Pellet Stove Suppliers:

- Dell-Point Technologies
  Blainville, Quebec
  1-877-331-6212
  http://www.pelletstove.com
- Grove Wood Heat Inc.
  Little York, P.E.I.
  1-902-672-2090

Agri-Biomass Residue for Energy Production in Eastern Canada

The recent ratification of the Kyoto Protocol has created an increasing need to develop renewable energy sources in Canada. This report was developed to provide an overview of available crop residues and livestock manure in eastern Canada and assess their potential for use as a biofuel. The inventories in this report are linked to an assessment of energy conversion systems that are either in the commercial stage or in the pilot stage.

Crop Residues

Cereal straws and corn stover were identified as feedstocks with high potential for bioenergy production in eastern Canada. The gross energetic potential of both cereal straw and corn stover is about 92 million GJ/year. With a combustion efficiency of 50% assumed, 46 million GJ of heat energy could be produced with a gross energetic value of 22.2 million GJ. If straw heating was used to replace oil-based heating systems, 4.0 million tonnes of CO_2 emissions could be displaced each year!

Livestock Manure

Releasing a significant quantity of methane (one of the most damaging GHGs), Canada's livestock industry will surely feel the effects of Kyoto. An opportunity for the livestock industry to meet its Kyoto requirements can be met through the generation of energy in the form of biofuel. Given that the gross energetic production from anaerobic digestion of livestock waste was estimated as 16 million GJ/year, 1.2 million tonnes of CO_2 emissions could be displaced each year by replacing heating oil by harnessing the methane biofuel generated by livestock waste.

On a farm-by-farm basis, the bigger the operation the smaller the costs of establishing and operating a biogas treatment system; therefore economically the greatest potential to produce electricity from biogas is large swine and poultry farms. Biogas production from livestock waste could become more cost-effective with centralized treatment facilities that include organic wastes from slaughterhouses and the food industry.

Conversion Technologies

Bioenergy conversion systems with the most potential are combustion, cellulosic ethanol production and anaerobic digestion of livestock manure. Pelleting of crop residues for combustion also represents a significant opportunity for low cost and environmentally friendly energy.

A biogas system based on the anaerobic digestion of livestock waste is becoming more economical due to the increasing size of farms in Eastern Canada; however as of yet the investment costs still remain very high on a per farm basis and no pilot projects have been conducted in this area.

Widespread utilization of biogas on small to medium-sized farms would probably depend on heat-related applications rather than electricity generation.

The viability of bioenergy from agricultural residues depends mostly on linking environmental benefits with energy production. For example, anaerobic digestion of livestock waste could become a necessity, given rising human health concerns over water contamination. This mounting health concern could soon lead to regulations governing the treatment of such waste, hence, making energy production from it more economical (by offsetting the cost of treatment).

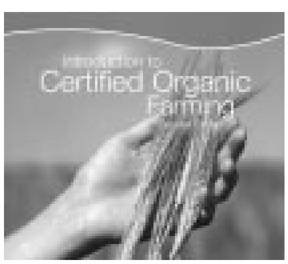
Currently the environmental benefit of bioenergy production from agricultural wastes outweighs the benefits of energy recovery. However, it is clear that considerable potential for bioenergy production from these wastes exists in eastern Canada, but that extensive work remains in matching appropriately scaled conversion technologies with existing feedstock supplies before its full potential can be realized.

The full report is available on the REAP website at www.reap-canada.com

Reference

Helwig, T., R. Jannasch, R. Samson, A. De Maio, D. Caumartin. Agricultural Biomass Residue Inventories and Conversion Systems for Energy Production in Eastern Canada. July 1, 2002.

REAP-Canada and CFBMC Release Introduction to Certified Organic Farming 2nd Ed.



REAP-Canada is proud to have participated in the writing and compilation of the second edition of the Introduction to Certified Organic Farming! This edition explains the basic elements of certified organic farming and the organic food system in Canada. It is geared towards a broad audience of novice organic farmers, conventional farmers considering converting to organic, processors and marketers, as well as policy makers, produce managers and/or check-out clerks who want to learn more about the products they handle. It describes how organic systems manage soil fertility, weed and pest infestations, as well as livestock production. It also examines international organic experiences, and provides an overview of the organic market, plus the processing and retailing of organic foods. In addition, the motivation, farming practices and experiences of an extremely rich and diverse cross section of organic farmers are described in farm profiles from each province.

This edition was produced by the Canadian Farm Business Management Council (CFBMC) through funding from the Canada Adaptation and Rural Development Fund of Agriculture and Agri-Food Canada (AAFC). Copies are of this book are available through CFBMC for $35 + tax. A video entitled Introduction to Certified Organic Farming 2nd Edition can be used in conjunction with this book and is available from the CFBMC.

The Western China Agro-ecological Village Development Project

A partnership between the Chinese Administrative Center for Seabuckthorn Development (CACSD) and Resource Efficient Agricultural Production (R.E.A.P.) – Canada

Deforestation, overgrazing and the expansion of land used for crop production into ecologically fragile lands in Western China has contributed to extremely severe soil erosion from wind and water forces over a 2.9 million km^2 area (which is over half the land mass of the region). The annual erosion rates in the yellow river watershed reach up to 300 tonne/ ha/ year with an average of 110 tonne/ha/yr, which makes it the worst in the world in terms of soil erosion on such a large scale.

The Ministry of Water Resources is working on 10 demonstration watershed areas in Western China with several Canadian agencies to implement sustainable land use practices that reduce the severe soil degradation, improve water management and reduce poverty in the region. The conservation measures being implemented by the Ministry of Water Resources to help resolve the problem include the reduction of grazing and widespread planting of conservation plants such as sea buckthorn and caragena, and engineering measures including terracing, check dams and water conservation systems for households.

REAP-Canada is an independent research and development organization that has been working to develop sustainable farming systems since 1986. We aim to develop agricultural solutions that resolve major global environmental problems including climate change and deforestation. Farmers are involved in our participatory research and demonstration programs to ensure that the techniques and technologies developed are readily applicable in real-life situations, both in Canada, and internationally. REAP began its Agro-Ecoligical Village (AEV) development programming in the

Training session with local farmers in Gansu Province, China

Reconstructed landscape in Dingxi County, China

Philippines in 1998 with support from CIDA. This included promoting ecological agriculture, bio-energy, improved energy self-reliance, restoration of natural resources, micro-credit programs, community development and GHG reduction strategies. Training, mentoring, demonstrations and crop trials are important means of enabling farmers to develop sustainable agricultural systems. REAP is also involved in appropriate technology development including efficient cook stoves that use crop residues instead of coal and fuelwood, and GHG friendly farm implements produced and distributed through farmer groups.

The CACSD is working in partnership with REAP-Canada to implement the Agroecological Village development concept in China. A 3-year project has been funded by the Shell Foundation sustainable communities program with project implementation sites in Inner Mongolia and Gansu province. The aim of the project is the holistic development two communities in western China in a manner that overcomes poverty and environmental degradation with sustainable agricultural systems and community building. This will be achieved through the introduction of a farmer-to-farmer education and training program, increasing local capacity through the improvement of local communication and resource networks and the establishment of farmer field testing and trial sites demonstrating appropriate technologies and seed varieties.

The partnership aims to improve the communication and support and technology sharing between Countries like China and Canada, as well as to increase self reliance among the marginalized Chinese farmers living in environmentally sensitive areas, while at the same time reclaiming degraded and vulnerable environments.

The Western China Agroecological Village Development Project is funded by the Shell Foundation Sustainable Communities Program and the Chinese Bureau of Water Resources.

The Agro-ecological Village Development Model: Experiences in the Philippines and China

By Roger Samson and Claudia Ho Lem

REAP-Canada is becoming increasingly active internationally, working with several organizations and communities on rural development initiatives including the implementation of the Agro-ecological Village development model. There are several important cornerstone design concepts of the agro-ecological approach that we would like to share, along with the experiences and lessons learned from REAP's efforts over the past 5 years.

In 1998, REAP-Canada initiated its development programming activities on Negros Island in the Philippines with Paghida et sa-Kauswagan Development Group (PDG) and the MAPISAN Farmers Alliance in Southern Negros, along with national support from the MASIPAG Farmer–Scientist Partnership network and the University of the Philippines at Los Banos. The principal funding source for the programming was a CIDA ESDP-Partnership Branch project entitled "The Southern Negros Sustainable Agriculture Development Project, which began in July, 1998 and ended in September, 2002. The goal of the programming in the Philippines was to reduce rural poverty and rehabilitate the natural environment by empowering small farmers to organize themselves through the development of ecological farming systems. One approach of the agro-ecological village programming that evolved to meet these goals was the development of training, education and field-testing infrastructure customized to address the social and ecological needs of rural farmers at the village level. In July 2002, several thousand farmers members of the MAPISAN Farmers Alliance, formed the Negros Center for Ecological Farming (NCEF), a farmer-led and scientist supported organization, as a means for farmers to play a greater role in the development of sustainable farming systems in the region. REAP has subsequently realigned its developing programming partnerships in the Philippines to respect the new farmer-led sustainable agriculture movement that is occurring. In July 2002, REAP also began a new partnership with the Alternative Indigenous Development (AID) Foundation in Bacolod, Negros Occidental. The AID Foundation works in partnership with the NCEF, and is a leading agency in the Philippines in developing appropriate technologies for meeting the basic needs of communities for food, water and energy.

The agroecological village development model is helping empower peasants in China and the Philippines to take a lead role in their own development process.

In 2002, REAP-Canada established a partnership with the Chinese Administrative Center for SeaBuckthorn Development (CACSD), a division of the Ministry of Water Resources, to pilot the agro-ecological village development model in the dryland areas of North Central China. The local project partners are the Bureau of Water Resources in Inner Mongolia and the Bureau of Water Resources in Gansu Province. The primary funding source for the 3 year project entitled "The Western China Agro-ecological Development Project" is the Shell Foundation Sustainable Communities Programme. The project aims to improve the economic and social well being of marginalized farming communities and women, while at the same time protecting and enhancing the natural resource base through the use of participatory development methods and the agro-ecological village development model. This project will also include the development of training networks, farmer education and field-testing infrastructure customized to address the social and ecological needs of the local rural farmers.

I. CONTEXT

New strategies and efforts are required to create effective sustainable rural development approaches that respond to the many challenges facing impoverished small farmers in developing nations with lasting effects. A holistic and integrated approach must be used to address the interrelated challenges facing impoverished households including inadequacies in food, health, nutrition and education, low income and issues related to living in an environment with degrading natural resources. To reverse this cycle of impoverishment, it is of paramount importance that sustainable methods of development are introduced. Individuals, organizations and support agencies must be sufficiently aware of local conditions (Table 1) and effectively organized to work together to create self reliant, resilient and empowered communities.

Ecological restoration needs to occur as many rural areas in developing countries are becoming severely degraded. Farmers require basic training on the principles of ecology and sustainable farming. Ecological farming systems need to be further developed and seeds for these systems locally adapted and further improved. Appropriate technologies need to be introduced which can further enhance the ecological infrastructure and self-reliance of communities. The social and ecological infrastructures of communities also need to be developed in a synergistic way that creates a positive feedback for continued development and reestablishes the communication and information exchange networks.

It was to sustainably develop the social and ecological infrastructure to create empowered and self-reliant communities that 5 years ago REAP-Canada began working with international organizations and communities to develop the agro-ecological village (AEV) development model.

II. Agro-ecological Village (AEV) Development Programming Activities

An agro-ecological village is described as a community that is largely self reliant through the creation of integrated and ecological food production and energy systems. Central to this approach is the conviction that ecological land management and sound community organizing forms the basis for sustainable community development.

The adoption of this approach will improve a communities understanding of agro-ecological processes. Over time, this will:

Table 1. Examples of problem factors contributing to the impoverishment of farmers and the environment in which they live

Philippines-Negros Occidental	North Central China
FACTORS CONTRIBUTING TO POVERTY OF FARMERS	
• Struggles to gain land through the agrarian land reform program • Serious risk of crop loss from drought • Government corruption • Lack of affordable government services for education and health care • Lack of capital and training to develop their farms • Harassment by powerful landlords • Growing population and large families • Typhoons and droughts • Natural resource degradation • Lack of clean drinking water and food • Spending on alcohol, gambling, and fiestas • Lack of off farm income opportunities • Non existent to poor farm to market roads, overloaded road network	• Loss of livelihood from new grazing restrictions on sloping areas • Quantity and quality of water for households and farm operations • Lack of training and capital to develop farms • Small production area in a harsh climate • Poor farm to market roads. • Lack of off farm income opportunities • Regional and global environmental degradation
ENVIRONMENTAL DEGRADATION	
Loss of forest cover and biodiversity- 95% of the island of Negros has lost its primary forest	Severe erosion (levels of 200 tonne/ha/yr) from grazing of denuded sloping upland areas and intensive cropping of annual crops on the highly erodable loess soils
Monoculture production systems: approximately 50% of agricultural land area is used to produce sugar cane	Loss of soil organic matter as all crop residues are completely removed from the fields (roots included) for cooking, house hold heating and livestock feeding
Woodfuel gathering and charcoal production are used for household energy at unsustainable levels	Complete absence of tree cover from wood gathering and overgrazing
Crop residue burning: approximately 90% of the rice lands and 2/3rds of the sugar cane lands are burnt each year	Vulnerability of the environment to desertification and global warming Loss of water from aquifers and groundwater reserves due to excessive drought and water harvesting
Erosion: Large amounts of sloping land are under unsustainable annual cropping systems.	Overuse of chemical fertilizers and pesticides
Overuse of chemical fertilizers and pesticides	Excessive and increasing of salinization of soil and water

The Agro-ecological Village Development Model:Experiences in the Philippines and China

Table 2. An agro-ecological approach to rural development in the Philippines

Activity	Agro-ecological system	Conventional approach
Approach	• Emphasizes self-reliance and empowerment through optimal use of on-farm resources • Orientates market development towards local markets and import displacement • Minimizes human impact on local environment and biosphere • Low cost participatory development approaches such as farmer to farmer training emphasized. Focus on long term project sustainability and lasting effects.	• Emphasizes development of export markets to pay for imported goods • Communities are vulnerable to external forces and loan-dependent • Degrades local natural resources and biosphere • Top down training and development approaches
Food	Food security and improved nutrition achieved through diversified ecological farming of rice, corn, root crops (sweet potato, cassava and taro) grain legumes (peanuts, and mungbeans), seasonal fruits (bananas, papaya) and vegetables (sweet potato leaves, water spinach,eggplant, squash), eggs and fish.	Much food imported, including rice, canned and dried fish, processed foods, livestock feeds, farm land dedicated to sugar cane
Soil tillage	Carabaos (water buffalo) used, tillage reduced through use of perennial crops and ratooning of rice and sugar cane	Tractors and fossil fuels, heavy reliance on annual crops
Seeds	Community seed banking of open pollinated seeds, new seeds assessed in trial farms, farmer driven participatory plant improvement	No local adaptation trials, plant improvement or seed saving. Imported hybrid seeds dominate plantings
Soil Fertility	Maintained through minimizing soil erosion, decomposition of crop residues, introduction of N fixing sugar cane and rice cultivars, crop rotation, nitrogen fixing legumes, azolla, mudpress (byproduct of sugar cane milling), carabao dung, rice hull ash.	Urea, phosphorus and potassium fertilizer
Insect and disease control	Biological control strategies, resistant cultivars, balancing soil fertility with the crop, planting rice in an east-west orientation and wider row spacing,	Insecticides and fungicides
Weed control	Mechanical weeding devices, crop rotation, balanced soil fertility management, crop residue mulching	Herbicides and tillage
Irrigation	Use of ram, treadle and bush pumps for irrigation	Gasoline and diesel powered irrigation pumps
Household cooking	Use of rice hull cookers, efficient wood stoves, biogas, all fuels farm-derived	LPG fuel stove, open fire cooking, kerosene as fire starter
Marketing	Emphasis of internal self-reliance and import displacement with value-added processing	Monoculture production, products sold to distant markets
Finances	Indebtedness minimized because food security is achieved, low input use from ecological farming Several cash crops are sold through various periods in the year	Heavy debt load at usury rates for high input requirements of monoculture cropping of sugar cane
Training	Participatory Approaches emphasizing Farmer to Farmer training on ecological farming systems	Limited training of farmers using top down government trainers teaching high input farming methods.

- Increase the capacity of local communities to manage their resource base in a sustainable manner
- Provide farming families with food security, improved health and increased income with a reduced dependence on outside assistance
- Enable more active participation of women in decision making on farms and in communities
- Reduce soil erosion and ensure the long-term capacity of the land for food production
- Improve surface and ground water quality and quantity
- Minimize the use of synthetic pesticides and reduce health risks to food producers and consumers
- Help protect and restore biodiversity
- Decrease greenhouse gas emissions through reduced fossil fuel use and minimized crop residue burning

The general characteristics of an agro-ecological village in the Philippines are outlined and compared to conventional approaches in Table 2. (Note: A similar chart is available for the dryland areas of China)

Filipino women working in the sugarcane fields in Negros Occidental.

Some of the main AEV project activities that have been undertaken (or are planned) in the Philippines and China include:

1. Baseline data gathering and surveys/case studies: This information provides the background for measuring progress in a community and provides an initial assessment of the local situation. Data is gathered from approximately 30 households per community and includes information related to income sources, food systems, farm production, schooling, housing, family health and gender issues.

Indicators that measure progress in communities are key components assessed during the baseline date gathering. They can be developed with the community through a Participatory Rural Appraisal (PRA) process. Ideally a participatory monitoring and evaluation system can be established where communities identify and track key indicators for measuring community progress.

2. Institutional Building Process: A number of approaches can be taken to enhance community awareness and organization.

Sensitization: Communities can become more aware and understanding of their local situation through a process of sensitization and exposure by community organizers. This process enables community members to share their historic situation and present-day concerns. They then can begin the process of identifying barriers for their development and ways to overcome them. Beneficiaries can also be made more aware of outside factors that may affect them such as international trading practices and climate change.

Participatory Rural Appraisal (PRA): To begin a more systematic understanding of the development needs of communities, a process of community self-examination can be undertaken by people with experience in group facilitation. PRA facilitators can use tools such as resource mapping, seasonal calendars, Venn diagrams, transect walks and mobility maps to deepen the beneficiaries understanding of their villages and individual farm situation. The PRA also furthers the process of building trust and understanding and improves communication between project staff and beneficiaries.

Community Organizers: Local people with effective interpersonal skills need to groundwork the project with beneficiaries. This may involve the investment of significant energy in the community and working with key community leaders who can collectively break apathetic attitudes that may exist. The organizers can work with beneficiaries to identify the various tasks to be managed by the community and work to gradually increase responsibilities of beneficiaries as they gain confidence, experience and capacity in managing their own affairs.

Villagers from Dingxi Community, Gansu Province, China

3. Farmer to Farmer Training: Locally adapted ecological farming training modules need to be developed. An introductory course can cover subjects such as principles of ecology, soil fertility, soil and water conservation, cropping systems (crop rotations, multiple cropping, intercropping etc), forage management, weed management, pest and disease management. More advanced courses on crop and livestock production and other subjects can follow based on feedback from the PRA and following assessments of the introductory training programs. The courses are delivered using participatory methods and using farmer trainers through a peer education approach. Typically, several first liners (experienced farmer trainers) can be used for faciliating the training along with support from a second liner (farmer trainer in training). In this way, an ongoing process of trainer development and mentorship is encouraged.

Introducing appropriate technology tools like rice weeders can help enable peasants to convert to ecological farming practices.

4. Farm Planning: Following the introductory training in ecological farming the farmers go through a basic farm planning process. It provides them an opportunity to better assess their goals and objectives and to do a more systematic planning to achieve their targets. During this exercise, farmers have peer support from other farmers in the community and the farmer trainers. The goal is not to make a complex fixed farm plan, but for farmers to begin the process of planning to better utilize and organize their on-farm resources and management skills. The basic overall plan can evolve through experience and be adjusted to local climatic and market conditions.

5. Farm Development:

Crop improvement programs: An important strategy for creating self reliant communities and advancing ecological farming is to introduce plant material improvement programs with local farmers groups. A common approach is to use farmer-run adaptability trials to test a large number of plant materials for their suitability to the local environemnt and growing conditions in different areas. Farmers can then share the results of these trials through their farmer to farmer training network and can also provide on the job coaching with mentoring of farmers to follow up on training activities. Farmer-led plant breeding programs have evolved in the Philippines with rice and corn. REAP has been successful in Negros in working with farmers organizations to identify cultivars of nitrogen fixing sugar cane and helping support development of ratooning rice varieties managed under SRI (System of Rice Intensification) that are more nitrogen use efficient. These eco-technologies can have significant long term impacts on reducing farm expenses and increasing productivity levels while enhancing soil fertility and mitigating greenhouse gases.

REAP-Canada Western China Agroecological Village Development Officer Claudia Ho Lem (left) conducting survey of villagers in China.

Appropriate technology equipment: Through the PRA process, communities can largely identify their most urgent and basic technological needs. They can also be slowly exposed to new technologies from outside the region. An assessment can be made of various options that are available to meet their needs and to gradually work with communities to assess the more promising options and further improve them. Facilities can also be constructed enabling communities to control their own production of new or local technologies. In Negros, REAP tested solar cookers, biogas systems, improved wood stoves, hay boxes (heat retaining devices) and rice hull cookers to help resolve the fuelwood crisis. Based on feedback from communities, rice hull stoves were chosen for further development. REAP subsequently produced the Mayon Turbo stove, a low cost, advanced combustion rice hull stove. Approximately 5000 rice hull stoves have now been introduced at a cost of $11 CDN/each in the Western Visayas region of the Philippines.

Microcredit Programs: Farmers in both the Philippines and China lack access to credit. However credit should be of the last things introduced during the project timeline and the least emphasized componet of a development orientation towards greater self reliance. After a community is sufficiently organized, credit programs can be provided to members based on their farm plans. Emphasis can be made on providing loans for tangible assests such as basic farm tools and animals for draft power. These loans are less risky than loans for inputs such as seed or fertilizer which are quickly utilized. In some instances, it may be necessary to provide loans for farm work during non-harvest periods if food security problems impair the ability of community members to develop their farms because of malnourishment.

III. Challenges and Lessons Learned:

Philippines: Overall, the implementing agencies and farmer beneficiaries and organizations have appreciated the developmental impact of the AEV programming. Aside from the loss of one key staff in the Philippines (who left the project because his family was facing harassment problems in his home area), the project was implemented relatively smoothly and no major barriers were experienced. One obstacle encountered in the Philippines was the slow loan repayment when the impoverished farmers had minimal income during the lean months of non-harvest or when poor weather conditions occurred.

The choice of community and staffing appeared to play key roles in the successful implementation of the project, along with the initial selection of the local project partner. It has been observed that it is essential for staff to create strong relationships with the community, gain their trust and understand their needs. The AEV project was particularly successful in the Mabuhi-pa community in the Philippines. Some of the reasons for this appear to be:

- Mabuhi-pa organization had sufficient background organizing to begin the project implementation
- A strong local community organizer lived in the community
- Strong support from the local NGO partner who had several staff with significant experience in community organizing and a similar developmental orientation

- A highly experienced farmer trainer (who has a model farm) that worked with the community and lived adjacent to it
- Strong project coordination from several staff with gregarious and enthusiastic personalities, good facilitation skills, and positive and focused energy for empowering and team building in the communities.
- The project was implemented in an area of Southern Negros where significant capacity already existed amongst local farmers and organizations in sustainable agriculture systems and farmer-to-farmer training.

China: In China the AEV model is at an early stage of implementation. Our main concern in the first year has been to strengthen capacity of local partners and farmers in participatory development processes and to develop appropriate training modules. However there is limited experience in working with farmers groups in farmer-to-farmer training networks and participatory methods. Some of the farmer groups are also somewhat passive recipients of development assistance as the government has been providing them with relatively strong support services and they have been following the government's lead. Most farmers have received limited education and training but are eagerly seeking out new information. Both the government staff and farmers recognize farmer-to-farmer training as an efficient means for information to reach larger numbers of farmers. They also recognize the increasing role of farmer leaders in community development. Our experience to date in working with the Chinese government staff is that it is relatively easy to get things done when the government decides it wants to do something. There appears to be a great sense of pride and accomplishment in making a successful project that can contribute to positive change in the region and subsequently for China. The local partners have been diligently working to implement soil and water conservation measures in the highly eroded dryland environment of north central China and the results achieved to date are impressive with large areas now under field contouring. The sloping lands are being revegetated with nitrogen fixing shrubs and naturally regenerating grasses. Technological interventions that have been successfully introduced include soil contouring, passively heated greenhouses (with night covers), biogas systems, solar cookers, and underground water cisterns. The main challenge of the project is to integrate this technical experience into a larger developmental framework. A new level of effort needs to be made in China to develop staff with expertise, experience and interest in working with communities to develop their farming systems ecologically and to develop the social infrastructure of the communities through community organizing.

IV Conclusions:

Overall, the AEV approach is a logical evolution for rural development programming that provides a more holistic and comprehensive approach for nurturing sustainable community development. Communities (rather than land areas), need to be used as the basis for sustainable rural development. Communities need to be ground worked before project implementation can begin. Village groups can be highly engaged in participatory processes through the PRA, farmer to farmer training and advisory networks for plant improvement. Through a step by step process, communities can be empowered to take ownership of their own development. Technological innovations can be introduced through both ecological farming systems development and innovations in appropriate technology. Development workers need to facilitate the strengthening of both the social & ecological infrastructure needs of communities. A positive feedback cycle can be created for social and ecological infrastructure development that can create genuine sustainable community development and the full empowerment of farmers and their support organizations.

The agroecological village development approach facilitates the development of diversifed and self reliant farms that enable impoverished households to improve their quality of life and the environment in which they live.

ECO-RICE: Radically Redesigning Rice

By Roger Samson and Candace Stryker

The 'Green Revolution' of the 1970's was led by the development of new plant genetic materials that responded favourably to intensive growing conditions with high levels of pesticide and fertilizers inputs. In the short term it led to dramatic increases in productivity. More recently, yield increases have been less than remarkable and the many problems with the green revolution approaches have been well recognized. In the case of rice farmers in the Philippines, soil fertility declined, agricultural and ecosystem biodiversity was decimated, and many small farmers suffered from serious indebtedness and health problems from using large quantities of chemical inputs.

New efforts are now underway by REAP-Canada and partner agencies in the Philippines to increase rice productivity by intensifying production using an agro-ecological approach. The approach aims to redesign the system of cultivation using perennial grasses like sugarcane as the model "grass" crop for rice development. With rice being the most important food crop in the world, increasing rice yield through the introduction of "ECO-RICE" cultivation systems could be just what is required to create substantial gains in food security, as well as improve health and reduce the indebtedness of small farmers in the Philippines and around the world. The ECO-RICE cultivation approach aims to utilize water and solar radiation more efficiently, as well as develop and strengthen biological processes important for soil fertility maintenance and plant productivity.

Leopoldo Guilaran proudly displays a new ECO-RICE release that he bred on his own farm. His breeding work for the Negros Center for Ecological Farming is supported by REAP-Canada.

Cane trash in a sugarcane ratoon crop helps control weeds, improves soil organic matter, conserves soil moisture and fixes large quantities of nitrogen for the cane crop.

The inspiration for this work came from our success developing ecological sugarcane farming systems with small farmers in the upland areas of Southern Negros in the Philippines. There were several components integrated together to make the ecological farming of sugarcane a reality. Understanding the success of ecological sugarcane lays the groundwork for understanding how and why "ECO-RICE" can become a reality. In the case of the ecological sugarcane farming, several important cultural changes were made to make the new agro-ecological sugarcane system productive and sustainable, such as:

1. Eliminating crop residue burning: Decomposing crop residues in the field helps maintain and enhance soil organic matter levels and conserves the soil moisture available for plant growth. It also helps improve nutrient cycling processes and leads to large amounts of nitrogen being fixed during the crop residue decomposition process (up to 150 kg N/ha).
2. Selecting biological nitrogen fixing (BNF) varieties through adaptability trials: 12-20 sugarcane varieties are planted on an array of local soil types used for sugarcane cultivation (frequently marginal and sloping soils) and grown without added N fertilizer. By making selections on their own farms and under low input environmental conditions, farmers can readily identify biological nitrogen fixing varieties that are well adapted to low fertility soil conditions. Previous research in Brazil indicated that there is significant genetic variability amongst sugarcane varieties for having the N fixing bacteria that live in the stems, leaves, and roots of the plant. Some varieties are capable of deriving all their nitrogen needs from this source[1].
3. Improving Ratooning: The combination of selecting for varieties of sugarcane with large numbers of tillers, in addition to the conservation of trash mulch helps improve regrowth of the ratoon crops (a crop regrowing follow-

ing a harvest). This reduces the frequency of having to replant the crop and helps maintain soil organic matter. Selecting BNF varieties and encouraging BNF during the decomposition period also enables the ratoon crops to maintain adequate N nutrition and helps impoverished farmers eliminate the need for N fertilizer.

The benefits of integrating these cultural changes are that they mutually support each other and create positive feedback cycles. For example, increasing BNF in the plant will increase productivity, which subsequently leads to increased trash production. Additional carbon contributions to the soil help increase soil organic matter and encourage soil microbial activity, which in turn improves soil aggregation and biological N Fixation.

In sum, ecological sugarcane has become successful because farmers have learned how to use adaptability trials to select for strong tillering and ratooning varieties with the Biological N Fixing (BNF) Trait, and how to incorporate these new varieties into agro-ecological farming systems.

Decomposing sugarcane trash fixes up to 150 kg of nitrogen and improves soil fertility.

Sugarcane breeders at the Suygar Regulatory Authority in Negros have developed several new sugarcane varieties that are biological nitrogen fixing and well adapted to ecological farming.

CREATING ECO-RICE

Several cultural changes are also being integrated to bring about ECO-RICE Development. The three main system components being integrated to develop ECO-RICE are:

1. System of Rice Intensification (SRI)
2. Lock Lodge Ratooning
3. BNF and/or Nitrogen Use Efficient Varieties

A brief understanding of these components is necessary to understand how they can function together to increase rice productivity.

System of Rice Intensification: Optimizing the environment for the Plant*

Currently there is a great deal of interest in SRI production systems because they can produce considerable increases in productivity[2]. However, unlike the green revolution, SRI is not chemically intensive but is more management intensive. The SRI system evolved in Madagascar in 1983 by a priest, Fr. Henri de Laulianie, who sought to create the best possible growing environment for rice. The main findings of his work that are critical to increasing productivity are:

1. Rice is not an aquatic plant: Although rice can survive when grown under flooded conditions, it does not thrive. Under continuous submergence the rice roots remain shallow (largely in the top 6 cm of soil) and largely degenerate by the seed-producing phase of growth. For optimal growth, rice should be kept in a well-drained soil during its vegetative growth phase.
2. Transplanting individual seedlings to the field early (not later than 15 days): This practice enables the full growth potential of individual plants and encourages a large number of tillers and bigger individual plants (Conventionally transplanted rice is planted in small groups of seedlings one month after sowing).
3. Wide spacing of plants will lead to greater root growth and increase tillering. SRI rice is planted as single plants in 25-50 cm rows. This minimizes competition and enables plants to develop large deep root systems.

Rice ratoooning: closing the yield gap by continual harvesting sunshine

One of the outstanding advantages of introducing "Green Revolution" seeds and synthetic nitrogen (N) fertilizer inputs was the overall shortening of both the period of rice cropping and the downtime between cropping cycles. Under conventional rice management systems in the Philippines, rice now matures in approximately 90-100 days. After harvest, the straw is burned and the field reworked for planting the next crop during a period of approximately 10 days. Synthetic fertilizers are applied to drive the N cycle for the subsequent crop. While these practices can be considered unsustainable over the long term, in the short term they lead to high productivity.

The ecological production system used under traditional rice farming systems is based on less intensively cropped soil and later maturing cultivars (typically of 110-120 days; which allows more time for soil mineralization processes to liberate N to the growing crop). A 30-day period for decomposition of crop residues is recommended to avoid N immobilization by the decomposing straw in the next crop, and to encourage asymbiotic N fixation processes in the soil. Overall, the ecological rice farmer has a cropping cycle of approximately 145 days as compared to 105 days in the case of the conventional rice production system. Yields are similar for conventional and ecological rice production (after farmers have gone through the initial organic transition process), however the longer production period for the ecological rice places it at a disadvantage in terms of overall rice productivity during the year. A promising means to address this problem and reduce production costs is the introduction of rice ratooning. Ratooning is a practice that allows a new crop to emerge from the residual stubble without having to rework the soil. Ratooning was a popular practice of rice farmers in the Philippines prior to the Green Revolution, and is now regaining popularity in areas of the United States with short growing seasons as a means of double cropping. Recent research on the new ratooning technique of lock lodging (where stems are broken over at the base) has increased yields by 95% compared to conventional ratooning when the crop is mowed and allowed to regrow[3]. Under lock-lodging, yields of promising ratooning varieties are approximately 75% of conventionally grown crops. A lock-lodged rice crop has an established root system and carbohydrate reserves in residual stems and leaves which are important for a rapid regrowth of the crop canopy to occur[4]. Lock-lodge ratooning advances the harvest cycle by about 25-35% compared to a conventionally prepared crop (10 days between crops) or 35-43% when a 30-day period for straw decomposition is practiced. In terms of kg grain produced per day, lock-lodging has demonstrated the potential to produce equivalent yields as compared to conventionally grown rice[3]. Breeding and selection of plant materials for lock-lodging would probably further improve the relative performance of lock-lodged rice above conventionally produced rice. Significant advantages to farmers include reductions in


ECO-RICE selections are made under low fertility soil conditions which enable farmer breeders to readily identify rice strains with improved N nutrition.

Conventional High-Yielding Rice

95 days growing | 10 days fallow | 85 days growing | 10 days fallow | 85 days growing = 285 days (3 crops)

Organic Rice

115 days growing | 30 days fallow | 110 days growing = 255 days (2 crops)

ECO-Rice

115 days growing | 80 days ratoon | 80 days ratoon = 275 days (3 crops)

Leopoldo Guilaran is a master trainer and farmer breeder of the Negros Center for Ecological Farming. He is selecting ECO-RICE strains that can be grown without added N fertilizer, have strong tillering capacity, ratoon well and are adapted to the SRI planting system with wide plant spacing.

input costs of 50-60%[5], reduced indebtedness (as harvest cycles are faster and input requirements lower), reduced labour and farm draught animal requirements, greater cropping flexibility, and reduced risks for crop losses from severe typhoons and droughts. The major risks of ratooning are increased pest and disease pressure[6]. Ecological rice varieties may prove more effective than conventional rice plant materials as they are heavily screened for resistance to pests and diseases through breeding for horizontal resistance[7].

Biological Nitrogen Fixation in Rice

One of the most outstanding challenges of ecological rice production is managing N fertility. This task is even more daunting when rice is managed in a ratooning cycle. In ecologically grown ratooning sugarcane crops, N requirements are met by N fixation in decomposing trash and from planting BNF fixing varieties. Our initial experience is that selection of rice for BNF and/or efficient N using varieties can be best achieved if the rice is selected under SRI management and unfertilized conditions. Under SRI, the system produces larger plants and volumes of biomass, as well as aerobic soils conditions that support beneficial bacteria. Having a nitrogen limited soil environment enables the plants to better express their differences in adaptability to N restricted growing conditions.

ECO-RICE: Developing the System in the Field

REAP is collaborating with the Negros Center for Ecological farming (NCEF) to develop ECO-RICE systems on small farms in the Western Visayas. NCEF farmer/plant breeder Leopoldo Guilaran is spearheading the fieldwork with a number of advanced strains of ECO-RICE. These strains have been selected for high tillering capacity, improved N nutrition, productivity, disease and pest resistance. Farmers are now beginning to cultivate and developed ECO-RICE strains, and are gaining experience in incorporating both SRI and lock lodging management production systems. It is evident to small farmers that the new ECO-RICE system can dramatically reduce their production costs, as well as give them more cropping flexibility. If the season is dry the ratoon cycle can be shortened to one cropping and the field planted to more drought tolerant crops such as soybeans or peanuts. In a good rainfall year, ECO-RICE farmers should be able to get three rice crops per year in about the same time period as a conventional high-input rice farmer. ECO-RICE However, they would do so without the two cycles of crop residue burning, and the production costs for animal draft power, seed, and production inputs.

The main challenges to the system will be increased potential for pest and disease problems in the main rice growing regions. The best results therefore will likely be introducing ECO-RICE to diversified farming regions where rice is not the dominant crop in the region. The challenge now will be to see if small farmers will adopt the ECO-RICE system. With the many advantages ECO-RICE seems to offer for increasing productivity while also reducing poverty, it is hoped that it will stimulate further research and eventually become a mainstream reality.

References

1. Triplett, E.W. 1996. Diazotrophic endophytes: progress and prospects for nitrogen fixation in monocots. Plant and Soil. 186: 29-38.
2. Rabenandrasama, J. 1999. The Madagascar System of Rice Intensification: A Revolution in Rice Production. Enhancing Sustainability of the Rice Economy in the Philippines: Workshop Proceedings. P. 126- 130.
3. Mohan, R., L. Aruna, J. Ram Mohan and R. Poonguzhalan. 1998. Lock-lodge Technology for Rice Ratooning. International Rice Research Notes Volume 23 # 3. P. 24.
4. Turner, F.T. and M.F. Jund. 1993. Rice Ratoon Crop Yield Linked to Main Crop Stem Carbohydrates. Crop Sci. 33: 150-153.
5. Rolodge Advance Rice Ratooning Technology, 1998. INK "http://www.geocities.com/RainForest/2923/p18.htm" http://www.geocities.com/RainForest/2923/p18.htm
6. Bahar, F.A. and S.K De Datta. 1977. Prospects of Increasing Tropical Rice Production through Ratooning. Agron. J. 69: 536-540.
7. Robinson, R. 1999. Return to Resistance: Breeding Crops to Reduce Pesticide Dependence. Ag Access, Davis, California. 480 pp.

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