PAPER ON ENVIRONMENT, CLIMATE CHANGE AND FOOD SECURITY IN ASIA

Submitted to

Fourth Session of the Technical Committee of APCAEM
10-12 February 2009, Chiang Rai, Thailand

By

Dr. M. Aslam KHAN
Professor
Department of Geography
University of Peshawar, Peshawar, Pakistan

Introduction[1]

The United Nations Asian and Pacific Centre for Agricultural Engineering and Machinery (APCAEM) aims at promoting sustainable agriculture development for the eradication of poverty by guaranteeing environmental sustainability. Such agro-based environment- friendly technology is considered as Green Technology (GT).

Literatures show GT encompasses a continuously evolving group of methods or materials, from techniques for generating energy to non-toxic cleaning products. It is that innovation which reduces waste by changing patterns of production and consumption. It is also defined as environmental healing technology, which reduces environmental damages created by the products and technologies for peoples' conveniences. Most of the businesses may not be very excited to "go green" by reducing emissions since their motto is to make money not to save the planet. The global strategy should be to help businesses do both.

Objective

The overall objective of the study was to conduct feasibility study by summarizing the overview of the status of the application of GT in selected member countries of APCAEM. The specific objectives are:

1) Identifying appropriate technology suitable for income generation through sustainable agriculture i.e., ecological agriculture, rural renewable energy, etc;
2) Examining the impact and implications of national policies for making recommendations for the extension of appropriate technology;
3) Diagnosing policy-level impact of GT on rural income generation under the sustainable agriculture development framework;
4) Reviewing the challenges and available policy options for the adoption of GT

The objective was also to initiate GT for bringing innovation and changes in daily life by meeting the needs of present generation without damaging or depleting biodiversity for the future generation. The present study therefore, explains link between the applied technologies and their relationships with environment-friendly agriculture; poverty reduction; rural environmental concerns; rural income and gender dimensions.

Methodology

The feasibility study attempts to identify the gaps in the application of GT and explores the viability for their application based on the results from experiments through agricultural and environmental technologies. The study identifies and assesses appropriate technologies; reviews policies; reviews impact assessment and recommends available options. The GT application is reviewed by further

---

[1] Present paper is based on author's work completed for UNAPCAEM. The author would sincerely like to acknowledge the invaluable contributions made by Professor WANG Maohua from China, Dr. S.K. Tandon from India, Prof. G. Gantualga from Mangolia, Dr. S.K. Adhikari and Dadhi Adhikari from Nepal, Dr. Kwang-Jae CHOE from ROK, Dr. Nguyen Quoc Viet from Vietnam, Prof. Ping Chang, and Ms. Zhaorui Meng of UNAPCAEM on the original version of the report.

elaborating the issues on how this technology can raise farm income, conserve biodiversity, acknowledge women's participation and justify the sustainability of Mother Nature.

As reliable data on emerging technologies for sustainability assessment are still inadequate, the recommendations are largely based on qualitative methods and on an operational definition of sustainability using priority indicators. Furthermore, the review of selected regulatory measures in the chosen countries is made to find out their strength and weaknesses to facilitate GT initiative. Recommendations are made to develop favorable regulatory frameworks for the further development of GT.

Technology has been selected on the basis of seven criteria suggested by Robert C. Wicklein in his paper entitled, "Design Criteria for Sustainable Development in Appropriate Technology: Technology as if People Matter" (http://www.iteaconnect.org/Conference /PATT/PATT14/Wicklein.pdf). The criteria are:

1. System independence
2. Image of modernity
3. Individual technology vs. Collective technology
4. Cost of technology
5. Risk factor
6. Evolutionary capacity of technology
7. Single purpose and Multipurpose technology

The study involves consultation with relevant stakeholders to properly assess the overall value of GT application. The situation analysis of GT in general in selected member countries of the United Nations ESCAP and evaluation of the good practice model of the application of GT in selected areas in the proposed countries, namely; India, Malaysia and Nepal is expected to have produced the practical guidance for policy decisions in the subsequent phase (II) of the project with regards to the development and delivery of best practice model.

The present study shows that the adoption of GT has increased agricultural output without depleting presently available resources beyond the point of recovery. This study also found that solar photovoltaic, wind energy, biofuel, biogas, micro & small hydropower, biomass, solar thermal, improved water mill, geothermal energy, bio transgenics, organic farming, integrated pest management (IPM), agro forestry are some of the most feasible technologies in the APCAEM member countries.

This study has made situation analysis of selected technology on the basis of following indicators:

1. Current Performance
2. Policy
3. Cost benefit
4. Performance Indicator

Green Technology and their Interlinkage

The demand for cereals in the developing countries is expected to increase by 59% in the next 25 years but the growth rate in cereal yields has declined alarmingly (Janvry, Graff et al., 2000). The major question today is to increase the yield by devising the technology that will save the environment without sacrificing growth. The case for alternative agriculture technology is therefore realized to meet huge global demand. The advances in solar, wind, bio-energy and energy efficiency design has speeded up the development of technology-driven energy and cost efficiency mechanism to justify economic growth.

There is a link between poverty reduction and growth in productivity. The productivity can be increased if local knowledge is combined with the improvement in technology to meeting particular conditions. The irrigation of deserts is proved to be economically feasible and desirable to upgrade low productivity marginal lands into higher productivity land through the improvement and development in technology. As yield increase has been an important source of growth, FAO estimates over next couple of decades, about 80 per cent of the production expansion will be linked with yield increases and about 20 per cent with agricultural land expansion (http://www.fao.org/Wairdocs/TAC/X5784E/x5784e08.htm). This reiterates the importance of the proposed feasibility study.

The wastewater and sewage disposal has been major threat to human health in developing Asia. The liquid waste discharged by domestic residences, commercial properties, industry or agriculture generates potential contaminants and concentrations that to some extent is minimized or recycled in the developed world. It necessitates the adoption of available and affordable technology for renewable energy including sunlight, wind, rain, and geothermal heat, which are naturally replenished. The technologies that are available are solar power, wind power, hydroelectricity/micro hydro, biomass and biofuel for transport.

Data shows agricultural land being increased by 13 per cent in the last 30 years at the expense of lowland forests and their rich biodiversity. With virtually no reserves of land with crop production potential, Asian Development Bank's (ADB) estimate shows that land use per person will fall from 0.17 hectares in 1990 to 0.12 hectares in 2010 (http://www.adb.org/Documents/Conference/Technology_Poverty_AP/adb5.pdf). Furthermore, the pressure from worldwide urbanization, manufacturing and population growth necessitates a renewed commitment to clean energy and environment solutions. The need is a balanced mix of alternative energies and the development of new technologies. The skyrocketing costs of energy and agricultural inputs have reduced profitability, which has severely damaged the environment. This necessitates the proper assessment of the constraints and potentials of natural resources by examining policies of respective governments, and appropriateness of agro-technologies. The development of biotechnology is therefore, recommended to properly assess socioeconomic, food security and environmental impacts for helping the poor rural communities for maintaining sustainable agriculture.

Globally, including the Asian and Pacific Region, major agro-technological changes have been noticed. Such changes have been in agronomic practices; developing crop varieties with increased resistance to various diseases and pests; fertilizer-use and water conservation technology; and technologies making cultivation suitable under various agro-climatic conditions. As a reference to environment-friendly technology, organic agriculture has been considered as the fastest growing fields of the food sector. Therefore, organic agriculture has become a niche market since it forms 1%-2% of the total food market share (http://209.85.175.104/search?q=ccache:/W513sqG3UwJ:orgprints.org/9431/01/9431_Pali_Poste_r.pdf+9431&hl+ne&ct+clnk&cd+2&ql+np&client=firefox-a) and demonstrates a popular case for organically managed land practices.

Studies show every 1% increase in per capita agricultural output led to a 1.61% increase in the incomes of the poorest 20% of the population. On average, every 1% increase in agricultural yields reduced the number of people living on less than US$1 a day by 0.83% (Thirtle et. al., 2001). Hence, development of agriculture sector, defined in terms of increased production with decreased average cost, becomes prerequisite for the overall development of an underdeveloped economy.

The revolution in Information Technology for precision farming, applied research in understanding ecological systems as production ecology and gene revolution for advancement in biotechnology have brought about major technological changes in agriculture. Although the technologies are available such as, the biotechnology, genetic engineering etc, the challenge is to determine the most suited and affordable technology by developing market mechanism for making applied technology competitive and sustainable.

In some countries government purchasing is encouraged for the products whose contents and methods of production have the smallest possible impact on the environment (http:/www.green-technology.org/what.htm). In recent years, much more emphasis has been given in linking environmental factors with diversified development activities. For example, the terminologies, often used as "green building", or "high performance building", and or "sustainable building" address the impact of technology on environment. It is found that energy, water, and materials are used so efficiently while constructing the structure, it not only support the longer lifetime of the structure alone, but also the health and productivity of occupants.

The fundamental concern of any technology is its sustainability. Some popular experiments are carried out in South Asia as a simple tool for income generation. For instance, in Bangladesh, the mobile-lady offer door-to-door services in the village by taking the water testing kit for testing of water pH. They read the water pH meter measurement and explain the status of shrimp ponds for healthy harvests. They also offer additional information to the farmer and soil pH testing is one of such services provided to crop cultivators. The mobile lady thus connects communities to the tele-centres. In the absence of mobile-lady, the farmers would either spend 2500 Taka or travel long distance to get such services (http://www.sustainabilityfirst.org/2007/07/mobile-lady-story-of-women-empowerment.html).

It is sad to note that although rural women are responsible for half of the world's food production and produce between 60 and 80 per cent of the food in most of the developing countries; their contribution to global food security is not properly recognized and is overlooked in development strategies (http://www.fao.org/GENDER/en/agri-e.htm). The indigenous people especially the vulnerable women who live in a risk-averse mindset and work in under-resourced and under-privileged region of Asia need to be supported by modern technology to combat fragile ecosystems and other related externalities. This necessitates linking gender issues in policy documents to support women from poverty reduction and food security perspectives.

Status of GT in APCAEM Member-Countries

(Nepal, India and Malaysia)

The world is realizing country-specific budgetary constraints and the failure of development assistance to make poor people's life better. For this obvious reason, development critiques have been asking the question "can development be exported"? Therefore, the big hope of utilizing indigenous local resources is green technologies. This alternative can be sustainable, which generates employment and increases income.

Globalization has contributed to the decline in the demand for cereals and pulses in food basket. There is a higher demand for high-value crops such as fruits, vegetables, milk, meat, livestock products, egg, fish and other processed commodities. High transaction costs per unit of output and tough conditionality of importing countries have undermined the gains from agricultural trade in general. Poor countries have not been competitive due to the inadequacy of skill, capital, technology and required regulatory measures.

South Asia faces constraints in the governance of biotechnology. Therefore, the regulatory measures need to be strengthened for the effective management of bio-safety. India initiated biotechnology as a tool for the growth of agriculture and health sectors since the Sixth Five Year Plan (1980-1985) period. Biotechnology in India has helped sustaining cotton production and also the development of virus-free potato seed, banana and micro-propagation of sugarcane through tissue culture.

In Nepal, biotechnology policy focuses on food security and poverty alleviation. As this policy largely emphasizes on the agriculture sector, the government intends to provide easy and affordable access to biotechnology products and appropriate inputs such as bio-fertilizers etc to the agriculturists. In principle, biotechnology should mean recombinant DNA technology and tissue culture for the development of improved products; its application is however, limited to tissue culture propagation of few economic plants such as, potato, banana, citrus and the development of animal vaccines.

Nepal is overwhelmingly an agricultural country with more than three-fourth of its people adopting agriculture as their occupation. Nepalese agriculture is heavily based on forest. Traditionally, there has been close link between agriculture, forest and livelihood of Nepalese poor. Developments in renewable energy sector of Nepal offer opportunity of cross cutting amalgamation of rural (renewable) energy sector and agriculture sectors. Examination of the possible nexus can suggest strategies for green and sustainable agriculture. Modern biotechnology especially in agriculture has helped to do things that people could not do before. To give some examples, the technology has produced first generation of Genetically Modified (GM) crops such as herbicide-tolerant and insect-resistant crops. The examples of second-generation plants are the nutrient content like vitamin A-enriched rice and oils that have improved lipid profile. The third generation plants are being developed to provide specific health benefits (http://findarticles.com/p/articles/mi_qn6207/is_/ai_n24373048). Although we find complaints about the health and environmental problems from GM crops, it has not yet been proved. Instead, the benefit of technology is much higher since it can contribute to increasing GDP, protecting biodiversity from excessive expansion of agricultural land and safeguarding human and animal health by reducing the use of agrochemicals.

To develop the regional and global competitiveness, Malaysia is commercializing the technologies through the Bio-valley Strategic Plan. As biotech thrives on innovation, the Bio-valley is a centralized development area for biotech with incentives for entrepreneurial culture, cooperative development, and collaboration between academic institutions, industry, and investors both within Malaysia and overseas. The aim of biotechnology policy is to transform and enhance the value creation of the agricultural sector and make impact on human life and economic progress. Under this policy, the scientists are actively engaged in fermentation based activities, production of valuable biologicals, plant or animal cell culture, value addition, and genetically superior planting materials (http://www.dbtindia.nic.in).

Surveys conducted over 2,000 manufacturing companies in Malaysia reveals that several factories have already started to save energy costs (http://eib.ptm.org.my/index.php?page=article&item=98). It opens up opportunities to companies that can offer energy management services for identifying ways to save energy and costs. The Academy of Sciences Malaysia (ASM) assists in upgrading the technological capabilities and competencies in the industry. A report from USAID estimates that total energy efficiency market in Malaysia will increase to US $ 557 million by 2015 from merely US $ 167 million in 1996. The fiscal incentives need to be strictly implemented to encourage renewable energy and energy efficiency technologies through investment tax allowance and import duty and sales tax exemption for the equipments used in energy conservation.

In Malaysia, the data on the quality of air and water are available on-line and on-demand basis by any individual particularly those having asthmatic and other environment-health related problems. The ICT Application in Environmental Governance in Malaysia project has proven the Best Practice in the Application of Information and Communications Technology (ICT) for Environmental Governance. It is unique in the sense that this project is considered as the only known privatized program for monitoring the quality of air and water on-line and on continuous basis (http://www.stockholmchallenge.se/data/itc_appl_in_environmental). It gives hope for replication in other member countries.

Almost 70 per cent of Indian population depends on agriculture, which is one of the energy intensive sectors. Agriculture consumes about 35 per cent of the total power generated through electrically operated pump sets. It is expected that about 30 per cent of savings is possible through appropriate technology. For example, larger valve can save fuel and power to draw water from the well. It has been shown that the farmers can save 15 liters of diesel every month by simply reducing the pipe height by 2 m. The use of good quality PVC suction pipe can save electricity up to 20 per cent (http://www.nedcap.org/index_files/Page2210.htm).

Feasible Green Technologies

The study identifies selected feasible technologies. Solar photovoltaic technology for instance, converts sunlight into electricity using semi conductor modules. Used generally for meeting lighting requirements, they can also be used for pumping water, refrigeration, communication, and charging batteries. Solar photovoltaic has application as green agricultural energy source for pumping water, street lighting in villages, lighting in rural houses and pest management.

Solar photovoltaic technology converts sunlight into electricity using semi conductor modules. Solar photovoltaic has application as green agricultural energy source for pumping water street lighting in villages lighting in rural houses and pest management (BCSE, 2004). In India daily solar incidence varies from 4-7 kWh per square meter depending on the location and averages to 5.5kWh (MNRE, 2008). In Malaysia monthly average solar radiation is 4000 to 5000 Whr/m^2 and solar energy received in a year is 16 times the annual Malaysian conventional energy requirement (EcoSecurities, 2003). Solar map developed by Centre for Energy Studies (CES, 2005) shows 7kWh/sq.m/day average annual Global Horizontal Solar Irradiance in Nepal.

Wind energy is in a boom cycle. Overall, wind energy contributes only 1% of global electricity generation, but some countries and regions are already producing up to 20% (http://eib.ptm.org.my). Its importance is increasing in the sense that comparatively with other sources; the wind energy produces less air pollutants or greenhouse gases.

Biofuel as bio-ethanol and bio diesel have the potential to assume an important portfolio in future energy platter. Food security concerns and risks to environment and biodiversity are parameters that necessarily need to be assessed while analyzing sustainability linkage of agriculture and biofuel. Also, conversion of wasteland to farmland with some crop options can be viewed as positive impacts. This area is going to be the hot cake for future research.

In India, if all available sugarcane molasses is utilized 0.8 million kilolitres of ethanol thus produced can replace 9% of current petroleum requirements. India also estimates to have 3.1million hectares of Jatropha plantations by 2009 (http://www.finfacts.com/irelandbusinessnews/publish/article_1011463.shtml). One hectare of plantation in average soil gives 1.6 tons of oil.

Biogas is the product of anaerobic digestion of organic matters by methanogenic bacteria. Biogas qualifies on the merits that this technology utilizes organic agricultural waste and converts it to fuel and fertilizer. Direct impacts of biogas are fuel-wood, agriculture residue, livestock manure, and kerosene savings. Increases in soil fertility and crop production have also been observed.

Hydropower plants ranging from maximum capacity of 500 kW in Nepal to 25 MW in India are conceived renewable. Generally used in rural electrification, hydropower plants can take an equally important role in facilitating irrigation and value addition at source of agricultural products.

Agriculture residues and wastes are converted to electric and thermal energy through processes like combustion, gasification, and cogeneration. **Biomass** technologies compliment mainstream crop production and reduce or completely replace consumption of traditional fuel. Experiences of some APCAEM countries portray biomass to be effective means of increasing agricultural revenue and conserving exhaustible resources.

Improved **Water Mills** (an intermediate technology based on principle of traditional water mills) in Nepal have made milling efficient (up to 3kW can be generated) and reliable, by also increasing the income of millers. In Nepal, 25,000 traditional mills are still in operation (http://www.aepcnepal.org).

Geothermal technology has potential in China, Thailand, and the Philippines. A geothermal power plant not only generates electricity but also produces hot water for cold storage and crop drying.

The use of **bio transgenics** (BT) also referred to as Genetically Modified Organisms (GMO) has been growing at 45% per annum in developing countries which now account for 39% of 103 million hectares planted worldwide (Pehu et. al, 2007). Mostly in India and China, 9.2 million farmers planted BT cotton on 7.3 million hectares in 2006 (Ibid). Recent developments such as the modified high yield oil seeds can trigger rapid spread of transgenic crops.

Most **transgenic technologies** are under research and development phase and comprehensive results have not yet been ascertained. Among food crops few like rice, eggplant, mustard, cassava, bananas, sweet potato, lentils, and lupines have been approved for field testing in one country or the other, while some like BT Maize (mostly for feed) in the Philippines, publicly developed transgenic vegetables in China are allowed for cultivation.

Organic and biodynamic farming systems have soils of higher biological, physical, and in many cases chemical quality than that of conventional counterparts. When productivity in terms of inputs applied and outputs obtained and social costs of conventional farming are considered, organic alternative has been found to be significantly economical.

Identifying **Integrated Pest Management** (IPM) as a knowledge intensive approach dichotomous to conventional chemical intensive approach best serves the purpose of this research. IPM, especially through initiative like Farmer Field School programs where farmers are envisaged experts with their expertise emanating from routine hits and trials, interactions, and trainings have both empowered farmers and maintained agricultural and environmental balance.

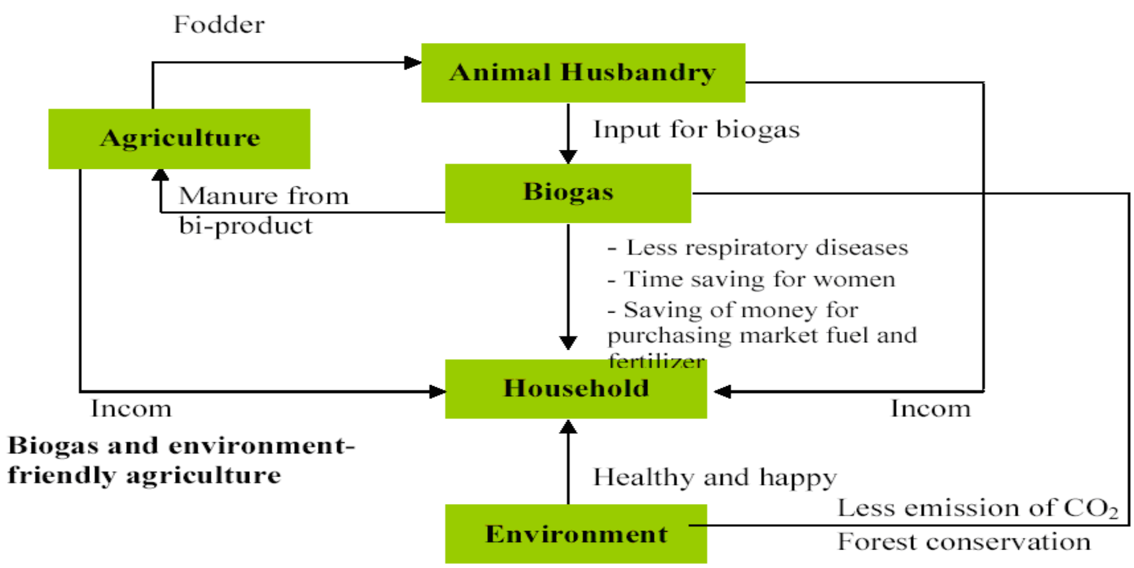
Precision agriculture uses **ICT** to cover the three aspects of production namely for data collection of information input through options as Global Positioning System (GPS) satellite data, grid soil sampling, yield monitoring, remote sensing, etc; for data analysis or processing through Geographic Information System (GIS) and decision technologies as process models, artificial intelligence systems, and expert systems; and for application of information by farmers.

Good Practice Model

Nepal-Biogas

The best practice model in Nepal has been the Biogas and agro-forestry. Biogas has link with agriculture, forest, environment and overall livelihood of the people. It is capable to increase income of people, save environment and health and contributes managing time for women and children.

Figure 1: Sustainability and Biogas



Biogas has direct and indirect impact on poverty reduction through improved health status, time saving for woman, cost saving for fuel and fertilizer. From the environmental standpoint biogas contributes in conservation of forest resources, reduces indoor pollution, decreases greenhouse gas emission, and helps in cutting down the use of chemical fertilizers. As shown in table 1 below, since methane combustion is smokeless and non-toxic, biogas as cooking fuel significantly improves household environment.

Table 1: Net greenhouse gas saving per digester in Nepal (tCO_2 / biogas plant/year)

Size of plant	Terai	Mid-hills	Average (Terai and Hills)
4 m^3	3.17	5.75	4.46
6 m^3	7.27	8.00	7.63
8 m^3	9.33	9.94	9.63
10 m^3	7.44	7.87	7.65
Average of all sizes			**7.35**

Source: (Pandey 2005)

Benefit of biogas is estimated to be very high in comparison to cost. Following table summarizes basic elements of cost benefit analysis.

Table 2: Summary of cost and benefit of biogas

Cost	Benefit
Installation cost	Time saving for women
Maintenance cost	Reduced expenditure for kerosene and other fuel
Transaction cost for searching	Conserved forest
	Manure for farming
	Less use of fertilizer
	Reduced respiratory dieses
	Income from CO_2 fund

Biogas has been feasible technology due to following point of technology evaluation as explained in methodology.

Table 3: Evaluation of technology for adoption

Characteristics	Impression	Reason
System Independence	Yes	Less capital is required, available through subsidy
Image of Modernity	Yes	People feel proud after installing it
Individual vs Collective	Collective	Individual during installation, collective for maintenance and operation
Cost of Technology	Low	Relatively less than other source of energy
Risk Factor	Very low	After sales service is readily available
Evolutionary Capacity	Very high	Increased restriction of using forest product and scarcity and expensive hydroelectricity
Single and Multi Purpose	Multipurpose	Cooking, lighting, manure and even to run small rice mill.

Nepal-Agro forestry

Agro-forestry as a sustainable land-management system, increases the overall yield of the land, combines the production of crops (including tree crops) and forest plants or animals simultaneously or sequentially on the same unit of land and applies management practices that are compatible with the cultural patterns of local population.

Growing trees on farm is common practice in Nepal. There are several theoretical and empirical evidences to show the impact of agro-forestry on sustainable and environmental friendly agriculture, income generation and poverty reduction in rural area and positive impact on gender. Agro-forestry is more profitable than forestry or agriculture alone, and may have a number of social and organizational advantages (Amatya and Newmann, 1993).

Table 4: Net benefit from agro-forest, agriculture, and forest

Net benefits ('00000 NRs/ha)

Year	Forestry alone	Agriculture alone	Agroforestry
1	-0.37	0.1	-0.25
5	0.02	0.095	0.09
10	0.02	0.095	0.12
20	5	0.085	7.085

Source: Adopted from Sharma, 2007

Like biogas, agro-forestry also has excess of benefit over cost as shown below:

Table 5: Summary of cost and benefit of agroforestry

Cost	Benefit
Initial investment	Income of farmer
Opportunity cost of land	Improved social wellbeing
Marketing cost for forest product	Improved environmental quality
	Reduced threat from pest, insect and animal on other crop
	Women empowerment

India-Jatropha

India is second highest populated country with one of the highest growth rate in the world. This necessitates high demand for energy. India's energy demand is expected to grow at an annual rate of 4.8 per cent over the next couple of decades (Gonsalves, 2006). Most of the energy requirements are currently satisfied by fossil fuels – coal, petroleum-based products and natural gas. Domestic production of crude oil can only fulfill 25-30 per cent of national consumption (Ibid). Therefore, India is promoting jatropha. Major attraction of Jatropha lies on its growing capacity even in saline, marginal and infertile soil. Since it can grow without water, drought has no impact on it. Furthermore, it requires little maintenance that in turn reduces cost of production.

There is worldwide debate over usefulness of biofuel. Many scholar suspect that biofuel feedstock may take away arable land from food grain production. This will have negative impact on poverty and food security. But Jatropha is free from this charge. Jatropha production has very high potential to ensure environment-friendly agriculture.

Some of the elements of exhibiting attribute are:

- Less use of fertilizer and pesticide
- Reduce emission of green house gasses
- Maintains the soil fertility
- Pleasant landscape through intensive farming
- Reduce soil erosion

Similarly Jatropha require low initial investment, reduce working hour in farm (it has direct impact on welfare of woman). Jatropha can be grown in the land whose opportunity cost is zero.

Although Jatropha has been taken as boon in India, some important problems have also been identified.

Following are the problems revealed by farmers regarding Jatropha cultivation (Dhanda, 2004 cited in Gonjalves, 2006).

1. Lack of confidence in farmers due to the delay in notifying, publicizing and explaining the government bio-diesel policy
1. No minimum support price
2. In the absence of long-term purchase contracts, there are no buy-back arrangements for purchase centres for Jatropha plantations
3. Lack of availability of certified seeds of higher yield containing higher oil content

4. No announcement of incentives/subsidy and other benefits proposed to be provided to farmers
5. Non-availability of cultures of Jatropha

Table 6: Summary of cost and benefit of jatropha

Cost	Benefit
Direct production cost	Income of farmer
Opportunity cost of land	Improved social well being
Reduced income of petro-product seller	Improved environmental quality
	Reduced threat from pest, insect and animal on other crop
	Reduced risk from oil price and import shocks

Table 7: Evaluation of technology for adoption

Characteristics	Impression	Reason
System Independence	Yes	Less capital is required
Image of Modernity	Yes	Relatively new concept so people will not hesitate to adopt in the ground of social prestige
Individual Vs Collective	Collective	For economies of scale people will have to grow collectively
Cost of Technology	Very low	Only labour is the significant input
Risk Factor	Very low	Little will be at stake as it is grown in marginal land
Evolutionary capacity	Very high	Fuel shortage in India will expand the Jatropha production
Single vs Multi Purpose	Multipurpose	There are many use of Jatropha. Jatropha is not only a cash crop but also technology to save environment and fill the gap of energy supply

Malaysia-Biomass

Biomas is available on a renewable basis through forest and mill residues, wood wastes, agricultural crops and wastes and animal wastes etc. Because of the high sunlight intensity and high rainfall, production of biomass is possible throughout the year. Major contributor of biomass is palm oil industry, mainly lingo-cellulosics.

Wood residues, palm oil waste and agricultural waste are being converted into usable forms of energy for heat generation. Increased utilization of such renewable energy including biomass and municipal waste has worked as a means of pollution control

Table 8: Potential power generation from oil palm residues at palm oil mills in Malaysia (Year 200)

Type of Industry	Production ('000 Tonne)	Residue	Residue Product Ratio (%)	Residue Generated ('000 Tonne)	Potential Energy PJ	Potential Electricity Generated (MW)
Oil Palm	59800	EFB at 65% MC	21.14	12641	57	521
		Fiber	12.72	7607	108	1032
		Shell	5.67	3390	55	545
	Total Solid			16670	220	2098
	POME (3.5 m^3 per ton of CPO/65% of FFB)			38870		320

Source: Malaysian Oil Palm Statistics, 2002, 22nd Edition, MPOB.

National Policies for GT: Impact, Implication and Challenges

With regards to the policy in the studied countries, Nepal for instance, has neither separate nor umbrella policy for enhancing GT. Periodic plan document is the major source of policies. Currently, Nepal has concluded the Tenth Five Year Plan (2002-07) and executing the Three Year Interim Plan (TYIP) (2007/08-2009/10). In the TYIP, there are several disaggregated objectives and policies that may influence the adoption and expansion of GT.

India is one of the neediest countries for renewable energy resources. India's goal is to add 10,000 MW in the power generation capacity through sources of renewable energy. With the purpose of expanding renewable energy, India has brought several policies and programs including "New and Renewable Energy Plan" under the proposed 11th Plan, Electricity Act, Renewable Energy Act etc. The Renewable Energy Act has been formulated to meet 20 percent of the country's total energy requirement by 2020 (Ghosh, NA).

Malaysia's Green Technology revolves around renewable energy. Agriculture sector is only the third large sector which contributes only 8.2 percent to the GDP. This share is heavily dominated by oil palm that is largely produced for biofuel. The country has new energy policy (5th Fuel Policy). The basic principle is to promote new sources of renewable energy to supplement to the conventional supply of energy. The fuel diversification policy which includes oil, gas, hydro and coal will be extended to include renewable energy as the fifth fuel, particularly biomass, biogas, municipal waste, solar and mini-hydro.

Malaysia's Five Fuel Diversification Policy provides the renewable energy policy guidance while the current grid-based small renewable energy programs or SREP (Small Renewable Energy Program), embodies national renewable energy strategy. The Government provides both investment incentives and tax exemption for promoting renewable energy.

There is a consensus that although there is a strong business case for "sustainability", it is one of the most difficult and complex tasks to balance between environmental and business concerns. There is a problem in balancing between the societal benefits of "green" practices and regulations with their costs.

The Inter-governmental Panel on Climate Change (IPCC) in its Fourth Assessment Report outlines human activity for creating scary effects of climate change to damage the world environment. The global temperature has risen by 1.8-4°C and sea level rise of 18-59 cm is expected by the end of the century. This scenario necessitates the early success in deploying renewable carbon-free technologies by moving away from the coal and oil based economy to low carbon economy including solar, wind, nuclear, bio-fuels, hydroelectricity, batteries, hybrid cars, etc. Efforts in recent years are found in building giant space mirrors to reflect solar radiation back into space for commercializing renewable energy.

As population is expected to increase to at least 8 billion by 2020, the amount of arable land available to meet increased demand from a burgeoning population is limited. The need is to meet such demand through improved yields of commonly grown staple crops. Boosting production using fewer natural resources is possible through biotechnology. The contributions of biotechnology includes the production of "Golden Rice" which is enriched with beta carotene and iron that can help combat vitamin-deficiency, a principal cause of blindness and anemia; plants resistant to toxic metals that will increase the areas available for farming; and insect-resistant cotton that provided better yields is improving the lives of farmers in China, South Africa and elsewhere.

The development of innovative, appropriate and efficient information and communication systems is possible through the establishment of ICT infrastructure, which can prove to be nations' critical tools in the promotion of development. Among the proposed countries in the present study, Malaysia is relatively in a better financial position to use ICT technology. India has advantages to have local producer of computer hardware or software. However as the price of PC equipments is out of the range of most individuals, the service is not affordable for the majority of individuals and small businesses. The reason Nepal is way behind in terms of precision agriculture in South Asia is because the ICT content, applications, services, and management is poor.

Technologies that were reviewed for three APCAEM member countries (India, Malaysia and Nepal) were solar photovoltaic, wind energy, biofuel, biogas, micro and small hydropower, biomass, solar thermal, improved water mill, geothermal energy, bio transgenics, organic farming, integrated pest management, information and communication technology. These countries have been using all these technologies more or less to a greater extent. However Malaysia is more interested towards biofuel (oil palm production) while India is equally interested towards biofuel and other renewable sources of energy. In case of Nepal, biogas and hydroelectricity are two major areas of green technology where government policy pays special attention. But the common point of these three countries towards GT is that they have laid emphasis to energy sector technologies.

For poor people, agriculture technology including GT has little importance. The only way through which GT can support these poor people is increased wage rate in agriculture via increased productivity. But GT is not capable to compete with modern technology with inorganic manure and other chemicals. This is the possible reason for not giving priority for GT in agriculture sector in poor countries. This is also evident from the fact that in Malaysia IPM (Integrated Pest Management) with FFS (Farmer Field Schools) approach never got operational, in India, IPM activities are surviving through government budget. In Nepal as well, the situation of IPM is not different.

The energy service, in form of electricity from small-scale wind and solar photovoltaic, has been found indirectly encouraging farmers' incomes and savings by reducing health hazards from indoor air pollution and expenses incurring in the purchase of commercial fossil fuels; and by creating non-farm opportunities. Public investment for the promotion of these technologies is necessary. An ideal scheme would not only be socially equitable but also create structures and process flows to guarantee long-term sustainability of technologies.

The use of solar thermal, especially solar water heaters, at household level can be expected to grow with inevitable rises in energy price. However, technical assistance through public programs will be necessary to increase application of solar dryers in agro processing. The role of agricultural cooperatives, agricultural networks and line agencies is very important towards creating markets and market links for products from clean processing.

The micro and small hydro schemes can deliver power required for agricultural growth. Irrigation canals carrying water from tailrace of power plants are also distinct possibilities. It is therefore important to consider multi-functionality of these schemes and formulate strategies accordingly.

It was observed that in the entire selected countries one or the other policy are pledges to create conductive environment for the transfer of green technology. In Nepal, the policy addresses adverse environmental impacts. However no direct linkage exist establishing green agriculture technologies as the instrument to meet these objectives. Similarly, Indian policies and plans are either silent or ambiguous on greening the agriculture. Malaysian initiatives as Small Renewable Energy Programs and Five Fuel Diversification Policy, speak inadequately on the possibilities of linkages between sustainable agriculture and energy policies. Furthermore, although there exist policies in each of the country, they face implementation problem. Thus to demystify the scopes of existing policies and their implications on sustainable agriculture, close investigations is necessary by further scrutining the existing policies in Phase II program.

The possibility of alternative technologies to adopt GT should not be assessed in isolation. Implications on income and opportunity creation; output, input, and ecological balance, gender equity, etc. is recommended to consider. As GT assures potency for sustainable agricultural growth, significant effort is needed to substitute conventional practices. However, this will be possible if efforts are made to develop indigenous energy sources for enhancing the culture of practicing eco-friendly energy resources.

References

Amatya, S.M. and Newmann, S.M.(1993). Agroforestry in Nepal: research and practice.

Agroforestry Systems, 21: 215--222, 1993.

BCSE.(2004). Increasing Access in Developing Countries. The Business Council for Sustainable Energy.USAID, Washington, D.C.

CES.(2005). Solar and Wind Energy Resource Assessment in Nepal. AEPC, Kathmandu

de Janvry, Alain, Gregory Graff et al.(2000). Technological Change in Agriculture and Poverty Reduction. Concept paper for the WDR on Poverty and Development 2000/01, University of California at Berkeley, USA.

EcoSecurities.(2003). Renewable Energy in Malaysia-Market Prospects. EcoSecurities Ltd. for DTI, Pub URN 03/754, U.K.

Ghosh, S.(NA).Sustainable Energy Policies for Clean Air in India. Background Paper Prepared for The Atlantic Council of USA.

Gonsalves, Joseph B.(2006). An Assessment of the Biofuels Industry in India.

MNRE.(2008). Ministry of New and Renewable Energy, India. http://mnes.nic.in

Pandey, B.(2005). Case Study: Financing for Rural Energy Development in Nepal. Energy Resource Development Series No. 40. UNESCAP, Thailand.

Pehu, E. and C. Ragasa, (2007).Agricultural Biotechnology Transgenics in Agriculture and their Implications for Developing Countries. Background Paper for World Development Report 2008, The World Bank.

Sharma, S.P. (2007). *Agro-forestry Policies in Nepal.*Presentation made in the modular seminar on Agro and Farm Forestry System, Msc-FEM, Freiburg University, Germany.

Thirtle C, and Xavier, I., (2001) Relationships between Changes in Agricultural Productivity and the Incidence of Poverty in Developing Countries. DFID: London.

Website Visited

http://www.iteaconnect.org/Conference /PATT/PATT14/Wicklein.pdf

http://www.fao.org/Wairdocs/TAC/X5784E/x5784e08.htm

http://www.adb.org/Documents/Conference/Technology_Poverty_AP/adb5.pdf

http://209.85.175.104/search?q=cache:IW5I3sqG3UwJ:orgprints.org/9431/01/9431_Pali_Poster.pdf
+orgprints+9431&hl=ne&ct=clnk&cd=2&gl=np&client=firefox-a

http://www.green-technology.org/what.htm

http://www.sustainabilityfirst.org/2007/07/mobile-lady-story-of-women-empowerment.html

http://www.fao.org/GENDER/en/agri-e.htm

http://findarticles.com/p/articles/mi_qn6207/is_/ai_n24373048

http://www.nbbnet.gov.my/plan.htm

http://www.dbtindia.nic.in

http://www.stockholmchallenge.se/data/ict_appl_in_environmental

http://www.nedcap.org/index_files/Page2210.htm

http://eib.ptm.org.my

http://www.finfacts.com/irelandbusinessnews/publish/article_1011463.shtml

http://www.thehindubusinessline.com/2004/11/05/stories/2004110502740900.htm