

COMPARISON AND ANALYSIS OF CASES

4.1 MARKET MAPS

The following sections highlight features of the Market Maps developed for each case study to compare different approaches and their contribution to successful start-up and development of the Small-Scale Bioenergy Market Systems, as well as their actual or likely impact on rural livelihoods.

4.1.1 Market System Initiation

In tracing back the initiation of the market systems for the cases, an interesting range of initiators and initiation strategies have been uncovered. In general although there is often an individual or institutional driving force, in all cases a coalition of interested parties has been established in order to initiate projects and initiatives, which have in turn led to the establishment of new market systems. These coalitions have been required to overcome barriers to the establishment of initiatives which in general cannot be solved by one institution alone.

Even in the cases where the lead initiator has been a private company such as in the Tanzanian Sisal Biogas case or Sri Lanka Biomass Spice-Drying cases, there has been crucial support from development donors to enable technology development and piloting. In cases such as Guatemala Jatropha Biodiesel and Kenya Charcoal Afforestation initiation has been by NGOs, but with integral partnerships with local private companies. In all cases the support of local and/or national government from relatively early stages has also been important in removing legal barriers. In several cases, most notably the Thailand Jatropha Co-operative, the involvement of Universities has been important in supporting technology research and development in particular. In many cases where significant numbers of farmers or outgrowers are involved, the involvement or indeed initiation of CBOs, co-operatives or producers associations has been a key feature in getting initiatives off the ground.

In this respect it is not possible to say based on these case studies that a particular initiation model for small-scale Bioenergy initiatives has proved most effective, but rather that in order to overcome barriers to establishing a local bioenergy market system a combination of capacities, resources and authorities is required. While this is true, the role of committed individuals within organisations and within communities themselves can also be easily identified within several cases, in providing visionary leadership and coalition building skills in initiating projects.



The moment of initiation for different projects varies and is of course open to interpretation, but in general this can be considered to be the point when a first round of financing or funding is obtained and activities start in earnest to break barriers and create a new reality in which the initiative is possible. Funding and financing for initiatives covered in this study is very diverse and includes private, donor, government, community and charitable funding, often combined in varying proportions and discussed in section 4.1.5 below.

Some of the key activities involved with initiation seen in the case studies covered include:

- **Co-ordination** – In all cases a key initial activity has been the building of the initiating coalition whether that involves farmers, donors, technology providers etc. This is usually required before financing is obtained but continues immediately after as the initiative gains momentum.
- **Capacity Building** – In all cases training and capacity building has been a primary activity and catalyst for initiatives. In some cases such as the Kenya Commercial Afforestation case and all Jatropha projects, the initial training is regarding production processes such as planting, seedling care etc. In cases where the primary material (often Bioresidues) is available such as Brazil Bioethanol Micro-Distilleries or Peru Oil Recycling, the capacity building is mainly regarding processing steps. In others where the fuel is already available such as Ethiopia Bioethanol Stoves, the training focus is around the appliance technology. In other cases, particularly chains built from nothing, such as Mali Jatropha Electrification, training is provided at all stages.
- **Technology Transfer** – In several cases the transfer of a key processing technology has enabled the initiation of a project. In the Senegal Charbriquettes example it was a new rotor press, in the India Biodiesel Water-Pumping case it was a Mafuti Mali Oil Press (from Kenya) and in the Guatemala Jatropha Biodiesel example it was Oil Extraction and Transesterification Equipment. In many cases these have been subsequently modified for local use but where similar crops are used elsewhere, importing corresponding processing equipment has been found to be an important leapfrogging step in creating a new market chain.
- **Marketing/Outreach** – In many cases in order to build support for an initiative or indeed customers for a new more environmentally-friendly energy product or practice, marketing and outreach has been practiced by initiatives. This can involve free or cut-prices samples such as in the Brazil Bioethanol Distilleries case or the Vietnam Farm Biogas case. In several cases most notably in the Senegal Typha and Charbriquette cases a separate entity, a women’s co-operative in Senegal, was involved in the project to be in charge of marketing to reach out to more consumers and spread benefits from the product sale.
- **Feasibility Study** – In all cases some type of feasibility study has been carried out to a greater or lesser extent. These were noted as important features of the Senegal Typha Charcoal and Guatemala Jatropha Biodiesel cases in particular.

- **Seedlings** – In most Small-Scale Biofuels examples a crucial initial step has been production and distribution (often for free) of seedlings whether they are *Jatropha* as in Mali or *Acacia* as in the Kenya case. This reduces barriers to entry for small farmers, should increase crop quality and survival where proper selection and quality control is carried out, and can be an important first step in developing trust and collaboration between actors.
- **Soft Loans** – Instead of providing seedlings or means of production free, in some cases including the Thailand *Jatropha* Co-operative case, soft loans were given through the co-operative instead to initiate production.

4.1.2 Market System Development

The market systems covered in this study can be seen to be in very different stages of development with some having been established up to 10 years ago while others have started only early in 2008. The stage of development of a chain is a crucial parameter in assessing the success of a model in contributing to Livelihoods in a sustainable way and this is a challenge in conducting studies such as this on the emerging Biofuels industry in particular. As can be seen from the cases covered, many are in relatively early stages and as such longer term sustainability issues are yet to be seen and have strong interactions with larger global trends and issues such as oil prices, evolution of EU subsidies and climate change policy and financing responses. However, as initiatives grow in size, especially likely in cases possibly linked with larger global markets or companies such as Guatemala *Jatropha* Biodiesel or Tanzania Palm Oil, new opportunities and threats are presented in terms of potential revenues as well as risk and price pressures on producers. Co-operative set-ups and local production and consumption chains such as Thailand *Jatropha* Co-operative and Mali *Jatropha* Electrification are less exposed to both these risks and revenue opportunities, but still have significant growth potential in terms of coverage within rural areas and spread of co-operative systems without interacting with global markets.

In general it can be said that the longer established market systems like Tanzania Sisal Biogas, there are more and different actors involved in the main chain compared with more recently established chains. Emerging pilot chains such as Mali *Jatropha* Electrification and Senegal Chardust Briquettes tend to be more integrated with a smaller number of players taking key roles (or multiple roles) in the main chain. As Bioenergy market chains develop it can be seen that the chains tend to grow and diversify in numbers of actors at all levels, even in the cases where Co-operatives or relatively insulated market systems are concerned, provided an energy demand remains and the enabling environment and supporting services remain in place. In systems where Bioenergy is one component of a separate chain, such as in the Sri Lanka Biomass Spice-Drying case, the expansion of the market system will be led by end markets for the main chain product. In all cases this growth in numbers of rural participants deriving their livelihoods from Bioenergy is an important measure of the impact of Small-Scale Bioenergy Initiatives on livelihoods discussed in Section 4.4.

4.1.3 Bioenergy as a component of wider Rural Market Chains

As noted in the previous section, it is important to distinguish between the different roles of Bioenergy in the larger Market System in order to establish the impact on Livelihoods. The role of Bioenergy in the cases covered fall into one of the following categories:

- **Bioenergy as the main output of the chain** – This is the case for all Biofuels initiatives as well as Bioresources cases established to serve household cooking, mobility and electrical applications. Energy demand is relatively constant in that people cannot do without energy and must find it somewhere to serve their basic needs. In this respect it forms a stable demand with growth potential in response to better, cheaper and more convenient sources, while in some markets the environmental impact of the fuel is also a relevant criterion.
- **Bioenergy as a productive input to another chain** – In cases such as Sri Lanka Spice Drying, the Bioenergy forms an input to another market chain helping enhance its competitiveness and increasing efficiency. In this case the Bioenergy chain is reliant for its end market on the other productive chain and the Bioenergy market chain is governed by the requirements and success of that chain.
- **Bioenergy as a by-product of another chain** - This is the case for all Bioresidues initiatives such as Peru Veg Oil Recycling and Tanzania Sisal Biogas. In these cases the likely extent of the bioenergy market chain is also limited by the size of the main market chain which governs the amount of residue by-products available.

All the roles above are viable for Bioenergy initiatives and are being exploited in small-scale initiatives as can be seen from the cases selected. Where improved Bioenergy serves an energy end-use within rural communities (either as the main output or as a by-product) it makes a direct contribution to rural energy access and quality of life. However, given the importance of productive uses in creating jobs and incomes, the contribution of Bioenergy as an input into other chains is also of great importance and can make a greater contribution to rural economic growth.

4.1.4 Enabling Environments

The prevalent Enabling Environment for Bioenergy varies dramatically between countries and indeed between types of Bioenergy within the same country. Some important components of Enabling Environments which came out strongly in the case studies are as follows:

- **Government Regulation/Incentives**

In all cases Bioenergy regulation falls across the jurisdictions of regulatory authorities with Ministries of Energy, Rural Development, Agriculture, Forestry, Water, Land, Rural Electrification etc, often being found to have overlapping responsibilities. Additionally in most cases regulation of Bioenergy can be seen to be in a state of flux as competing interest groups argue over the correct direction for different types of Bioenergy development, particularly as sector profile has grown with high oil prices, energy security and climate change debates. In general a focus on the liquid biofuels sector has dominated discussion about regulation and incentives in comparison with the Bioresources and Bioresidues sectors which are often ignored as being the domain of the poor. Regulation in these sectors

has historically been limited to restrictions on forestry use, waste dumping or charcoal production without the offering of alternatives, often forcing production underground. However this is changing and regulation on sustainable Bioresource and Bioresidues use is notable in the Kenya and Senegal cases for example. In Sri Lanka, Bioresources have been recognised as a key national energy asset to be used and managed as a counterbalance to fossil energy import reliance.

Regarding Biofuels, in some countries regulation is developed and supportive such as in Thailand and Guatemala which favour Biofuels development with tax incentives and subsidies although this is targeted mainly at the large scale. In Brazil the Ethanol case shows that regulation on Bioethanol for transport is highly developed but to the exclusion of household use, which is a challenge to energy access initiatives. In other countries such as Kenya and Peru Biofuels legislation is still in development and as such existing initiatives operate in a regulatory vacuum which is an important source of instability, risk and limitation to the sector.

■ Standards

Another important Enabling Environment factor noted in the case studies related to regulation is the availability, appropriateness and enforcement of relevant standards for Bioenergy. In several cases such as Kenya Charcoal Afforestation and Peru Vegetable Oil Recycling the lack of standards on Bioenergy products such as oil and charcoal tend to lead to a lack of trust and respectability in the sector. A lack of standards on products also applies to the production processes and no sustainability criteria can generally be enforced if these mechanisms are missing. However in cases such as Guatemala and in India where standards are in place, this can be an important enabling factor.

■ World Oil Price

An element of the Enabling Environment arising again and again in the case studies is the Oil Price. In this most international of markets, Bioenergy projects in particular are often linked to international oil prices. This linkage can be weaker or stronger depending on local arrangements in terms of tax and transportation costs leading to widely varying prices for oil products such as kerosene, diesel, LPG and petrol which compete directly with Bioenergy in most demand segments. The viability in particular of liquid biofuels projects is linked to diesel and petrol prices, however as a tiny fraction of this market and serving people who have very limited access to these resources in normal situations anyway, most small-scale Biofuels projects covered by this study have chosen to insulate themselves from the larger market at least in the initial stages while processes are improved.

4.1.5 Supporting Services

Supporting services which enable the main market chain to function cited in the case studies **included financing/loans, factors of production** such as fertilizer and machinery, **transportation, legal and contract** assistance, **Technology R&D, bargaining support, training and capacity building, market information** provision, **marketing** and others. These services are drawn upon by various actors in the chains and some, such as training,

are most important at the beginning of the development of a market chain while some, such as transportation, are required on an ongoing basis.

Supporting services are provided in some cases by departments within market actors but in most cases are provided by organisations not directly within the main market chain. These can include NGOs, such as in the Guatemala Jatropha or India Biofuel Water-pumping case, Government agencies such as in the Senegal Typha and Chardust cases, Universities such as in the Thailand Jatropha Co-operative case, or private actors providing more standard services such as transport or construction.

Marketing is a key supporting service to the success of a market chain and is sometimes provided by market actors themselves and sometimes by supporting services providers such as NGOs or Government etc. It is often through marketing that market actors can have an influence on the Enabling Environment by creating awareness and changing public perceptions as consumers and voters, which can in turn influence purchasing trends and policy.

Funding and Financing are also clearly crucial to the success of small-scale initiatives especially given that they are often functioning in weak rural markets where lack of capital in particular is a key constraint. Approaches employed in the cases covered vary from primarily government and donor support such as in the Mali Jatropha Electrification, and Thailand Jatropha cases, to mainly private such as in the Tanzania Palm Oil case. As might be expected the donor and government support is stronger in cases where rural development including energy access is emphasised, while private financing is stronger where more lucrative export markets are involved. However, all cases covered involve a combination of financing from market chain participants, private (local, national or international) financiers, government and donor agencies and all lay varying levels of emphasis on development, environment and economic outcomes. As such these cases can be said to represent positive examples of projects taking the perspective that these are mutually reinforcing. The extent to which this remains the case over time will be the test of the sustainability of the project and the scale-up models which they pursue.

4.2 RELATIONSHIPS

Given the importance identified of coalitions or partnerships in starting and developing Bioenergy Initiatives, relationships are a crucial feature of initiatives and the following section notes some key factors linked to relationships within initiatives and market systems which have come out of the case studies.

4.2.1 Leadership and Participation

All case study initiatives have what could be described as leaders of the initiative which are an NGO in the case of the Ethiopia Ethanol Stoves case, a private company in the case of the Tanzania Palm Oil case and a University in the case of the Vietnam Jatropha Co-operative case. In all cases also it is possible to identify charismatic individuals within these leading organisations who provide crucial impetus as well as providing a nexus for interest and collaboration on the initiative.

However as noted in the section above, none of the initiatives is wholly dependent on one organisation and all have clearly spent time developing participation and support for the initiative within other linked stakeholder groups and between other actors in the market chains. This focus has enabled the cases to gain as a minimum of sufficient local support, government support and funding support to progress. Particular features include the encouragement of co-operative and producer group formation in many cases, even where the project is led by a private sector company such as in the Tanzania Palm Oil or Sisal Biogas cases. Other approaches include the use of Public-Private Partnerships such as in the Senegal Charbriquette cases.

4.2.2 Level of formality

A range of levels of formality have been noted in the case study approaches which appear to be very dependent on contract enforcement regime in the country. Most notably in the Kenya Afforestation Charcoal case initial investment in seedlings and tree plantations by a private partners working with an NGO was lost after it became clear that contracts on sale of the final product would not be honoured and highest market price at the time would be taken by the growers. However at the same time agreed prices and contract adherence have been seen to be key to reducing risk and encouraging co-operation in many other cases including the Tanzania Sisal Biogas Case and the Mali Jatropha Electrification case. This is especially significant in these cases as outgrower models are used with initial investment from the end user in the outgrowers so if that is not honoured then not only is the investment lost but the security of supply (Sisal or Jatropha oil to the generator) is compromised and the whole initiative may fold.

In this instance processors, producers and appliance partners in some of the cases can be seen to recognise the importance of the other players in the chain and are supporting them in their stability and strength such as through assisting in the creation of both producer groups such as in Tanzania Sisal Biogas, and user groups in the case of Mali Jatropha Electrification. In these contexts negotiation of relationships and formal arrangements tend to have more likelihood of success on all sides, although wider circumstances, such as commodity prices and loans are still a factor.

In many cases as can be seen from the Relationships tables on page 3 of the cases, a combination of formal and informal arrangements are made throughout a market system so for example a fuelwood supplier may guarantee contract supply to the Spice Dryer in the Sri Lankan case, but in turn the supplier will have a series of informal relationships with fuelwood collectors which will not be under contract.

4.3 BALANCE OF RIGHTS, RESPONSIBILITIES AND REVENUES

Analysis of the balance of Rights, Responsibilities and Revenues of the actors in the initiative market systems provides a window into the power dynamics of a market system which in turn offers a perspective on where vulnerabilities lie. The reduction of vulnerability amongst rural populations and producers is a key element of the Livelihoods impacts which the study seeks to address and main points emerging from the case studies are discussed in the following sections.

4.3.1 Distribution of Risk

A crucial measure of vulnerability is the extent to which livelihoods are at risk. Risk is a function of the likelihood of an event transpiring (such as a crop failure or natural disaster) and the seriousness of that event (such as whether a crop failure wipes out an entire livelihood, or whether a family has another income or food sources or reserves). In this respect keen attention is required in a market chain as to who carries the risk of failure. In the case where this is small scale rural producers without alternative livelihood options, this can be seen as a direct threat to security of livelihoods.

All the initiatives covered in this study claim to have addressed these issues in spreading risk between larger players and smaller actors through a number of mechanisms. Diversification is common and in all biofuels cases the projects encourage intercropping of energy crops with food crops, via trainings and practical assistance, and the use by small-farmers of only currently unproductive land (in the case of Guatemala Jatropha Biodiesel for example). In cases where there is a time delay in bioenergy production, the initiatives encourage or promote additional growing of short rotation food crops and honey (such as in the case of the Kenya Afforestation Charcoal project).

Risk for small producers also arises from isolation and lack of awareness about wider market signals and prices. In this respect the initiatives encourage co-operative setup and producer groups enabling joint bargaining, pooling of resources for mechanisms such as bridging loans, and bulk purchasing for reduced costs of production. All of these act to reduce risk for each producer. This approach can be beneficial throughout the chain since Bioenergy processors, buyers and investors are also at risk where producers are unstable, contract enforcement is weak and bargaining is with individuals. These factors can damage security of supply and raise transaction cost as well as costs of production if new suppliers must be sought.

With guaranteed pricing such as in the Mali Jatropha Electrification and Ethiopia Ethanol Stoves cases for example, risk is shared as long as joint bargaining and communication is in place between producers, processors and consumers. The timeframes of such agreements are important to enable adequate market flexibility within affordable price bands, as well as security over the longer term for Bioenergy producers and consumers.

4.3.2 Business and Management Models

Rights, Responsibilities and Revenues are reflected in the Business and Management models applied by initiatives, whether they apply to one main actor within the chain or to an umbrella organisation such as a co-operative within which most functions of a market chain occur. The Business Models discussed in this section are those targeted as the end-goal of the project even if they are currently operating in different mode. Again, several model types are in evidence in the case studies with many facets. However they can broadly be said to fall into the following categories:

- **Fully Commercial – Wider markets**

In the cases of the Tanzanian Palm Oil, Tanzanian Sisal Biogas and Guatemala Jatropha Biodiesel the models are designed such that in normal operation they will be

fully commercial in terms of the relationships between market actors and if higher prices are offered for products in international markets these may be exploited. The initiators are working on the assumption that mutual self-interest on the part of the various market chain actors will enable the continuation and development of the chain. This is expected to bring new investment and income into rural communities, however risks are entailed on all sides since at any time a higher offer to producers (from another purchaser such as a large oil company) or a dip in the international market (a drop in the oil price for example), could cause the chain to collapse since other factors such as environmental protection and rural development will not be explicitly priced in. Additionally, pressures to go to larger scales, reducing costs (ie revenues to producers) and reducing direct energy access benefits in the area (ie all products are exported to higher value markets) may be inexorable.

■ Fully Commercial – Local Markets

Some initiatives such as the Senegal typha Charbriquettes and Chardust cases, the Kenya Afforestation Charcoal project and Peru Oil Recycling cases operate on a fully commercial basis but are only expected to serve local sub-national markets. In these instances linkage of the energy benefits to local populations is clear and although exposure to wider markets remains, a more localised market more closely linked with the producers themselves is targeted. It is notable that these are the markets normally engaged in by rural producers. Initiatives focussing at this level have an advantage as long as the Bioenergy product is sufficiently better than alternatives in terms of price, quality, convenience or perception. It is notable however that the projects in this section are for lower grade energy products than the liquid fuels which are found either in the Fully-Commercial Wider Markets or Semi-Commercial categories. Outside revenues are also limited and competition from less environmentally sound but more convenient sources is ever present as noted in the Senegal and Kenyan cases.

■ Semi-Commercial

Market systems which arise between organisations and individuals within a co-operative such as in the Vietnam Farm Biogas case or the Thailand Jatropha case, or within constrained regulatory circumstances in terms of subsidy or market restrictions such as in the Mali Jatropha Electrification or Ethiopia Ethanol Stove cases, can be described as semi-commercial. In these cases profit is made by all actors and money changes hands in proportion to market rates. However these are insulated from wider markets and prices are controlled within agreed bands. These systems are generally less attractive to external private finance support but also place higher emphasis on rural development outcomes and stability for participants in the chain. Initiatives following this model could be described as social-enterprises and are more generally eligible for ongoing donor or government support at some level. Another feature of this model is that access to the services is generally restricted to members of the Co-operative or within the restricted system and wide membership is needed if benefits are to spread.

■ Volunteer

The only case based on an element of volunteerism or self-help is the India Biodiesel Water pumping case which employs a “Sweat-Equity” approach whereby participants

work in collection of oil seeds or operation of the oil press to earn participation in the benefits of the scheme. This enables participation in the initiative by extremely poor individuals and communities, but also implies very limited involvement of the private sector and potentially limitations on scale up in communities with better, although still limited, access to finance and means of production.

Within each of the above general models there is of course a wide range of sub-models and leadership and responsibility systems. It is also argued that to some extent the choice of model depends on the circumstances and traditional organisational systems within the countries, and this is undoubtedly true. That said, in cases where the Enabling Environment is conducive, the cases covered here would imply that Local Market oriented and Semi-Commercial approaches are offering the most direct energy access benefits to rural areas. Whether broader livelihoods benefits can be brought via increased income through connection to wider markets depends largely on the terms of that connection, and on the point at which it is made in terms of the development of the market chain.

4.3.3 Land and Resource Rights

Land and Resource rights are a crucial concern, particularly in Bioenergy projects involving cultivation of energy crops or access to natural Bioresources. In the situation of Bioresidues, rights are usually clear and lie with the previous processor of the residue, be it from forestry such as the Senegal Charbriquettes case, agriculture as in the Tanzania Sisal Biogas case, or industry as in the Peru Veg Oil Recycling case.

With respect to Land Rights, different situations are again notable in the cases covered, varying primarily by country based on the land reform and allocation systems within each country, and sometimes between each actor in the chain. From the perspective of the security of rural producers the cases fall into the following categories:

- **Land ownership of small farmers secure** – In the Guatemala Jatropha Biodiesel case for example the Government has previously allocated land to small-farmers as is the case in the Vietnam Biogas case after the Doi Moi reforms initiated in the 1980's
- **Lease or Usufructuary rights available to small farmers** – In the Mali Jatropha Electrification case small-farmers, as is typical in Mali, have usufructuary rights on the land, which means that short-rotation crops can be grown, but this poses a problem for longer term plantations (including Jatropha bushes). In the Tanzania Sisal Biogas for example small farmers have a lease on land issued by the company on condition of adherence to a contract negotiated with producer associations.
- **Unclear or no Land tenure** – In cases where natural resources are used which are not clearly owned by anyone, such as the Senegal Typha Charcoal or India Biofuel Waterpumping cases, generally collection operates in a grey area until extraction reaches a certain level. Specifically in the Indian case restrictions of removal of resources from forest is a key constraint and dispensations for indigenous dwellers have to be sought.

Case initiatives appear to have sought to work within local constraints on land and resource rights, and in building the necessary coalitions of support for small-scale

initiatives have had to negotiate these issues with the local people, local government and the various relevant departments of national governments, as noted in section 4.1.4 on Enabling Environments. Typically this has involved a number of Ministries, and sometimes overlapping legislation regarding land, natural resources, processing and distribution rights, and several initiatives note challenges in terms of gaining the clarity on these rights required to secure investments.

4.3.4 Intellectual Property

Intellectual property was mentioned as a key issue in a minority of cases which may be because the production or processing equipment in most cases is one part of the wider initiative with the equipment often bought or adapted from a company as part of the cost of establishing the market chain. However in some cases, particularly where the initiative has as a major component transfer of a specific technology and has significant private involvement and investment in the R&D, then Intellectual Property and patent rights are a relevant issue. This is the case for example in the Sri Lanka Spice Drying case, where the dryer was the key technology which opened up a new chain, and the Ethiopia Ethanol Stoves case, where patent protection has been sought to protect private investments in the CleanCook stove as well as in the development of the stove manufacturing facility in Ethiopia. None of the Biofuel cases involved any intellectual property around plants or seeds.

4.4 LIVELIHOODS OUTCOMES

This section focuses on the general lessons which can be drawn from the cases in terms of their broader contributions to Rural Livelihoods. It draws as far as possible from the full range of activities and actors involved with each market system, including supporting services providers and enabling environment actors where relevant. It should be noted that conclusions in this section on Livelihoods outcomes are based only on the small-scale initiatives covered in this study, and do not necessarily apply to other or larger initiatives. It should also be reiterated that the early stage of many of the initiatives precludes assessment of long term benefits at this stage.

4.4.1 Human Capital

The main factor cited in the case studies in terms of an increase in Human Capital is undoubtedly that of training and capacity building amongst the rural producers, processors and consumers. All Small-Scale Bioenergy Initiatives covered have involved significant training, capacity building and human development support to encourage increased and full participation in the initiatives. The skills involved are not limited to practical skills regarding production and processing of Bioenergy, but also in several cases concern the efficient running of a small business and entrepreneurship. Additionally the establishment or support of co-operatives, producer associations and consumer associations, such as in the Kenya Afforestation and Tanzania Sisal cases, creates opportunities for learning about and gaining experience in the running of civil society organisations representing rural people and communities.

Additional to the benefits of participating in the initiative, in the cases such as Mali Jatropha Electrification and India Jatropha Electrification where modern energy access improvements in the local area are integral to the initiative, an increase has been noted in the access to information, health and education services. This is partially due to the availability of energy for lighting for studying at night, vaccine refrigeration and communications for example, but also because the retention rate of skilled and professional people such as health care workers and teachers increases when improved energy services become available. The transformational effect of this type of energy access, and the feeling of modernity and connection which it involves, have been noted to raise confidence, alongside the confidence that accrues from being involved with a successful small business activity, co-operative management and sustained income generation. These can be expected to have knock-on effects on entrepreneurship, community organisation, and new ventures in the future.

All five of the cases focussed on improved cooking fuels note the significant reduction or removal of the drudgery associated with collection and use of firewood, releasing human capital usually spent in these ways, particularly by women, to other uses. Particularly good examples of this include the Vietnam Biogas example where it is estimated that 50-80 person days per household per year are saved by that initiative. Additionally the introduction of cleaner burning fuels into households, such as Ethanol stoves in Ethiopia and Brazil, also reduce indoor air pollution by 93%, dramatically reducing the associated health problems which kill over 1 million people per year globally (according to WHO statistics), and impose a general drain on human capital, especially women and children, through poor respiratory health. Cleaner burning fuels also significantly reduce build up of soot on pots which require scrubbing, an additional time saving noted in the Vietnam case to be highly appreciated by household cooks, typically women.

4.4.2 Social Capital

Participation in the small-scale Bioenergy Initiatives, whether in co-operatives, outgrower societies or as independent participants in a collective initiative is consistently shown in the cases to build social capital within rural communities. This seems to be a very important component in many rural schemes either during initiation or subsequently when the initiatives start to take hold. For example through the establishment of the Mali Jatropha Electrification initiative both village and commune level co-operatives have been established with keen participation from local farmers while at the same time an Electricity Consumers Association of energy users has been established enabling representation of users. The development of joint action societies through the case initiatives within rural areas has also been shown to bring improved co-ordination and greater voice to rural people which in turn has helped them to interact with higher authorities such as government agencies and donors in addressing other issues faced by the community. A particularly good example of this is the Kenya Afforestation case where the associations established through the project are negotiating also now with cotton and rural development agencies.

In addition to the rural institutions developed through the initiatives, access to modern energy itself is also shown to play a major role in enabling social interactions after dark

and establishing new social opportunities and as such also acts to build social capital. Street lighting in the cases involving electrification show this most clearly.

In the case of Vietnam Farm Biogas another benefit noted by participants is the increased level of cleanliness associated with containing and digesting animal manure. Not only does this enable the rearing of an increased number of animals on the same land without health issues associated with animal dung but additionally smells and flies do not invade neighbours space which has been noted to improve relations between neighbours, a highly important factor particularly from a cultural perspective in Vietnam.

Social capital between rural producers is the underpinning of effective joint negotiation and action which is a key factor in these producers gaining better deals within market systems and in their interactions with intermediaries or larger processors. The cases show that where this is encouraged, it can bring benefits for all participants in the chain building the trust and co-operation relationships which are required for effective development of market systems.

4.4.3 Physical Capital

The main increase noted in the cases in terms of physical capital is in processing equipment enabling the conversion of bioresources, bioresidues and biofuels into improved bioenergy services. These include for example improved efficiency kilns in the Kenya Afforestation case, oil seed expellers in the India Jatropha and water pumping cases, transesterification equipment in the Guatemala Biodiesel case, micro-distilleries in the Brazil Ethanol case and briquetting presses in Senegal.

In addition to processing equipment, in some cases improved appliance technologies are an important physical capital component such as in the Ethiopia Ethanol Stoves case, the water pump in the Indian Biofuel case and generating sets in the Mali Jatropha Electrification case.

Increases in physical capital do not only derive from project interventions themselves in production, processing and appliances, but also from the increased income to farmers who in turn invest more in their own physical capital. For example small producers in the Tanzania Sisal Biogas case have been observed to invest in labour saving machinery for or additional income generating opportunities such as livestock to increase labour and land productivity, activities also noted in the Vietnam Farm Biogas case.

4.4.4 Financial Capital

Sustainable increase in financial capital is built in different ways depending on the initiative type and the nature of a participant's interaction with it. Taking existing activities as a baseline it is useful to consider the different ways in which different types of bioenergy project contribute to increasing financial capital:

In **Bioresources** projects, financial capital is built primarily through the creation of new income generating activities based on existing, previously under or non-utilised natural capitals. For example in the Senegal Typha Charcoal case revenues are being generated from the production of charcoal from an invasive river species while in the Sri Lanka

Spice Drying case abundant and fast growing *Gliricidia* growing in gardens and farms is being used to add value to the Spice chain by displacing expensive imported fossil fuels and improving quality over sun-drying which has to occur in the wet season. Financial revenues are therefore created in jobs in these new market chains in production and processing as well as in access rights to the resource.

In **Bioresidues** cases financial capital is mainly increased through an increase in revenues to the original processor who now receives additional income for a previously waste resource such as in the case of the chardust sold from charcoal yards in the Senegal Charbriquettes case or from the sale of waste vegetable oil in the Peru case which restaurants and hotels would previously have had to pay to have removed. In cases such as the Tanzania Sisal Biogas case where the organisation uses the Bioresidues itself as a means of production they then save on fuel bills, again increasing the viability of the business. Additional revenues are also of course created for participants in the businesses involved with the processing and retail of the Bioresidues themselves such as the charbriquette sellers in Senegal.

In **Biofuels** cases there are even more mechanisms and opportunities for increased financial capital gain since not only are processing and retail functions available for wealth creation but also production of the material itself which is not counted in Bioresidue or Bioresource projects. In this respect there is evidence from the Biofuels cases of additional revenue to small farmers for production of energy crops either instead of cash crops such as cotton in Mali, or from currently unused farmland in the Guatemala case, or intercropping with food crops as in the Thailand *Jatropha* case. Additionally there are the opportunities for new jobs created on farms now made viable by the new end market, such as in the Tanzanian Palm Oil case.

In addition to the opportunities above specific to the type of bioenergy resource in question, there are also other more general financial capital opportunities which are being harnessed or developed by the cases covered:

- **Carbon Finance** - is still a developing revenue opportunity for Small-Scale bioenergy projects but in the Ethiopia Ethanol Stoves Initiative it will be used to subsidise stoves to low income families while potential for carbon financing has also been noted in the Indian Biodiesel Water pumping case.
- **Income Security** - is a crucial factor in a sustainable livelihood and this is a feature of several initiatives including Mali *Jatropha* Electrification, Tanzania Palm Oil and Thailand *Jatropha* Co-operative which provide contracts and price guarantees for production. The security of this has real value to rural producers and can enable other productive investments via loans for example.
- **Government Support** – is forthcoming in a number of cases supporting the viability of Bioenergy projects driven by a policy imperative to reduce macro-level balance of payments deficits caused by fossil fuel imports. At the macro level the production of liquid biofuels in particular has clear potential to address cash outflow on imported oil which can make up a very substantial proportion of national GDP in several of the case countries covered, which has knock-on effects on financial capital available in the country.

- **Reduced running costs** - associated both with provision of services from imported diesel. For example savings in costs for water pumping in the India water pumping case, and in households energy costs in the case of the Vietnam Farm Biogas.
- **Bioenergy by-products** – In several situations there are by-products of the Bioenergy processing systems which also have market value for example Glycerine from Biodiesel production in Peru is sold to cosmetics firms or processed by the community themselves into soap in India for example. An additional by-product is fertilizer produced by biogas systems in the Tanzania Sisal and Vietnam Farm Biogas cases as well as from seed-cake in the *Jatropha* cases such as in Guatemala. This is either used directly by participants such as in Vietnam to increase yields or sold as a product to other farmers in Guatemala.
- **Premium on associated products** - Food produced with organic fertilizers derived from Bioresidue or Biofuel processing can attract higher market prices and this has been noted particularly in the Thailand *Jatropha* case.

4.4.5 Natural Capital

The Small-Scale Bioenergy cases covered by this study also demonstrate a number of contributions to natural capital through various approaches taken or features of the rural market chains established. Again there are different impacts on natural capital which are associated with different types of Bioenergy project:

In the **Bioresidues** cases natural capital existing in waste by-products is realised through improved processes to become a new type of capital which was previously underutilised, non-utilised or actually polluting. These include the large amounts of choking chardust in the Senegal case, sisal waste in the Tanzania biogas case previously rotting and emitting methane, Vegetable Oil in the Peru recycling case which was previously dumped, and waste molasses used to produce bioethanol in the Ethiopia example which would otherwise be a river pollutant. In none of the Bioresidues cases does it appear that a residue previously going to use in soil nutrient enrichment or other use has been diverted to Bioenergy to the detriment of natural capital. The natural capital impact of the production of the original product is not covered by the cases since in all cases this would be occurring whether the Bioenergy project was happening or not.

In the **Bioresources** cases it appears clear that an abundant natural capital is harvested in a manner which does not exceed the carrying and regrowth capacity of that resource and in fact acts to manage that resource in some cases within reasonable limits. For example the Senegal Typha Charcoal case involves the harvesting of an invasive river weed estimated to have a wet mass of 3 million tonnes in Senegal which is clogging watercourses, having a detrimental effect on river flora and fauna health and which in any case has a regrowth rate which is well ahead of any projected extraction rate under the initiative. In this case the net result is to reduce pressure on woodland by replacing with a more abundant resource not associated with other beneficial features such as restricting soil erosion. In cases such as the Sri Lanka Spice drying case, fast growing *Gliricidia* is used and as long as this continues to come, as it does

now, from rural home gardens and forest management including replanting it should not have a negative impact on natural forest resources.

In **Biofuels** projects the potential for reduction in natural capital is greater as with any agricultural activity, however in the small-scale bioenergy cases covered here there is no indication that this is taking place and that instead benefits of natural resource management are being realised. In the case of Kenya Afforestation the energy crop growth has served to increase forest cover by 200 hectares while trees are leguminous fixing nitrogen and improving soils compared with when the areas were bare or with thickets. In this case, as well as in the *Jatropha* cases, using indigenous trees serves to avoid upsetting ecological balances while the micro-climate is improved by forests and a new carbon sink is created. In the liquid biofuels projects clear statements are made by the participants that crop selections are suited to marginal non-forested lands and to be used on these or intercropped with other food crops to avoid conflict with existing natural capital or food production. Additionally organic fertilizers produced as by-products of oil-seed pressing are reintroduced to the soil which increases fertility and soil health as well as reducing polluting run-off into rivers from inorganic fertilizers. If these standards are maintained these small-scale initiatives should continue to make a positive contribution to increasing natural capital in rural communities.

In addition to these contributions specific to the type of bioenergy resource in question, there are some additional contributions to natural capital made by the cases more generally:

- **Reduction in forest depletion** - in cases focussed on addressing cooking needs in developing communities, whether in the Kenya Afforestation Biofuel case, the Senegal Charbriquette Bioresidue case or the Senegal Typha Bioresource case, a primary benefit of the project is to reduce pressure on forests for cooking fuels. By replacing unmanaged forest depletion with new resources or more efficient use of existing resources an important contribution is made to protecting forests which are a key natural capital resource providing multiple environmental services and under pressure globally and specifically in several case study countries as clearly visible in the graph in section 2.1.2
- **Substitution of fossil fuels** – fossil fuels are one of the most precious natural capitals available on the planet and in all the Bioenergy cases covered, plant resources which are renewable if managed properly are used in place of irreplaceable fossil fuels thereby reducing pressure on that resource. This does not in any way address inequitable access to fossil fuels, but cases highlighted offer windows into how Bioenergy resources can partially or completely replace some of the energy services people need in a world where access to fossil fuels is becoming increasingly difficult, expensive and ill-advised from a climate change perspective.