LOW COST MICRO IRRIGATION TECHNOLOGIES FOR THE POOR

FINAL REPORT

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PRACTICAL ANSWERS TO POVERTY

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Abbreviations

AMIT	Affordable Micro Irrigation Technology
AMM	Area Marketing Manager
BAU	Birsa Agricultural University
BDS	Business Development Services
BK	Bucket Kit
CBO	Community Based Organisation
CIDA	Canadian International Development Agency
CO	Community Organiser
CS	Customised System
CMS	Customised Micro-Irrigation System
DFID	Department for International Development (UK)
DK	Drum kit
DRDA	District Rural Development Agency
EDA	EDA Rural Systems
EIRFP	East India Rainfed Project
FO	Field Office
GoI	Government of India
GVT	Gramin Vikas Trust
HRW	HR Wallingford Ltd
IDE	International Development Enterprises
IDEI	International Development Enterprises India
INR	Indian Rupee
ITC	Intermediate Technology Consultants
ITDG	Intermediate Technology Development Group
KAR	Knowledge and Research (DFID funding programme)
Kharif	Monsoon season
LLDPE	Linear Low Density Polyethylene
MI	Micro-irrigation (drip and sprinkler irrigation technologies)
mn	Million
MSK	Micro Sprinkler Kit
MSL	Mean Sea Level
NGO	Non-Governmental Organisation
OSK	Overhead Sprinkler Kit
PRA	Participatory Rapid Appraisal
Rabi	Winter season
Rs	Rupee (Indian)
SC	Scheduled Caste
SDC	Swiss Agency for Development Cooperation
SHG	Self Help Groups
ST	Scheduled Tribes
TOR	Terms of Reference
USAID	United States Agency for International Development
USP	Unique Selling Proposition
Zaid	Summer season

EXECUTIVE SUMMARY

Introduction

This report sets out the final conclusions of a forty two month research project funded by the Knowledge and Research programme of DFID's Department for Infrastructure and Urban Development. The project ran from April 1999 to December 2002 with fieldwork occurring in India and Zimbabwe. The project undertook an action research focused on the work of the International NGO, International Development Enterprises (IDE). IDE was a member of the project team with primary responsibility for implementing their programme of marketing and promotion of low cost irrigation technologies in Eastern India. They made their methods and results available for evaluation by other collaborators in the project team. Project work in Zimbabwe occurred on a much smaller scale than in India and did not include the direct involvement of IDE in the marketing of drip technologies. The Zimbabwe work was confined to farmer evaluation of low head drum kits imported from India and sought to assess the ease with which the marketing and promotional methods used in India might be transferred to the conditions of Zimbabwe and other African countries. The purpose of the report is twofold:

(1) to document the results attained, and the implications of these

(2) provide guidance for future research and development activities in AMIT and/or a market-oriented approach to technology dissemination

The Affordable Micro Irrigation Technologies (AMITs) promoted by IDE in India are targeted towards small and marginal farmers. The same technical advantages as conventional micro-irrigation systems – improved water use efficiency, improved crop quality, reduced labour inputs etc – are potential benefits but the technology is packaged and marketed as kits suitable for use on very small land areas ranging from as little as 110 m^2 to 0.44 ha. The micro-irrigation systems promoted are predominantly drip (bucket, drum and customised kits) and to a lesser extent sprinkler.

Project Purpose and Research Questions

The project purpose was to *"Identify and address constraints to adoption of low-cost, improved, non-surface irrigation technologies by resource poor farmers on a commercially sustainable basis".*

The project was guided throughout by the need to evaluate the irrigation technologies and the marketing mechanisms used to bring them within reach of the poor. This was achieved by researching answers to the following four questions:

1) Do AMITs offer sustainable technical and financial benefits to the users when compared with existing irrigation practices?
2) Whose livelihoods can be enhanced by purchasing AMIT, in what way and by how much?
3) What are the constraints and opportunities of a market-oriented approach to support the sustainable adoption of AMIT by the poor?
4) How transferable are the technologies and the approach to other locations?

Research Methods

To answer these four key questions the project undertook action research in three distinct geographic regions – two in India and one in Zimbabwe.

a) **India East** - *Jarkhand and West Bengal.* Socio-economic research was conducted in a new area where AMITs have not previously been promoted. This provided the opportunity to evaluate and document AMIT interventions in an area with the following characteristics and issues: (i) no previous exposure to MI technologies on a wide scale, (ii) high levels of poverty, and (iii) highly drought prone. It also allowed observation and analysis of marketing approaches and the requirements for establishing a supply chain and a demand base large enough to sustain it commercially in an area where no market previously existed. Research also assessed whether such a market can deliver technologies to the poorest.

b) **India West** – *Maharastra, Himachal Pradesh and Gujarat*. This is an area where AMITs and the distribution systems that support them had been established for 3 years or more prior to the inception of this project. Thus, it provided the opportunity to evaluate the effectiveness of those distribution and marketing systems, as well as allowing evaluation of the irrigation systems in the field through users' assessment of their benefits and non-benefits and their livelihood impacts.

c) **Zimbabwe** – The AMIT kits were tested on a pilot basis in semi-arid areas of Zimbabwe on the basis of their technical and agronomic performance and potential impact on local livelihoods. The study allowed the project to assess the degree to which AMIT, and the marketing methods developed in India, can be transferred to an area with different economic, social and agronomic conditions.

All three study areas are characterised by similar climates, typified by moderate to low rainfall (350-1200 mm) distributed in a single rainy season of around four months with a subsequent dry season of eight months duration. Water shortage particularly at the end of the dry season is severe.

Project Results

East India: The market-oriented approach to AMIT dissemination only reached farmers in the middle and higher economic categories. The diffusion of AMIT to the poorest was almost entirely achieved through subsidies provided by local NGOs that IDE approached directly and drew into collaboration. Without subsidies from these NGOs the poorest farmers would not have taken up AMIT since their location is far away from the market chain's promotional area and they possess little purchasing power.

However, the AMIT marketing process in the East is still in the early stages. The third year of the research (2002) saw improved rates of adoption and repeat use of the technology by farmers in Purulia District (West Bengal). It is possible that the market could expand quickly in the next few seasons provided there is a continued and active presence of IDE or another body to champion the process but without this presence it is likely that the preliminary market will collapse and not be sustained. This is especially the case with the dissemination of relatively complex technologies like AMIT.

In the first year it was found that problems with the supply of AMIT kits and the time delay between order and delivery of the kits greatly damaged the market creation process and

risked losing any momentum gained by promotion. Stability of supply is an important prerequisite. More generally, the following enabling conditions are required:

- There should be felt water scarcity and limited water resources.
- AMIT users should have ready access to a water source that is located close to production area.
- Availability of, and access to, suitable land for agriculture.
- Cultivation and marketing of vegetable crops amenable to drip irrigation should already be well established.
- Markets for the produce should be close at hand.
- Basic agronomic guidance on alternative improved cropping systems, mulching and the use of fertilisers and insecticides should be provided.
- Support of local NGOs is essential to reach the poorest.

West India: Maharashtra State, where the research took place, presents an extremely different context to East India, with its semi-arid climate and poorer natural resource base. The type of AMIT products and farming systems being successfully taken up in this area are markedly different to the small-scale AMIT for vegetable production being promoted in East India and tested in Zimbabwe. The types of irrigation systems being adopted are a larger type of customised kit adapted to the specific context. They are **not** the small, low-cost, off-the-shelf bucket and drum type systems. Such customised kits, while more expensive, afforded greater return over investment. Thus, there are dangers in comparing the performance of the customised kits and the marketing efforts that sustain them, directly with geographic areas where the products being promoted were of different sizes and costs. Indeed one of the lessons from Maharashtra appears to be that while these smaller, very low cost kits were initially promoted, levels of adoption have been relatively low. Irrigators have preferred to buy larger customised kits as part of wider investments in deep wells and pumped water supplies.

Below are some of the factors that describe the specific context or enabling environment of West India where customised AMIT has been introduced with considerable success:

- **Farmers are poor but aware of drip and other technologies:** Maharashtra is a progressive state where farmers are poor but aware of new technology options that may benefit them.
- **Poor farmers have worked together to purchase pumps, pipes and other infrastructure:** often involving significant capital costs for which farmers save over a number of seasons.
- **Horticulture is the only option:** Horticulture is perceived to be the only form of cultivation that is possible in the tough terrain.
- **Drip perceived as the only option:** there are water shortages but sufficient water to cultivate a crop using AMIT. Farmers accept that drip irrigation is the only option to cultivate their land and they are familiar with the technology as a result of the Government of India's micro-irrigation subsidy system, provided in the main to wealthier farmers.
- **Government subsidy has established a drip irrigation industry and raised farmer awareness:** Maharashtra state has responded fully to the Indian Federal Government's subsidised drip irrigation promotion, operating the highest level of subsidy for drip technology in the country. Although the poorest do not have ready access to these subsidies the subsidy system has been a major boost to the drip irrigation industry and

has raised overall awareness. IDE's programme in the region is building on this base and starting at a higher level than other parts of India, or indeed most other developing countries.

- **Wage labour opportunities:** Maharashtra has considerable wage labour opportunities in the industrial areas of Mumbai and other major cities which provides economic support to the poor. Many poor farmers use this as a way of earning cash to invest in wells, pumps, pipes, and drip irrigation for horticulture.
- **Marketing opportunities:** Maharashtra produces a variety of fruits and there exists a chain of fruit markets throughout the state linked to other markets of India. New irrigation users are able to link easily into this chain to market their fruits.

Zimbabwe: Trials demonstrated the need for continued regular support of AMIT adopters with extension advice and technical training. The Zimbabwe component failed to generate strong interest in the kits, often because farmers did not perceive water scarcity to be a problem. In the short term, where farmers have access to rehabilitated or newly constructed small dams, the individual users do not perceive water as a scarce commodity. Furthermore, the market demand for vegetables in rural areas is often limited. Farmers did recognise that AMIT, if used effectively, gave higher yields of better quality produce and this was perceived as its main benefit. The current political economy in Zimbabwe is disruptive to private sector activity, to produce marketing, to transportation, and to farmer incentives. In such an environment this project would not recommend AMIT as being appropriate to local needs, nor the market approach as being achievable without considerable and sustained effort and resources by the promoter.

Research Questions

Q1. Do AMITs offer sustainable technical and financial benefits to the users when compared with existing irrigation practices?

Where adequate technical and agronomic training and support are given AMITs can offer technical and financial benefits. However, the degree of benefit varies greatly according to the type of kit used, types of crops grown, the attitude and skills of the user, their current wealth status and the wider commercial and agricultural context in which their farming takes place.

The smallest bucket kits may offer some improved family nutrition and food security during the dry season although households could possibly irrigate a similar very small plot through careful manual irrigation. Larger systems, generally customised rather than 'off-the-shelf' packs combined with a high value crop offer the greatest visible impact on livelihoods through an improved cash income that may contribute as much as 60% of the total annual income of a household. Low head kits, where a container is filled manually, do not appear to offer any significant savings in labour inputs, but larger customised pump-pressurised systems can reduce field labour.

The AMIT kits did increase the productivity of water under farm conditions, although in Zimbabwe, where detailed field records were kept the depth of water applied by AMIT was similar too, or slightly greater than, the depth applied on the 'control' plots. These control plots – small basins irrigated manually with buckets – were routinely under-irrigated, presumably due to the drudgery of carrying sufficient water. The AMIT kits applied the same or slightly greater depths of water but provided higher yields.

Quantitative data from sustained field records were not collected in India. However, a single farmer in the East India study reported that his water use dropped from 8 to 10 buckets applied twice daily, under conventional irrigation, to 2 buckets three times per day with the AMIT kit, during peak summer demand. If sustained over a season this would represent a 66% reduction in water use. In the West India study, where many farmers use pumps to draw water from wells, farmers estimate that the pumping hours required to irrigate an acre of pomegranate using the customised AMIT kits (3-4 hrs) was only half the time required when using the same source and irrigating by surface furrows. However, with the larger, customised kits there is little to distinguish AMIT from ordinary commercial systems apart from the use of simpler and cheaper system components. The greatest single benefit of AMIT may be that of revising the design and design standards applied when assembling smaller systems. But these systems are still generally pressurised, simple but custom designed and adopted by borderline or self-sufficient farmers, not the poorest of the poor.

The degree of sustainability of technical and financial benefits will depend on the availability of spares, of technical and agronomic support from the supply chain, continuing availability of the minimum water requirements, the presence of a viable market for AMIT produce, the ability to access that market, and (not least) the effectiveness and efficiency of the supply chain. The lack of any one of these can negate the whole viability of the sustained extension of the technology. It is apparent in Zimbabwe that many of these requirements are not in place, which puts the further expansion of AMIT in that country at risk.

Q2. Whose livelihoods can be enhanced by purchasing AMIT, in what way and by how much?

In eastern India, where there was no familiarity with the technology, limited technical training and support, and only local markets for produce the wealthier farmers were the main beneficiaries of AMIT, largely gaining in financial terms (about 5–8% increase in annual income). The very poorest seldom purchased the technology as it was too expensive for them, and they could not afford to take the risk. Where they were given a kit, usually as a grant through an NGO, they do see a benefit from an improved food supply. They are rarely able to grow sufficient produce to sell and thereby obtain cash income. This enhancement of food security for the poorest, however, is a desirable, beneficial and important livelihood benefit from AMIT.

In western India, however, where enabling conditions were more favourable, micro-irrigation technology fits as part of a larger investment in horticultural production. This whole technology and farming system package can contribute a significant beneficial impact on livelihoods (in terms of food security, yield, nutritional value, time-savings, water use) and can also help to raise annual household income in the West Indian context. The poorer farmers were able to benefit from this practice by saving earnings from wage labour over a period of years, and/or pooling resources with family and friends.

Experience in Zimbabwe found that it was households of average or above average wealth, with access to their own water source that showed greatest interest in using AMIT kits. The poorer families did not have private land or water resources to exploit, and were thus least likely to be able to enhance their livelihoods via AMIT. The absence of an accessible produce market also reduced interest in the technology.

It was found that women benefit directly from the use of the smaller kits which are used predominantly in the homestead gardens, while the larger drum and customised kits are favoured by the men. As explained in the previous research question AMIT did not significantly disturb or change the gender roles and pattern of labour in the Indian context. However, in Zimbabwe gender roles and the pattern of labour was altered by AMIT resulting

in an increase in the workload of women, sometimes significantly. It is likely that the benefit to livelihoods offered by AMIT will be less if it causes significant and unsustainable disruption to traditional gender roles and to family labour distribution.

It was deemed important to ensure that users have the following to have any hope of enhancing their livelihoods through use of AMIT and customised micro-irrigation technology:

- Technical agronomic support for the initial couple of seasons at least because of the changes required to traditional cropping systems[1].
- The ability to access and transport sufficient water.
- Availability of credit.
- Assured supply of quality production inputs.

The possibility of livelihood improvement via AMIT (through, either food security benefits, nutritional gains, or income generation) therefore will only be open to those farmers who have access to (or can be supported to have access to) the above points. In general this will not be the poorest farmers.

Q3. What are the constraints and opportunities of a market-oriented approach to support the sustainable adoption of AMIT by the poor?

The theory underlining the approach is that those innovative farmers should be targeted first of all. These early adopters of the new technology will not be the poorest but will be the wealthier farmers. IDE, the promoter of the market approach, believes that once the rural poor see how these farmers are benefiting they will also take-up the technology. If the product meets the needs of the farmers, considerable market growth should result, creating a sustainable supply channel for the product. The envisaged increased demand for the low-cost technologies, it is purported, will create employment on the supply side and result in consumer satisfaction on the demand side. However, the 'market-oriented' approach for AMIT is not entirely reliant on market forces but involves the following, non-commercial elements:

- Start-up costs (product and market development) provided through external grant assistance.
- Users – or facilitating intermediaries such as NGOs – pay only for the product (they do not repay the costs of product and market development).
- Costs of local NGOs, that are an essential element of the supply chain, must be met from their own funds – they are not reimbursed from the market price of the product.
- The price of the product includes a fair margin for the commercial players in the supply chain.
- Kit assemblers or distribution agents at the local level interact directly with potential users on a commercial basis and are expected to provide after-sales (technical) service.

The ***opportunities*** that this approach offers, as a means of getting irrigation technology into the hands of the poor are:

[1] There are issues associated with who should provide this support, what the constraints are, how sustainable the market approach's method is, and the costs involved. It is possible that NGOs, the private sector, or the local/regional government (not subsidy) could provide such technical support. Such costs must be considered in any strategy to roll out the technology and the approach to other countries.

- The approach may offer a more efficient and sustainable use of donor funds, but it remains unclear how readily a BDS facilitator (the consumer of donor and/or investment funds can withdraw without the system collapsing.
- Under optimum conditions the market-led approach may achieve sustainability faster than other methods of technology uptake, but the presence of a BDS facilitator should be ensured for at least 5 years.
- The market approach facilitates access to AMIT products more quickly and efficiently than via the government subsidy systems.
- The market approach can provide job opportunities within the market chain e.g. assemblers, dealers etc. and therefore may serve to stimulate the local and regional economy and private entrepreneurship (evidence not yet clear).

The ***constraints*** of a market driven approach to technology dissemination to the poor include:

- The market approach can bring technology and technical support to relatively poor farmers but cannot reach the poorest of the poor without further support.
- Local NGOs play an essential role in reaching the very poorest but they can distort the market development process if they provide direct subsidies to farmers. Well-managed credit, rather than subsidy is the preferred option.
- BDS Facilitators must finance the provision of technical and agronomic training for users. It is unrealistic to expect commercial service providers to fulfil this essential role.
- The highest potential livelihood benefit from AMIT is applicable mainly to high value crops where a market is available to the growers.

This research study was, however, unable to confirm that a sustainable marketing system can be established that remains viable once the primary facilitator withdraws. This appears to be a serious drawback to widespread adoption of a market approach to technology dissemination. This is particularly the case when complex technologies, like AMIT (which require a change in farming system) are to be extended.

Q4. How transferable are the technologies and the approach to other locations?

Low-cost drip irrigation technology cannot be treated as a 'silver bullet' technology that can be introduced into any environment. Rather, a minimum number of pre-conditions must be met before the technology is likely to have wide appeal such that commercial marketing can be sustained. The seven important criteria which are necessary to ensure transferability of AMIT technology disseminated via the market at a **village level** are to work in areas where: (a) existing agricultural practice includes irrigated cropping of vegetable, horticultural or other high value crops; (b) water is available but limited. (c) field plots can be observed from the homestead or the culture is such that equipment theft from the field is uncommon; (d) households have some cash earning opportunities to cushion the risk; (e) markets for produce exist and can be readily accessed; (f) farmers have access to good quality agricultural inputs and credit; and (g) NGOs or other agencies are present for at least 3 years to provide the necessary technical and agronomic support to adopters of AMIT.

These conditions, by their very nature, have a tendency to exclude individual poor farmers. Unless they pool their resources the poorest of the poor will unlikely be able to demonstrate these enabling factors. Areas not exhibiting these requirements are less likely to be viable areas for the AMIT market approach to be transferred to.

The enabling conditions necessary to transfer the technology and approach to other areas are to ensure that at the **project and/or programme level** the implementing team must be multi-disciplinary with a broad spread of skills. Secondly there must be adequate financial and human resources to plan and implement campaigns and demonstrations sensitively. Finally the strategy must be present in the area for at least 5 years to ensure take-off of the scheme and give a chance for sustainability of the technology and the market chain.

To ensure transferability at the **regional level** drip irrigation should already exist amongst the commercial farming sector at a sufficient scale to ensure supply of basic drip irrigation components within the region. Furthermore, produce price must support fair margins for the supply chain, where there is a free market or at least some degree of liberalisation, and government policies should be supportive.

Conclusions

It can be concluded that in the right context and with adequate investment in establishing supply and demand, the market-oriented approach appears to offer benefits in terms of potential for efficiency of crop production and water use. Developing and marketing a lower price micro-irrigation product aimed specifically at the poorer farmer can overcome the problems of state and federal subsidy systems. However, such an approach cannot be 100% reliant upon commercial forces and the approach, therefore, should not be purported as such. Major reliance is placed on local NGO staff and other agencies, and these, in turn, are reliant upon donor funds.

AMIT does not sell itself. The investment in personnel and marketing is very large. Furthermore, the BDS Facilitator (such as IDE) has high costs usually borne by a donor organisation (note that quantification of these costs was not possible during this study).

The research has shown that there are a number of issues concerning the marketing approach and its appropriateness to extending micro-irrigation technology to the poor, as described below:

- There is not currently conclusive evidence of a market sustaining itself after the BDS Facilitator pulls out.
- There are a large number of quite specific enabling conditions that must be in place before AMIT can be delivered to the poor as a potential channel out of poverty.
- Technical and agronomic support and training for users must be provided at least for the first two seasons of use and preferably beyond this.
- Customised kits and pressurised systems, more akin to conventional drip technology, tend to see wider adoption using the market approach than small drum and bucket kits, provided the context is right.
- From the Indian and the Zimbabwean experience drum kits are not perceived by farmers to offer sufficient benefits over existing practice to merit farmer investment. The labour and water savings made are evident but not huge in significance and improved yield and quality seem not to attract much interest from farmers unless there is a real market for the AMIT crops, and/or the many obstacles to get that crop to market can be overcome.

The market approach, if appropriate to an area and well implemented, may present a better way of providing extension and a better way of technology dissemination. The emphasis on market forces being the driver of the approach and the disseminator of the technology however, is slightly misleading, at least in the initial phases, as the facilitator must maintain a

presence for at least 5 years to create and sustain an effective marketing chain. The cost of their presence is also not covered by technology sales and therefore represents a subsidisation of the approach.

The marketing approach investigated here has potential as a means to extend and market technologies like AMIT, however there are a number of issues which need to be addressed, the most important of which being:

(a) the funding of market development and after sales service

(b) the involvement of NGOs in extending the technology and the commensurate effect of subsidies which these organisations provide

(c) the detrimental effect of subsidies being offered on the same technology in the same locality on a market approach, and

(d) the role of government departments in this kind of approach to technology transfer

Implications of Project Findings

The project purpose was to identify and address constraints to adoption of low-cost, improved, non-surface irrigation technologies by resource poor farmers on a commercially sustainable basis. The project has succeeded in identifying and understanding the constraints to adoption of AMIT technologies by the poor through a market approach to dissemination and uptake. It has gathered considerable understanding and analysis of the tenets of the market approach and of the specific enabling environment required to support such an approach. IDE has taken account of some of the research team's early findings and shaped their marketing efforts accordingly – thereby overcoming some of the constraints to AMIT adoption in East India. Whether that market will continue to function if the promoter (IDE) withdraws at this stage is less likely. Addressing and overcoming constraints to the market approach was not an objective in the West India and Zimbabwe components of this project but a good understanding of the constraints and the enabling conditions required in the West Indian and Zimbabwean context has been obtained. After three and a half years of research and an even longer presence of the main implementing partner, IDE in West India, there is a lack of conclusive evidence of commercially sustainable markets in micro-irrigation being developed that will continue to function if the promoter (IDE) withdraws. The theory is that at some point the market will no longer require support and will be self-perpetuating.

It is possible to conclude that small unit AMIT kits do not offer much incentive in terms of livelihood impact to resource-poor farmers, albeit they can provide some assistance with regard to food security through production of vegetables for the household. The larger customised and pressurised systems, more akin to conventional drip technology, do offer greater benefits and are more attractive to farmers who can make the required investment – these people are usually not in the poorest wealth categories but the technology nonetheless offers them substantial benefits. The technology is attractive in the Indian context because it places a low cost product in the market place that competes directly with the price of other 'commercial' hardware after state or national price subsidies have been claimed. AMIT makes drip irrigation available to the many thousands of farmers who cannot satisfy the requirements of the subsidy system. It may prove difficult to transfer such a context to many African states.

The market-oriented approach itself can offer advantages in getting technology to poorer farmers, in a specific enabling environment. The approach certainly overcomes the constraints of state and federal subsidy systems that exist in India. However, it is not 100% reliant upon market forces and should not be considered as such. Major reliance is placed

upon a promoting body that must provide considerable and lengthy investment in product development, market chain establishment, promotion and on-going technical and agronomic support. The costs of this agency are not recouped from the commercial marketing of the technology but represent the 'aid' (a form of subsidy) input into the process. Furthermore, there is heavy reliance on local NGOs. They play an essential role in increasing access to the poor but their subsidising of the 'market approach' must be recognised.

One of the original intentions of this project was that "irrigation products would be sold and in use in West and East India earning manufacturers income and farmers cash returns, using water more effectively and improving yields" (Output 4 of logframe). However from the findings described in Chapters 2-5 of this report such as:

- the difficulties encountered in starting up a market and ensuring a demand for the product, particularly in East India
- the small bucket and drum kits not being saleable and desirable on a large scale in the East Indian context; nor were they in the West where it was the larger, pump-fed customised kits that were more popular; and
- the failure to find conclusive evidence that AMIT products will be used, can be sold, can provide income for manufacturers, and can provide viable returns to the poorest farmers

it became apparent that this output was set at an over-ambitious level and also contained an inherent assumption that the irrigation kits would be sellable and desirable on a large scale. Such an output is dependent on factors outwith the control of the project such as farmers perceiving a value in the kits and thus demanding them, manufacturers who are willing and able to sell kits, and to make enough money out of them for it to be worthwhile etc.

It also became clear at the beginning of the research that the team's belief that they already had a proven technology that could be, and was being, readily marketed was not quite accurate. In reality in East India the project had to start from scratch with the introduction of the technology and the establishment of a demand structure and a market supply chain; whilst in the West the project found that most of the marketing was being undertaken by NGOs and did not conform to the type of market strategy that had originally been implied (ie. where subsidies are not used).

The project has been successful in testing claims that AMIT technology can be delivered through the market to millions of poor farmers throughout the world offering them water-saving kits and providing significant livelihood benefits. Our findings are of relevance to this lobby and should be used to qualify such claims and to improve the targeting and implementation of such on-going work. Of particular importance here is the recently established Global Network for Low-Cost Micro-Irrigation.

1 INTRODUCTION

This report documents the findings of AMIT project for activities undertaken in India and Zimbabwe for the period 1999-2002, and highlights work undertaken by the main collaborating research partners IDE and EDA in India and ITDG in Zimbabwe. Co-ordination of the research was undertaken by ITC as the UK implementing agency. This section summarises the research rationale, the research objectives and the project design.

1.1 Research Rationale

In semi-arid regions, and other areas where water is scarce and returns to small-scale irrigation are high, appropriate modern irrigation technologies may provide opportunities to improve livelihoods and reduce poverty. However, many modern irrigation technologies have long been deemed to be too sophisticated, expensive or large-scale to be adopted by small and marginal farmers with limited access to land and water resources. This is despite the knowledge that it is precisely amongst these farmers that the benefits of water saving, enhanced yields and reduced drudgery could have the greatest impact. The question that arises therefore is whether it is possible to identify, develop and market selected modern technologies that can be successfully adopted by the small farmer.

India has seen a huge increase in the area under micro-irrigation over the past 10 years. Now, with an estimated 350,000 ha under drip, India is second only to the USA in area under drip. The development of a large, national irrigation equipment sector and the existence of both state and national price subsidy schemes have catalysed this rapid growth. However, as with any new technology some may gain and others may lose: within a household, village or region. Often it is those with most assets and security who are able to take advantage of innovations. To date, only a very small number of the poorest, marginal farmers in any state have adopted any form of modern irrigation technology. It is important to understand how a technology affects livelihoods of all people within its sphere of influence – those who adopt, but also those who do not, and those who may be adversely affected by the adoption by others. The challenge is to understand how such technologies can be developed and disseminated to enhance opportunities and limit inequalities.

If appropriate irrigation technologies exist then how can they be made available to those who need them most? Though technologies such as these are clearly private goods the private sector cannot be expected to invest in developing, marketing and supporting products for the rural poor when richer, more accessible customers exist. Yet public sector approaches are costly, can be unsustainable and do not have incentive structures that give due priority to the farmer as customer and client. New models of public-private partnership are necessary. Could marketing, sales and product costs be fully cost-recoverable, and driven by incentives, while management, evaluation, market research, product development and after sales-services are subsidised? This may lead to more efficient, effective, equitable and accountable services being delivered beyond normal bounds to reach the poor, and a more effective and lasting use of donor support.

Over the last eight years the international NGO International Development Enterprises (IDE) has sought to use such a market driven approach to disseminate affordable micro-irrigation technologies (AMITs) in several Indian states. However, to date there has been little independent review and evaluation of the technologies or the marketing mechanisms used to disseminate them. If the claims made by IDE (Refer to www.ide-international.org and www.ide-india.org and to IDE and Winrock (March 2001). Smallholder Irrigation Market Initiative. Study on the dissemination potential of affordable drip and other irrigation systems and the concrete strategies for their promotion. Funded by the Japanese Institute for

Irrigation and Drainage; and to the SDC Global Micro-Irrigation Network Launch. Bern, Switzerland, 1-3 June 2002) are valid and their approach can be replicated in other locations this could have important consequences for the promotion of improved irrigation technologies amongst the very poor, not only in India but also in other developing countries. The same model may also be used for other types of poverty-reduction technology.

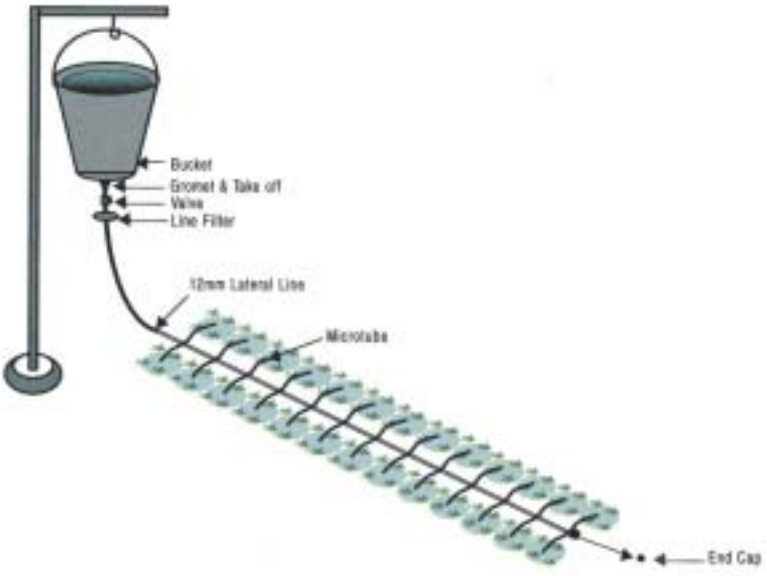
Previous studies in Zimbabwe focused on the technical evaluation of different irrigation technologies and demonstrated that yield and water use efficiencies could be improved when compared with traditional bucket irrigation. However, the studies were fairly narrow in their scope. They did not include any farmer participation in the evaluation of the technologies but sought to promote a selected option based on research station trials. In the field that technology was not considered by the farmers to offer sufficient practical benefits to justify its use and so was not adopted.

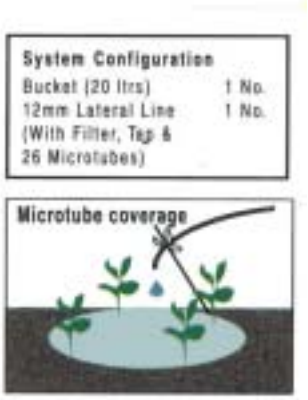
The rationale in Zimbabwe was to evaluate the technology in the different social and economic setting of an African state that offered a relatively well developed industrial base and a commercial farming sector. The research built upon the findings of earlier work undertaken by the Institute of Hydrology – that productive water points can improve the resource base of communities when water is scarce and savings can be made. The project considered the transferability of IDE's marketing approach to technology transfer to the poor from the Asian to the African context.

1.2 The AMIT Technology

Diagrams of the AMIT technologies researched in this project are given below along with the technical specifications and the cost of each package. The materials used to assemble the kits vary between locations depending upon what is available on the national market. In India the laterals and micro tubes are made from linear low density polyethylene (LLDPE) fittings are all 'off-the shelf' components, normally made from extruded polyethylene. The bucket or drum will be sourced from the local market.

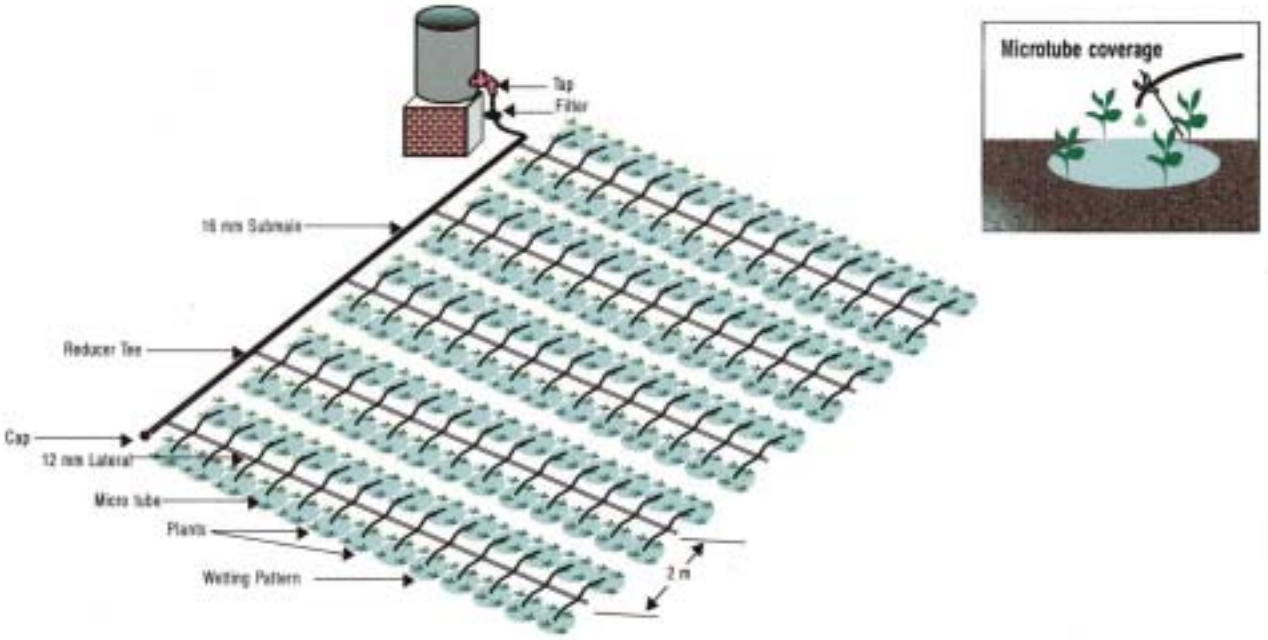
1.2.1 The Bucket Kit





Area coverage:	25m^2
Approximate number of plants irrigated:	100
Approximate number of times to fill kit:	3-4 times a day
Cost	US $5 (including the bucket)

1.2.2 The Drum Kit



Area coverage:	120m^2
Approximate number of plants irrigated:	500
Approximate number of times to fill kit:	1-2 times a day
Cost	US $25 ($12 for the kit; $13 for the drum)

For both the bucket and drum kits all the pipes are pre-fitted and packed in a small box. The idea is that the farmer simply has to unroll all the pipes, lay them on the ground and connect them to the bucket or drum. A small pictorial manual is usually also included to guide the farmer on the correct installation and planting requirements.

The basic design of these drip kits are such that they can be fed simply by gravitational flow of water and do not require the use of a pump.

1.2.3 Customised Micro-irrigation Systems (CMS)

As opposed to the bucket and drum kits described above the customised micro-irrigation systems are not pre-assembled and readily available off-the-shelf. Customised systems are actually assembled in the field itself based on the specific field conditions and the requirements of the farmer. An expert will research these requirements and then design the drip irrigation system based on the farmer's cropping requirements, water availability and the field dimensions. Such systems then are likely to be unique (ie. customised) and tailored to

individual requirements. They are therefore not available in stores and their design and provision requires specific attention and therefore increases the costs involved in the provision and therefore the ultimate price of the kit. Customised systems tend to be designed to cover larger areas, and are usually designed to work with some form of pumped water provision. The difference between these customised systems and the smaller off-the-shelf bucket and drum kits are therefore considerable.

1.3 International Interest in AMIT

The project has been successful in testing claims that AMIT technology can be delivered through the market to millions of poor farmers throughout the world offering them water-saving kits and providing significant livelihood benefits. Our findings are of relevance to this lobby and may qualify such claims and improve the targeting and implementation of future work. IDE has worked to make a case for the wide-scale promotion of low cost irrigation technologies. In 2001 they joined with Winrock International and the Japanese Institute for Irrigation and Drainage to submit a document to the World Bank Group on a "Smallholder Irrigation Market Initiative" (SIMI) (World Bank, 2001). Based on a series of rapid case studies with data from Kenya, Zambia, Bangladesh, Nepal, India and China the document describes a 'Global Initiative for Smallholder Irrigation' with the objective of bringing 1 million hectares per year under low cost irrigation for 15 years. While such an objective is well meaning it is unrealistic given that the global extent of commercial drip irrigation in 1981 was just 400,000 ha; an area which expanded to just 1.8 million ha over the ten years to 1991, (Bucks 1993). There is concern that other assertions underlining the Global Initiative may also be unduly optimistic.

Other international agencies that have a strong interest in low-cost micro irrigation for the poor and the use of market creation methods for their dissemination include the Swiss Agency for Development and Co-operation (SDC) and commercial manufacturers. As an aid agency SDC has provided considerable funding to IDE and has recently established a 'Global Network for Low cost Micro Irrigation (BeraterInnen News 2001). That network is an obvious channel for the dissemination of these research findings. Netafim is a major commercial manufacturer of drip and micro sprinkler irrigation hardware. During the last 3 or 4 years they developed and promoted a "Family Drip System (FDS)" indicating that they perceived a potential market for such a technology. However, Netafim did not find success in promoting these packages in India using a market approach (www.netafim.com). They are finding greater success on the African continent with a more traditional approach to dissemination using NGOs. A personal communication from Netafim states that "*We have tried to introduce our 'Family Drip System' in India, without great success. Trying to analyse the reasons for that…[a] company like us is not built to assist big numbers of extremely small land holdings and collect the proceedings afterwards…we failed in localising the proper NGOs and thus our marketing plans were not successful*." (Zvi Feler, Managing Director of Netafim Irrigation India Pvt Ltd).

1.4 Research Objectives

In order to evaluate the irrigation technologies being promoted by IDE and the marketing mechanisms used to bring them within reach of the poor and marginal farmer this action research project sought to address the following research questions:

1) Do AMITs offer sustainable technical and financial benefits to the users when compared with existing irrigation practices?
2) Whose livelihoods can be enhanced by purchasing AMIT, in what way and by how

much?

3) What are the constraints and opportunities of a market-oriented approach to support the sustainable adoption of AMIT by the poor?

4) How transferable are the technologies and the approach to other locations?

1.5 Project Design

To answer these four key questions the project undertook action research in three distinct geographic regions – two in India and one in Zimbabwe.

The two areas in India represent:

- **India East** - *Bihar and West Bengal.* A new area where AMITs had not previously been promoted. This provided opportunity to evaluate and document MI interventions in an area with the following characteristics and issues: (i) no previous exposure to MI technologies on a wide scale, (ii) high levels of poverty, and (iii) highly drought prone.
- **India West** – *Maharastra, Himachal Pradesh and Gujarat*. An area where the AMITs, and the distribution systems that support them, have been established for 3 years or more. This provided the opportunity to evaluate the effectiveness of the distribution and marketing systems put in place by IDE as well as allowing evaluation of the irrigation systems in the field through users' assessment of their benefits and non-benefits, and their wider impact in the communities, and on poverty reduction.

Introduction of the technologies on a pilot basis in **Zimbabwe** allowed the project to assess the degree to which the technologies and the marketing methods developed by IDE in India could be transferred to an area with different economic, social and agronomic conditions. The work built on earlier detailed technical research into small-scale irrigation with limited groundwater funded by DFID and took cognisance of continuing work to introduce modern irrigation technologies to farmers in the communal sector carried out by the private sector, government agencies (AGRITEX) and international donors.

The AMIT kits were tested on a pilot basis in semi-arid areas of Zimbabwe for their technical and agronomic performance and potential impact on local livelihoods. The study allowed the project to assess the degree to which AMIT, and the marketing methods developed in India, could be transferred to an area with different economic, social and agronomic conditions.

More detailed information on the project activities can be found in earlier research and progress reports such as the Inception Report, the BAU technical report on kit performance under controlled conditions in India, the Zimbabwe End of Season Evaluation report and literature review.

2 EAST INDIA STUDY

The project activities were undertaken by four collaborating organisations:

- EDA Rural Systems (EDA) - responsible for the socio-economic studies,
- IDE – responsible for action research
- EIRFP - responsible for certain development activities and general project support
- BAU – responsible for technical evaluation of MI equipment.

The methodology and findings of the project activities are outlined below.

The AMIT kits and IDE's marketing strategy were evaluated over six cropping seasons (three winter or *rabi* and three summer or *zaid*) in three and a half years (1999-2002). During this period EDA documented the dissemination process, with the objective of answering the four research questions. The EDA report for the period November 2001 to June 2002 for East India are presented in Annex 2. Detail of the findings during the first two years of the project can be found in the reports entitled AMIT Interim Report - India (March 2000), and AMIT Report 2000-2001 – India (October 2001).

EDA documented the introduction of AMIT kits marketed by IDE in Ranchi District, Bihar and Purulia District in West Bengal (refer to Annex 1). The area has relatively high rainfall (1000 – 1500 mm) with fertile soil, especially in localised areas. However, rainfall occurs mainly during the monsoon, limiting most irrigated cultivation to the *kharif* season (July to October). There is marked water shortage during the winter (November to February) *(rabi)* and summer (March to June) *(zaid*) seasons and irrigation capacity is limited. Nearly half of the land is classified as upland, where soil quality is sandy with low moisture retention. The lowland soils are better able to conserve moisture and are more easily supplied with irrigation. They therefore have a longer potential cropping season and higher yield potential. The area has high levels of rural poverty. Mean landholding is 2.5 acres (1 ha), and the majority of farming households fall in the poor (deficit) socio-economic class, having relatively more upland than lowland.

The research sought to understand the issues of access to and use of the technology; crop marketing; the provision of extension support, and farmer perceptions of utility, water-saving and impact, disaggregated by gender and socio-economic group, using the five categories developed by KRIBHCO (now GVT) East India Rainfed Project (Table 2.1).

Table 2.1 Economic Ranking Categories

Wealth rank category	Criteria
Surplus - S	High living standards. High income from various sources and through market sale of paddy.
Self –Sufficient - SS	Substantial income and yield from own land. Rarely dependent on others for employment.
Deficit – D1	Yield from own land not sufficient to meet family needs for more than 10 months of the year; involved in casual labour.
Deficit – D2	Yield from own land sufficient for less than 10 months of the year; involved in casual labour, landholding mainly upland.
Deficit – D3	Landless families, entirely dependent on casual labour. Barely able to meet basic needs.

Source: Derived from KRIBHCO 1999

Methods used by EDA included baseline data collection at the beginning of the project, interviews with the IDE staff, NGO partners, supply chain links, individual adopters, their family members and neighbours. EDA visited in the last year a total of 94 AMIT farmers out of which 62 installed AMIT during the summer season. Thirty-eight of them were new dry season customers and 24 were repeat AMIT users from previous seasons. The results presented here need to be considered in relation to the relatively small sample size.

2.1 AMIT Marketing

IDE began its AMIT promotional campaigns in December of each year which is the mid-winter season (the winter season in India is known as *rabi* and runs from October to February). Market development activities were mainly focused on Purulia. IDE's main effort was on direct sales and after sales services to individual farmers. Though the sales volume through NGOs was quite high, it resulted from bulk sales to just five NGOs of which SRI purchased 85% of the kits.

Live demonstrations, short campaigns and village camps were held to promote individual sales. During the course of the project IDE improved AMIT packaging to add more appeal and introduced product innovations to enhance AMITs popularity and take-off in the region. Om Engineering, the carrying and forwarding agent in Ranchi, was linked to manufacturers of drip irrigation equipment in Maharastra to ensure better quality products. New dealers were established in Ranchi and Purulia to ensure easy availability of AMIT.

Approach: During the first two years NGOs were the main focus of the marketing approach. However, in the last year of the project IDE laid considerable emphasis on individual AMIT sales and hired temporary staff to increase the capacity of their marketing support team in the East. IDE also acknowledged that subsidies for kits sold to individuals or to NGOs undermined success of the market approach and such practices were discouraged. However, flexible payments in 2 or 3 instalments during the season itself were allowed.

Promotional activities: IDE had to engage in widespread and comprehensive promotion to raise awareness of the AMIT kits and boost sales. The promotional campaigns began in December of each year and gained momentum between March-April enabling more than 60% of annual sales during this period. Handbills, banners and boards were used during short campaigns, live demonstrations, farmer exposure trips and village camps for promoting AMIT.

New initiatives: A new nut and washer system was introduced in the final year to prevent leakage from the tap – which was one of the complaints in the previous seasons. The "tank kit" was introduced through which AMIT could cover a larger area (also a previously aired complaint from farmers). AMIT packaging was improved to add more appeal to the product. The concept of network marketing – where anyone who generated AMIT orders obtained a commission for the service, was introduced to increase sales volumes. This initiative generated immense interest in AMIT.

Considerable resources: The resources employed in such marketing activities, in terms of personnel, time, costs, promotional materials etc were obviously quite considerable. Such costs of establishing a supply chain and stimulating demand are not recouped in the price of the AMIT products and are not carried by the market chain itself. This approach therefore requires an agency with a long-term (over 3 years) presence and significant funding and staff resources. This is particularly relevant for complex technologies like AMIT where a considerable amount of time is required to first expose farmers to the technology, followed by active extension with adopting farmers and subsequent follow up. This is in contrast to the transfer of simpler technologies such as the treadle pump.

2.2 Strengthening the Supply Chain

More responsibility for the supply chain: Three new manufacturers in Nasik, Bangalore and Amritsar were identified by IDE to supply AMIT components in the final year of the project. By this stage in the project Om Engineering, the carrying and forwarding agent in Ranchi, independently handled all the steps from procurement and inventory management to packaging, assembly, after sales service and settling warranty claim, thus reducing IDE's role as facilitator in the process. It would seem therefore that after 3 years of continued support by IDE the supply chain was beginning to consolidate its role and take greater control of the marketing and sale process.

New dealers for meeting demand: IDE identified Goel Machinery and K.C Pal and Sons, as new AMIT dealers in Ranchi and Purulia respectively. In addition, Om Engineering also sold AMIT kits from its new showroom in Ranchi.

Proactive dealers are important: The dealership, K.C Pal, showed foresight as this dealer was able to meet the high demand by selling more than 75 kits during the last season in East India.

2.3 AMIT Sales

Sales volume: By July 2002, the AMIT programme completed three years in the area, during which farmers had used the kit in three *zaid* seasons and two *rabi* seasons. A total of 135 farmers adopted AMIT in Ranchi, Purulia and Jamshedpur during this period. (Table 2.2; refer also to Annex 1, p18)).

West Bengal was the largest market for individual kits and Ranchi, where a local NGO, the Society for Rural Industrialisation (SRI), purchased 180 kits, was the largest market for NGO sales. In general the kits purchased by NGOs were provided to farmers on subsidy, either as a complete grant to households or a partial subsidy with some of the cost being met by the household. A minority of NGOs however favoured a soft loan approach based on varying repayment conditions.

Table 2.2 AMIT farmers – Ranchi, Purulia and Jamshedpur

When AMIT was Adopted		Adopters			
		Total	Interviewed in final year (2001-02)	AMIT users in final year seasons	
Year	Season			Rabi 2001-02	Zaid 2002
2000-01	*Zaid*	16	5	3	1
	Rabi	24	19	1	1
2001-02	*Zaid*	40	26	9	21
	Rabi	8	6	7	1
2002	*Zaid*	47	38		38
Total		**135**	**94**	**20**	**62**

Types of kits sold: Four types of kits were sold: bucket kit (78), drum kit (35), customised kit (222) and micro sprinklers (10). The prices of different types of kits ranged from Rs 225 (US $5) for bucket kits to Rs 3,000 (US $63) for tank kits. Individual farmers directly purchased 83% of bucket kits. This is because bucket kits involve less risk and yet provide

farmers (mainly first time users) the opportunity to use and understand the technology. Drum kits were purchased by both individuals during direct sales (57%) and NGOs through bulk sales (43%). The majority of the customised kits (85%) were sold to NGOs, mainly SRI which introduced biodynamic gardening (a form of organic farming) using customised AMIT kits.

Water scarcity – actual and perceived – is vital: The AMIT sales pattern shows that the demand for AMIT is higher (more than 75% of the kits) during the summer season. This is because water scarcity is more prevalent during this time and AMIT provides greater utility by enabling families to cultivate otherwise fallow land. In contrast, there is usually sufficient water during the winter months from residual moisture and farmers are able to cultivate their fields. Some AMIT adopters who had purchased kits in earlier summer seasons dropped AMIT use in the winter before taking it up again in the following summer. The perception of water scarcity by the adopters is important and critical to the uptake of AMIT. This is noted in Chapter 3 on West India where rainfall is lower than the East and is a large part of the reason for the higher adoption rates in that region.

Technical and agronomic support is essential: In cases of bulk sales to local NGOs, the NGOs provided IDE with a list of the farmers who were 'given' kits so IDE could visit them 2-3 times during the season. Such follow up support with individual adopters was more intense and ranged between 4-6 visits during the season. This was only possible because IDE staff combined follow-up visits with those for selling more kits in the same village. However, this is quite a resource-intensive exercise for one organisation to carry the cost of and it must be adequately provided for because this research (refer to Annexes 1 and 2) has shown that if this technical and agronomic support is not provided the kits will not succeed.

2.4 AMIT Findings in East India

The poor require support to purchase the kits: Out of 38 kits sold directly to individuals during the summer 2002 season, 21 were higher and middle income and 17 were poorer (deficit (D1)) farmers. None of the individual AMIT customers belonged to the poorest (D3) category. However, out of the 62 farmers who actually installed AMIT in the dry, winter season, 13 were from the poorest category. These poorest (D3) farmers had acquired AMIT kits through NGOs such as SRI in Ranchi, BSS in Jamshedpur and Kalyan KVK in Purulia.

It should be noted that NGOs differed in their approach to the provision of subsidies to farmers, Some offered a 100% subsidy while others tried to recoup the cost of the kits with soft loans. In many cases there was little evidence of farmers repaying these "soft loans". Without support the poor are risk-averse and less likely to invest in kits.

The poor prefer the smaller bucket kits: The middle and higher income farmers purchased bucket kits, drum kits and tank kits (tank kits are a very localised and specific customisation including a very large masonry water storage tank. They are not a widely promoted idea and thus are not described in section 1.2). The poorest adopters installed bucket kits. Evident popularity of the bucket kit amongst the poor is mainly on account of less investment costs and greater convenience of the technology. Such kits are small and therefore unlikely to produce excess produce for sale and therefore financial benefit. Bucket kits serve mainly to improve food security and family nutrition through vegetable production.

Access to own water source is preferable: The better-off farmers use AMIT on their own wells. Although the water level falls during the summer it is sufficient for AMIT. On the other hand the poorer farmers, who do not possess their own water source, must fetch water from community sources. However, as many communities do not allow the use of water from

common resources for irrigation, especially during dry seasons this is a major constraint to the poor adopting AMIT, and thus mitigates against the viability of AMIT for the poorest in a community.

AMIT must be located close to a water source and is preferred to be closer to the home: Homestead plots are preferred for reasons of convenience, involvement of the entire family in irrigation, and security. Bucket kits, are located very close to the wells. Drum kits and customised kits are relatively farther from the well usually within a distance of 20 feet. Homestead locations help in the demonstration effect of successful AMIT crops. Location is also determined by the water source and the majority of AMIT users use wells closer to the AMIT plot.

Familiar crops are preferred: Vegetables are the most favoured, with cucurbits the most popular AMIT irrigated crop during the dry season as their production continues even during monsoon. Bitter gourd is especially popular as it fetches a good price in the local markets of Rs8-10 (US $0.17-0.21) per kilogram with less price fluctuation compared to the other crops. Familiarity with its cultivation also reduces the risk of failure. Apart from cucurbits, Brinjal or Lady's Finger is the most favoured during summer using the drum kit. Local varieties are preferred for all crops because they are cheap, easily available and farmers are familiar with their cultivation. Drought tolerance is an important consideration for the selection of a particular crop/variety. The linking of production to market demand for produce is an important consideration, especially with regard to ensured profitability.

Labour requirements remain unchanged: The observations regarding labour saving and effort requires some clarification. Each irrigation with AMIT (filling the drum with a bucket and supervising the irrigation) takes around 30 minutes and has to be done twice a day every day. The direct labour comparison is with flooding and manual lifting (*latha*) which for 3 decimals (50m^2) would take 45-90 minutes (depending on how dry the soil is) but is only done once in 7-8 days. Flooding with a pump is not a relevant comparison – no farmer would go through the hassle of hauling out the pump, priming it and setting it going (25-30 minutes) to flood just 3 decimals of land (10-15 minutes). The conclusion here is that there is, on balance, no real saving in labour when comparing AMIT to other manual methods of applying water. This will however vary depending on the distance from the water source to where the kits are installed, with a shorter distance of around 15-30 metres favouring AMIT.

Women are involved with bucket kits but less so with drum kits: The women's role in the decision making process with regard to adopting kits was found to be limited since men tended to make the final decision. However, AMIT use was often not an outcome of an active decision made by the household either by husband or wife because most NGO's identified innovative farmers and subsidised them either fully or in part for the kits. Once kits were installed women became heavily involved, particularly for the bucket kit. Women found using the drum kit to be arduous and therefore more suited for use by the male member of household. EDA's work considered gender issues in the project's Interim Report March 2001, Part II; and the AMIT Report 2000-2001, October 2001, Section 2.2.4, p40.

Increasing Area under AMIT: The project found that the middle and upper income farmers, quickly re-invested their returns from AMIT to increase the area under drip. Poorer (D1 and D2) farmers also wanted to increase the area under AMIT and intended to invest further in the future. The poorest (D3) farmers also wanted to increase their area under AMIT but they were not able to invest their own funds.

The better-off were more focussed on earning revenue from selling surplus, and were able to increase the area under drip faster (assuming there is a good market for the produce). This is because they had better access to funds – either through prior sale of crop or through flow of funds from regular income sources – and they are agile in making additional investments

with the aim of earning higher returns during the season itself. On the other hand the poorer farmers have a slower pace of AMIT expansion due to limited investment capacity and less risk-bearing ability. They were worried more about losing the additional investment if the crop failed and were satisfied with prolonged production for consumption as the benefit from the AMIT plot.

All the poorer farmers who adopted AMIT in the first two summer seasons during 2000 and 2001 had dropped out by the end of the last dry season (2002). This was due mainly to the dependence of these farmers on off-farm income during the period February to June and as they habitually migrated to supplement their meagre incomes, they tended to be less concerned about AMIT and its generally low returns. In contrast, the wealthier farmers had increased the area under AMIT. This demonstrates that the relatively better off farmers are more likely to persist with AMIT even if their crop fails occasionally because they are more able to take risks, and/or they are tend to be more innovative.

The findings from the project indicate a varied degree of success and failure of the technology, these being (refer to Annex 1, p24):

Two thirds of the AMIT farmers were able to produce a crop during the dry season. 19 earned revenue from selling surplus production and 29 obtained production only for consumption but perceived this as beneficial. The AMIT crops failed for 11 farmers for reasons other than the technology such as crop failure due to poor germination, crop damage etc but the farmers recognised that and still wish to try AMIT again in the next season. Only one farmer is discouraged after crop failure and does not want to use AMIT in future. Three farmers had incomplete crops as they planted the AMIT crops quite late. Most of the successful farmers were from the higher and middle-income wealth rankings with failure tending to be among the poorer farmers. However, these data can only be considered as preliminary, due to the relatively low numbers of adopting farmers.

The results show that the bucket kit (suitable for the homestead garden) presented a good starting point for the farmers but other kits also have a value. The bucket kit was the most successful and 27 out of the 31 bucket kit users produced a crop. These are located at short distances from the adopter's home which ensure constant supervision, regular irrigation, family participation and joint responsibility for irrigation.

The customised kit was moderately successful and 9 out of the 13 kits were able to yield production. Though none of the kits yielded surplus for sale they did generate some production for consumption. The experience with the drum kit was less successful and only 38% (6 out of 16) farmers were able to harvest a crop. The unsuccessful drum kits were mainly in Jamshedpur (Bihar) where farmers could not provide regular attention, as they were involved in other activities, particularly the availability of off-farm income generating activities in nearby commercial centres.

Eleven adopters who cultivated the same AMIT plot in two consecutive summers felt that the production using AMIT was 20-50% higher than traditional methods. Moreover, AMIT prolonged the productive life of the crop. Farmers took 5-10 more harvests with AMIT compared to traditional irrigation practices. AMIT provided the potential to generate good revenue and enabled adopters to recover their investment costs within a few seasons *if* there was a good market for their produce.

AMIT increased the area under summer cultivation by ensuring the cultivation of 40 out of the 51 plots which otherwise would have remained fallow. It resulted in at least some production for consumption for these families and added to their food security.

In summary, the issue of increasing land area under AMIT was dependent on a number of factors: (a) wealth status of farmers and land holding size, (b) availability of off-farm income generating activities, especially for the poorer farmers, (c) timely planting of crop, (d) level of commitment of farmers, usually greater among the wealthier farmers, (e) type of kit, and (f) market for the produce.

2.5 Transferability (Enabling Conditions)

The following factors contributed to the greater level of success with the AMIT technology during the final year as farmers and IDE learnt from earlier years' experiences:

- Constant attention to the new method of farming, motivation from successful neighbours, well protected plots and choice of hardy crops
- Local markets available within 2-4 kilometres
- Steady market prices for the crops throughout the season (the superior quality of the AMIT output fetched better market rates)
- The water source for AMIT should be within 15-30 metres and should not become dry during the AMIT season
- The use of local seeds with known cultivation practices was also important as the germination of branded commercial seed was often a problem.

The following factors influence the viability of the marketing approach:

- Network marketing encourages good demonstrations, which convince others through exposure to technology first hand.
- Good technical and agronomic follow up is essential to sustain adopter's motivation throughout the season and also help neighbours interact directly with the promoting staff after seeing the technology. Though farmers might be aware of the cultivation practices, they are often unsure about additional measures for using micro irrigation. Therefore, the details of practices such as, improved cropping patterns, mulching, etc., should be explained in depth and farmers should be guided in these activities.
- Multiple AMIT farmers from the same village ensure that if one farmer fails, the success of the others convinces the community that the failure was not due to the technology but to other reasons.
- The entire family and not just the adopter alone should be convinced about AMIT. This would not only generate more interest in the technology, but would also promote joint responsibility for operating the kits in the homestead plots.

2.6 Marketing-oriented versus Subsidy-based Approach

Subsidies in the form of discounts on AMIT during the first season in the year 2000 helped increase the number of adopters but did not ensure motivated farmers who understood how to utilise the kits. Most of the farmers who received discounts soon lost interest and abandoned AMIT. When farmers lost interest, their neighbours also lost interest or wanted a subsidy which in turn reduced the future sales in the region. By the end of the project in the year 2002, IDE had adopted a zero subsidy approach for direct sales and only those farmers who were really interested paid and acquired the technology.

Thus, direct subsidies to achieve target sales are detrimental to uptake and sustainability and lead to inappropriate farmer selection, affecting the viability of the market chain. On the other hand the market-oriented approach enabled the selection of interested farmers who drive expansion of the AMIT market through their own success. A prudent range of products, the network marketing strategy (paying incentives to farmers who pursued their neighbours to buy) and dealers nearby, also helped the process.

However, the market-oriented approached only reached farmers from the higher economic categories. The diffusion of AMIT to the poorest resulted through subsidies from promoting NGOs. Several of these poor farmers persisted with AMIT when given agronomic and technical support and produced an improved crop yield which shows the usefulness of the technology for them. However, without subsidies from the NGOs the poorest farmers would have been unlikely to adopt AMIT since their location is far away from the promotional area, and the reach of the supply chain (one of the limitations of the approach), and they possess little purchasing power.

The open market system has also resulted in price uniformity for AMIT and has made the marketing process transparent and fair. By avoiding complex financing arrangements and bulk handouts the marketing process has reduced the scope for fraud and kickbacks. The greater transparency in the system has produced a more credible and conducive environment which can enable the market to develop rapidly in the future.

The successful poor farmers were keen to increase the area under drip irrigation but were not able to save up and invest in the kits themselves. They require support from the NGOs, or from the supply chain itself if it were willing. On the other hand the successful surplus and self-sufficient farmers who acquired AMIT through the market-oriented approach have re-invested the returns from AMIT cropping to increase the area under irrigation. Thus, they are moving away from the AMIT concept of using a low cost technology, in order to develop a larger higher cost enterprise but where AMIT has assisted them in the initial stages of enterprise development.

2.7 Future Strategy

The AMIT marketing process in East India is still in the early stages. However, there are signs of a growth in demand in Purulia, indicating that there may be potential for significant market expansion in the next few seasons, if IDE support is maintained. It is important to note that up until now a critical mass of farmers adopting AMIT has not been attained in East India. IDE should increase the awareness level of the community even further to generate higher sales and wider dissemination. It should continue with its strategy of developing clusters of villages with numerous AMIT adopters which would create a large demonstration effect. However, it should first aim to increase the concentration of AMIT kits within the existing village clusters before expanding the AMIT outreach horizontally to new geographic areas. Although the marketing efforts should continue during winter the main focus should be on the dry, summer season. Careful prior planning is required and the necessary human resources should be deployed on time.

For the AMIT market to take off and be sustainable in East India the following conditions are necessary:

- There should be an adequate supply of AMIT kits to avoid time delays between order and delivery of AMIT kits.
- There should be actual and perceived water scarcity.

- There should be known cultivation practices for AMIT vegetables.
- The presence of the enabling conditions detailed in section 2.5 should be ensured in new areas.
- Network marketing should continue.
- Flexible payment options at full cost should be designed to cater to more customers.
- There should be viable produce markets nearby.
- Basic agronomic guidance must be provided, particularly to new users. (Presently the provision of this guidance has come from IDE staff, however there are problems of the shortage of human resources to ensure sufficient long term backup. As the costs involved in this type of after sales service can be significant, other mechanisms for information transfer need to be sought e.g. collaboration with the Department of Agriculture or through NGO support. It is unlikely that a commercial supplier will be able to support this type of activity, especially give the long time element required.

The above scenario leads to an obvious vulnerability in the market-approach to technology dissemination. At this third year stage a momentum has been built up and it requires more effort to capitalise upon that. However, if IDE's strategy changes and shifts their attention away from East India (as may be possible) and/or if donor funds (routed through IDE and other supporting NGOs in the area) become unavailable, it is likely that AMIT adoption will decline and a lasting, viable market will not develop in this region.

One of the conclusions of this research, as will be seen in more detail later is that donor/institutional support, as the driver of the approach, is required for a considerable period of time, most realistically for at least 5 years, before a self-sustaining market can be established. This is especially important for complex technologies (AMIT) which involve an in-depth understanding of a new technology (by the client farmer) and commensurate changes to cropping systems.

3 WEST INDIA STUDY

The IDE programme in West India has been located in three states: Gujarat, Himachal Pradesh and Maharastra. In some parts of these states the AMIT products and the distribution systems that support them have been established for over five years starting in 1997. IDE's programme was the most mature in Maharastra and thus the most interesting and relevant from the perspective of this research into the impact of the marketing approach. Research was initially also intended to be undertaken in Gujarat but the poor security situation with the break-out of communal riots prevented this from occuring. Budgetary and time constraints then precluded any further research in Himachal Pradesh. Research findings have indicated that while Micro Irrigation (MI) as a technology is well proven, especially for drought prone areas of India, adoption by farmers has been slow in East India where adopters have found the technology complex and difficult to manage under the prevailing farming systems. This is in contrast to the findings in Maharastra in the West where adoption rates were very high with over 13,000 farmers purchasing AMIT within the first two years of introduction.

3.1 Study Objectives

The research objectives of the West India Market study were to:

1. Prepare a broad profile of different socio-economic categories of farmers, including cultivation patterns, access to water resources for irrigation, and livelihood practices for the area.

2. Undertake a review of AMIT outreach - number of farmers who have installed and are using AMIT, the pattern of purchase (through NGOs/from assemblers), analysis of outreach – socio-economic categories of farmers who are using AMIT; and enabling conditions (land, water, labour).

3. Make an assessment of the marketing strategy in terms of the main actors (promoters – NGOs; supply chain – manufacturers, assemblers; follow-up service providers – who?) and the capacity building undertaken by IDE, perception of constraints and issues of effectiveness, viability and sustainability.

4. Make an assessment of consumer (farmer) feedback on: use and maintenance of the technology, pre-sale promotion, cost and payment arrangements, after sales service and information (who provides? Is it timely? Is it adequate?), and perceived benefits of using different AMITs.

A summary of the main findings are presented here covering the enabling conditions, the transferability of the technology, and the sectoral lessons. They are presented in terms of the four research questions of the project which are set out in section 1.3. The complete findings of the study are presented in detail in Annex 2.

3.2 Sustainable Technical and Financial Benefits?

Of the five AMIT products promoted by IDE to in West India the bucket kit was rejected because it provided only a very small financial return in absolute terms, although the return to investment was high. The drum kit was also rejected as it was difficult to get sufficient water to fill one drum everyday without actually owning a well. Investing in digging a well is only viable if a farmer cultivates at least one acre of horticultural land. Sprinkler kits were rejected

because people were not interested in them for general field cropping systems. However, customised kits were accepted as the most appropriate technology as they were seen as suitable for horticulture (predominantly tree crops) on a reasonably large area, thereby gaining sufficient returns.

The poor co-operate to dig wells and share pumping facilities: Open wells and tubewells are the primary source of irrigation water in the project villages. Normally several families get together to dig a common well and share its water as the cost is prohibitive for a single household. During the dry period in May when temperatures are highest the wells may sustain a maximum of 4 hours of pumping. Farmers use diesel or electric pumps to lift water, sharing the operating and maintenance costs of the pump between them.

Drip irrigation perceived as part of a horticulture package which is the only option to escape poverty: Orchard crops are highly popular among all categories of farmers in the study area. Farmers frequently put all their life's savings into establishing an orchard, which they feel is the only crop enterprise that can lift them above the poverty line. The traditional irrigation practice for trees is either by furrows and mini basins or using a small container to carry water to individual plants.

Customised kits preferred but these are different to the other AMIT kits: Farmers find customised systems can provide substantial benefits over and above traditional irrigation practices. These benefits are: saving of water, saving of labour and saving of time. The most visible technical benefit is saving of water, which also results in an increased area under horticulture. However these customised systems are a different concept from the small, off-the-shelf, low-cost bucket and drum kits. Whilst still 'simple' they are larger systems that require individual design and carry a higher cost. Thus, there are dangers in comparing the performance of these customised kits and the marketing efforts that sustain them, directly with areas where the much smaller drum and bucket kit technologies are deemed appropriate. Indeed one of the lessons from Maharashtra appears to be that while these smaller, very low cost kits were initially promoted, levels of adoption have been relatively low. Farmers have preferred to buy larger, 'customised' kits as part of larger investments in deep wells and pumped water supplies.

Customised kits provide best financial returns: Farmers report that customised systems provide substantial financial benefits over the traditional irrigation practice. These benefits are: improved productivity, reduction of labour cost and reduction of input cost.

Although customised kits were the most expensive of all the AMIT products farmers acquired them by one of two means:

(1) Farmers saved over a long period to take up tree cropping, which involves some major investments over time and usually requires co-operation with other farmers to share infrastructural investment costs. The customised kits represent only a small percentage of this total investment.

(2) NGOs also extended credit to poorer farmers, who couldn't arrange sufficient capital to invest on horticulture development activities.

The evidence of this study suggests that the larger, customised, AMIT systems do offer significant technical and financial benefits to users when compared with traditional irrigation practices. However, the small, bucket and drum kit systems have not seen wide-scale adoption suggesting that they do not offer sufficient benefits. As the customised AMIT systems have only been available for 3 or 4 years it is still too early to make a definitive statement on the sustainability of the systems and the benefits they bring. The study did not find evidence of farmers abandoning systems because of operational or maintenance

problems. It is likely that the general high level of farmer awareness of drip irrigation that exists in Maharashtra state enhances the sustainability of the AMIT systems.

3.3 Whose livelihoods?

Horticulture farmers: AMIT can improve the livelihoods of farmers who are able to practise high value horticulture while living in water scarce areas, where there is some water available but not enough to practice traditional irrigated agriculture.

Higher yields of better quality crops: Financial benefit results from higher yields and better quality produce. The degree of benefit obviously depends upon the type and quality of the crop, the area irrigated and the prevailing market price.

Benefits from AMIT (CMS) varies with economic category of farmers: The data shows that all economic categories of farmers are purchasing AMIT, and that 60% of these farmers were poor or 'borderline' at the time of investing in AMIT. AMIT seemed to be improving livelihoods of farmers of all economic categories, though different categories of farmers perceived the benefit differently. Poor farmers perceived AMIT as a way to start agriculture (including horticulture), with limited water available through a community water source. In general the majority of farmers belonging to this group were seen not to practice agriculture, but were dependant more on wage labouring or alternative off-farm activities. Borderline farmers perceived AMIT as a tool to start a horticulture orchard, with the limited water available in the well after irrigating cotton. Self-sufficient farmers perceived AMIT as a tool to expand their area under horticulture with the available quantity of water. Wealthy farmers perceived AMIT as a way to replace some worn out parts of their existing system at a cheap rate.

CMS can facilitate an increase in income and livelihood in Maharashtra when combined with horticulture: Out of 23 adopters who were studied, 13 moved to a higher livelihood category. Of these 7 belonged to the very poor category, 4 were borderline poor and 2 were self-sufficient (refer to Annex 2, section 4.14, p38).

Market approach offers livelihood benefits to the supply chain players: Market development for AMIT also benefits those involved in the supply chain, by providing an expanded market to existing players (manufacturers and dealers of drip components) and a new or supplementary livelihood to other players (assemblers). With market expansion, there is additional business too for agricultural input dealers (fertilisers and pesticides), fruit merchants and credit institutions: i.e. local co-operative banks.

In summary, AMIT can improve the livelihoods of farmers in drought prone areas through the cultivation of quality high value horticultural crops (mainly tree crops). It however, benefits mainly the median wealth categories of farmers (self-sufficient and D1) who have the necessary resources (land and water in particular) to use customised kits. Through investment in these systems from funds usually earned off-farm they can benefit significantly. The poor benefit to a far lesser extent due in the main to the lack of suitable resources (fertile land and access to water) and the fact that they spend a significant proportion of their time involved in wage labour in order to subsist.

3.4 The Market Approach

The central tenets of the market approach to development and dissemination of appropriate technology for poverty alleviation may be described as follows:

- Use of development grants to develop products required by the poor that are currently not being developed by the private sector.

- Use of a highly interactive and repetitive process of product development, field-testing and test marketing to commercialise a product in order to reach the target group. This approach is in contrast to many public sector research institutions where the agencies don't sufficiently interact with the farmers and hence the product never gets out of the laboratory.

- Using commercial principles for dissemination of AMIT products to farmers makes it possible for the products to be available to farmers on a sustainable basis beyond the life of a project. This is in contrast to many NGOs who are involved in developing appropriate technologies but that don't continue with the farmers after their programme ends.

- One agency or organisation (in this case IDE) plays the role of a facilitator without getting directly involved in the supply chain. Such facilitation helps to focus the organisation on market development without the commercial entities being dependent on IDE for their sustainability.

This study has found that the market driven approach has not been very effective in bringing low cost irrigation technologies to the very poor. To reach this group the 'market chain' has to be augmented by other agencies – normally a local NGO (Refer to Annex 1, p20; Annex 2, p27, Section 4.7). These NGOs play a role in bringing the technology to the awareness of the poorest but more importantly they very frequently provide a hidden subsidy to the system, either through an overt price reduction or free distribution policy or through "soft loans" that are not repaid. In 'better' cases NGOs provide credit which is recovered. Annex 2 (p28) shows that 90% of the poorest farmers received AMIT via NGOs on some sort of subsidy or credit scheme (Annex 1, p31, first 4 paragraphs and Annex 3, p25, section 4.2, last two paragraphs, also support this assertion).

Where a technology or product is simple and easily applied the marketing approach appears to offer considerable benefits. However, the adoption of drip irrigation requires major changes in crop and water management practices, it is not a simple product. For effective adoption it must be supported by good quality and sustained extension advice. Such training and advice cannot be offered by commercial agencies working in the technology supply chain at an early stage of market development without external financial support as the financial returns would not merit their investment. In Maharashtra where farmers already have a high awareness of drip irrigation state agencies are able to train and support farmers and market chains are able to absorb produce then the commercial, marketing approach to AMIT dissemination appears effective. Where these pre-conditions are not met then the promoters of AMIT must provide considerable training and support to very large numbers of small farmers and it is difficult to meet the costs of these services on a commercial basis.

3.5 Transferability (Enabling Conditions)

Maharashtra is located in a plateau region, characterised by small patches of fertile river valleys and long stretches of barren-rocky land with very deep water table. Historically the

richer classes have owned the fertile valleys and the poor have lived on the degraded lands. Field crop production is nearly impossible to practice on the degraded lands and therefore the poor in these areas have been forced to look to non-crop based sources of livelihood i.e. goat/sheep herding and wage labour. Because of good agriculture in the fertile zones and extensive industrial activities around Mumbai and Surat the poor people have ready access to good wage labour opportunities all year round.

When IDE came with its AMIT products to the region they faced several unique challenges and opportunities which were quite different from other areas or countries:

(1) Farmers were convinced that general agriculture was not worthwhile in that area.

(2) Cultivation of hardy fruit trees was becoming popular in the area as they can be grown with less water and they present a desirable livelihood strategy.

(3) The poor farmers compared every new livelihood option against doing wage labour.

Some critical aspects of the marketing strategy used by IDE in West India that also contributed to the take-off of the programme in this region were:

- **Creating a new and substantial market for a supply chain:** The AMIT programme opened up a completely new market of small orchards for the poorer farmer which was not covered by the existing supply chain for irrigation hardware. The potential numbers of these small orchards appear to be quite large, with a good business volume.

- **Farmers did not require convincing of the need for, or viability of, the technology:** Horticulture was seen as the only option that has the potential to move farmers out of poverty and eliminate the need to migrate for wage labour. Farmers, therefore, did not require convincing of the technology to the same extent as in East India., This reduced the level of inputs required for publicity and promotion.

- **Supplementing the government horticulture programme:** The Government of Maharastra is promoting horticulture among small farmers by supporting them in pit digging and providing quality planting material. AMIT is seen as an important tool to make the above programme successful but it compliments a larger, pre-existing programme

- **The IDE Kits were the same price as Government-subsidised kits:** The market approach offered by IDE made it possible for farmers to get the kits at the same price as the subsidised ones but without the hassle. IDE systems were able to be priced at 50% less than the Government systems just by addressing some of the inefficiencies the Government had. This was possible by introducing several technical and marketing innovations, which reduced the cost.

  - Technically Government systems used button emitters and IDE used micro-tubes, which were cheaper than emitters.
  - On marketing front Government used Indian Bureau of Standards (IBS) (Government quality approved) marked products and IDE used non IBS products. IDE found that it costs additional money to get IBS certification and therefore the manufacturers were pricing it higher. IBS mark is good for someone who cannot visually identify good quality.
  - Secondly in the case of Government systems under subsidy, it used to take over a year for the suppliers to get their money from the date of supply. Hence the manufacturers used to hike their price to incorporate this delay. IDE brought in a cash down system of payment.

The government used to provide 50% subsidy from its price. With the above interventions IDE could price their kits at 50% of the Government price. Thus the price of IDE systems was similar to the price that would have been paid by the farmer under the Government system (after 50% subsidy).

- **Avoids the bureaucracy and delays of the subsidy system:** IDE systems became more popular than Government systems because they were more easily available. In contrast to purchase drip on the Government system the farmer had to go through a long process of application, verification etc. and even then only limited farmers could get it as only subsidy was available with the Government every year. The market approach therefore helped farmers avoid the delay and bureaucracy associated the State subsidy system.

- **Making it compatible with NGO priorities:** Many local NGOs work with socially disadvantaged sections like poor and marginalised peoples. They find AMIT, if integrated with small orchard development, one of the best income generation activities for the poor. In contrast the government subsidy programme did not involve NGOs or the poor. AMIT also forms a logical next step to many agencies working in the rainwater-harvesting sector. However this NGO involvement means that this is not a straightforward market forces only approach as it is sometimes described. NGOs are the only means by which the technology can get to the poorest through the subsidy and technical support they provide. The purchase of AMIT via the market is not feasible at this level of poverty due to lack of financial resources and risk aversion.

- **Building on an existing base:** The subsidy programmes of the Government created wide-scale awareness of drip in the state and built a good manufacturing base. The AMIT programme has built upon this base to reach the poorer farmers whom the subsidy programme excluded.

The State of Maharastra provides a number of features favourable to the adoption of micro-irrigation and is the most successful AMIT programme of IDE. The enabling conditions that were experienced by the programme for the successful adoption of AMIT in this State are given below. While replicating AMIT in other locations, similar adjustments would likely be required in the programme strategy for a similar level of success.

- **Poor but aware farmers:** As a state it presents a very interesting developmental dichotomy. On the one hand the State has a substantial number of people living below the poverty line (roughly 25% according to State Government estimates), but on the other it is also one of India's most progressive states. Hence farmers here are, despite their poverty, become quite aware of new technologies that may benefit them. This situation is also found in most of the western and southern states of India, but not in eastern India to same extent.

- **Orchard crops are seen as the only option:** The State is in the heartland of the Deccan plateau and the terrain is absolutely barren, with the majority of the land not even suitable for rainfed agriculture. Orchard cropping is perceived to be the only form of cultivation that is possible in this tough intractable terrain.

- **Drip irrigation perceived as the only option:** In the heartland of semi arid India there is acute shortage of water. The annual rainfall in Solapur in Maharastra is only 300 mm and the water table has fallen to below 60 metres, and in the summer months of May and June even the drinking water is supplied by the Government in tankers. Hence, farmers perceive that drip irrigation is the only option to irrigate their land with the limited quantity of water available. Farmers who own a well normally have very little water in the well

during this period. With conventional irrigation the water left in the well is not enough to provide irrigation to the complete plot. But with drip irrigation farmers find that the limited water that they have is able to provide basic minimum irrigation to all the plants for them to survive through the summer months. At most times they find that by practising drip irrigation some water is left for their domestic needs. This is a big incentive for people to adopt drip irrigation.

- **Government support builds infrastructure and awareness:** Subsidised drip systems by the Government was a partially centrally sponsored scheme but the extent of benefit depended on the extent of matching contribution the State Government was willing to make. Maharastra is the state which has responded fully and taken maximum advantage of the scheme. It has the greatest area of subsidised drip irrigation in the country. This achievement, though it did not reach the poor, did serve to boost the drip irrigation industry, increasing overall awareness and availability of drip components in the state. The IDE programme effectively built on this base and started at a higher level than other parts of India, or indeed most other developing countries.

- **Wage labour opportunities:** The State has considerable wage labour opportunities for poor farmers, as agricultural labour in large sugarcane fields in the fertile zones and as porters in the port or in the industrial area of Mumbai. Most of the poor farmers use these places as their economic fall back option, when there is no work on their own farms. Most of the poorest farmers use this as a way of earning hard cash to invest over a number of years in digging a well, buying a pump set and pipe, establishing a horticulture garden, and installing a drip system (refer to Annex 2, section 4.14, p38-39).

- **Marketing opportunities:** Maharastra produces a variety of fruits crops in different regions and there exists a chain of fruit markets throughout the state linked to other markets of India. This market chain has its roots at several rural markets with the presence of fruit merchants, who procure the fruits from the villages and sell in the fruit markets on a commission basis. New fruit growers are able to easily link into this chain to market their fruits.

- **Active local facilitators:** Conceptually in the AMIT market creation approach the roles envisaged to be played by different stakeholders are:

    - IDE or other championing body – national facilitator
    - NGOs – local facilitators
    - Assembler/Dealer/Nursery – service providers
    - AMIT farmers – micro entrepreneurs.

Under this approach, an operational area is divided into several sub-units defined by the operational area of one partner NGO playing the role of a local facilitator. The NGO plays a key role. In the case of Solapur, the NGO MPSSM was a very active local facilitator succeeding in continuing the programme during 2000-01 when IDE was not present. MPSSM allowed its interested field staff to become assemblers and provided a Rs.2 million (US $42,000) grant as a revolving fund to its Self-Help Groups as credit to poor farmers so that they can take up AMIT and start a horticulture garden.

Thus, the "enabling conditions" found in Maharastra are special, possibly unique. Firstly, India is far ahead of any other developing country in terms of promoting drip irrigation in general. Second, within India, Maharastra is by far the state with more installed drip than any other. Such a situation is **not** typical when compared to other situations found in developing countries elsewhere or even within India itself.

Finally, it is also important to note that what has really taken off in this area are larger customised kits with a pumped water supply. The numbers of drum and bucket kits being utilised are quite few. Furthermore, the keener adopters of AMIT in East India are also requesting larger tanks (presumably filled by pumps) so as to irrigate larger areas. This calls into question whether the small drum and bucket systems are really meeting a need. It is possible to conclude that they have a small role but that the real livelihood gains are to be made from bigger customised systems, and yet these larger systems are less accessible and therefore offer fewer benefits to the poorest.

4 EAST AND WEST INDIA COMPARED

This chapter compares the studies from East and West India, where in both areas IDE is promoting small-scale drip irrigation. The two areas (as elsewhere in the country) depend on groundwater resources. These typically recede during the summer months and as a result cultivation is not usually feasible. Table 4.1 reflects the very different contexts for drip irrigation and technology dissemination in the two areas.

Table 4.1: West and East India – A Comparison of the Main Study Areas

Selected features	East India	West India
Depth to groundwater	25 feet	50 feet
Water lifting mechanisms	Manual methods. A few pumps	Pumps only
Introduction of drip irrigation	Recent - begun by IDE in 1999	Long-standing – introduced by State Govt in 1980s
AMIT technologies (main)	Bucket = 0.004 ha. Drum = 0.012 ha.	Customised (CMS) = 0.4 - 1.2 ha.
AMIT costs	Bucket kit – Rs275 ($6 = $2000/ha) Drum kit - Rs 975 ($20 = $1660/ha)	CMS = Rs9,000/acre (US $190 = $470/ha)
Associated capital investment	Nil (few pumps – usually through government subsidy)	High – pipes = Rs15,000 (US $310) + cost of well and pump (Rs40,000 (US $830)) also used for other plots
Cultivation with drip	Vegetables – short gestation	Fruit – mainly long gestation eg. Pomegranate orchards
Supporting systems: - markets for produce - component suppliers - NGOs	 Local, small scale Distant Relatively few	 Large scale, established national markets & close proximity to them Locally established within the state Greater presence and experience with watershed projects
IDE's role	Product testing and promotion, setting up the supply chain, Direct marketing	Product modifications, Business Development Services – AMIT part of a wider package
Role of State/Policy influence	Little active support by the state governments of West Bengal and Jarkhand to MI support	Maharastra state particularly proactive in supporting subsidised MI systems

Drip irrigation is very recent in the East. The focus there has been on small-scale bucket and drum kits appropriate for vegetable cultivation during the summer, mostly for home consumption with some sale in local markets. In the West, farmers are more aware of drip irrigation as an irrigation technology as a result of government support over the past decade, the need for horticulture on the poor quality land, and established markets and other support systems.

This provides different contexts in which to review the research questions that underlie this project.

4.1 Sustainable Technical and Financial Benefits?

There is good potential for sustainable technical and financial benefits for users in both areas if a number of underlying conditions are met, namely: suitable marketable crops exist, there is a readily accessible water source, high levels of crop management are practiced, water scarcity is a major problem.

Initial technical problems in the East (including clogging of the laterals, water leakage) have largely been addressed as farmers have learned to use clean water and to filter it. No technical problems were reported in the West (though research here did not focus on this issue) because farmers it seemed were more aware, and had better extension support through NGOs and commercial buyers.

In comparison with flood irrigation drip has enabled in both study areas:

- Cultivation of land during the dry season when without drip irrigation there is insufficient water for cultivation
- Cultivation over a larger area with the available water
- Uniformity of water dispersal thus improving productivity (20-40% for vegetables, 80% for fruit) and quality of production
- Labour increase in irrigating in the case of manual filling of drum: for vegetables, this has to be done twice daily (instead of once a week for flood irrigation). Twice a day is the basic scheduling advice for the summer months given by IDE when the kits are sold or distributed. This rule of thumb has been determined by IDE based on calculations of crop water requirement. However this number certainly varies throughout the growing season and actually depends on the soil moisture. Twice a day requires a fairly significant effort and is usually done by men. Use of a pump reduces labour effort but has cost implications. Filling the bucket kit is not seen as very labour intensive since it is easy to combine with domestic tasks, and usually involves women and children.
- Larger systems, using pumps, reduce labour requirements; also some labour saving since no need to mend irrigation channels, less weeding; no head loading (earlier practised in the west, especially by women, since water source is up to 500 metres from the cultivated area); ease of irrigation in plots covered with vegetable plants.

Nutritional benefit: The benefits from the bucket kit are in the form of making vegetables available for family consumption.

Financial benefits: Financial benefits from the other types of kits result from increased quantity and quality of production, only if there is a viable local market for produce sales. In the West AMIT for horticulture reduced the costs of hired labour and the need for some agricultural inputs.

Cost Recovery: The returns on investment are high – over 100% for bucket and drum kits in the East, with cost recovery within one season. Returns per individual on investment in drip irrigation for horticulture in the West depends on the gestation of the crop (usually long term 4-6 years for tree crops), but cost recovery of the total investment (including share of well/pump and saplings) is possible within the first full year of production.

Technical and agronomic support is essential to realise benefits: The following types of support are necessary to ensure and maximise these benefits, especially for poorer farmers:

- technical guidance at the time of installation, including advice on protecting the plot

and water requirements for different crops

- agronomic guidance appropriate to the crop, e.g. adding fertilisers through the drip, mulching for vegetables, pesticides, pruning and grading for fruit
- advice on good quality inputs – especially seed and fertiliser/manure

It has not been possible in both study areas to determine the cost and resource implications for this necessary input, however it is likely to be large. Such support would not be a financial burden that an NGO or commercial organisation would undertake without some form of reliable and sustained support from an outside donor.

Sustainability: The sustainability of the benefits will depend on the provision of these forms of support during the introduction phase in any local area (eg. 3-5 years), as an input to farmer awareness and experience. Continuing availability of the minimum water requirement during the summer months is also essential for sustainability of AMIT farming systems.

4.2 Whose Livelihoods?

It is largely the self-sufficient and marginally poor farmers, those who have access to a limited water supply, and not the poorest who are most likely to benefit from AMIT. AMIT contribution to livelihoods depends on the size of kit, and effectiveness of initial guidance, especially agronomic, as well upon issues such as access to land, land quality, access to and availability of water, type of crop farmed, market for crop product, access to agricultural inputs and access to finance.

There are also some potential knock-on benefits to livelihoods for those involved in the market supply chain.

In both East and West, potential access to AMIT depends on a farmer's land resource, which usually reflects economic status. The small scale of AMIT, and the various options even within small scale, potentially enable relevance to all categories of farmers except for the completely landless or farmers with unlimited access to water throughout the year (Table 4.2).

Table 4.2: Relevance of Different Types of AMIT to Different Categories of Farmer

Land/water resources	Economic status – broad categorisation: also depends on size of landholding and alternative livelihoods	Relevance of AMIT	Potential Impact of AMIT
Landless	Very poor	Not relevant	Nil
Homestead plot only; or some cultivable land, no well, but access to water source	Borderline/Poor/very poor	Bucket kit	Low to Moderate
Cultivable land, access to nearby water source/well, limited water, no pump	Borderline	Drum kit	Moderate to High
Cultivable land, own water source, limited water, pump	Borderline and non-poor	Drum kit and customised drip	High
Cultivable land, water source with pump, unlimited water	Non-poor – Surplus	Not relevant	Nil

Men are the main decision-makers in agriculture, in both study areas, taking responsibility for purchasing and marketing transactions. Women's involvement follows the traditional gender division of labour: sowing, weeding, harvesting, storing. Irrigation tends to be seen as men's work, though women are more involved in homestead plots and using the bucket kits. They are less involved with the drum kit, and least with larger customised systems for horticulture.

Poorer farmers face the following constraints in terms of both access and benefit:

- capital or credit to cover investment costs
- limited understanding and experience of appropriate agronomic practices
- less likely (due to: low awareness, limited cash flow, limited options) to use good quality inputs (seeds, fertilisers)

The results so far from the East have been more favourable for non-poor (self-sufficient) and borderline farmers with better awareness of vegetable cultivation practices, income from alternative livelihood sources (to invest in the AMIT plot) and market confidence. Successful farmers are extending AMIT over a wider area, investing in larger water tanks and additional laterals. There have been more drop-outs amongst poorer farmers who had limited success - probably due to inadequate guidance. So far none of the poorest have been willing to invest directly in AMIT. All of the very poor farmers have used vegetable production from AMIT for family consumption only.

In the West, where over the past decade (under the government supported programme) better off farmers have established the utility of drip irrigation for horticulture, poorer farmers too have invested in AMIT, especially for cultivation of pomegranate which is suited to the degraded land conditions. The ability to pay the investment costs comes from two contributing factors: cash income from relatively highly paid migratory casual labour to urban centres in the state, and joint investment by related households in a well and pump which are essential for irrigation in the area. The substantial capital investment leads to high cash returns over a period of 15 years. Here too, however, the returns tend to be lower for (new, poorer) farmers with less exposure to horticultural practices and market practices.

Summer cultivation with AMIT in the East has contributed 5-8% of annual household income (5% for poorer farmers - using a bucket kit; 8 for non-poor farmers - using a drum kit). For farmers who otherwise would not have been able to cultivate in the summer, this is additional income. For (the smaller number of) farmers who would have cultivated vegetables in the summer, the net addition to household income from using AMIT is 2%. In the west, horticulture with AMIT contributes 60% of household income, including for poorer farmers. Farmers attribute around 25-30% as the net addition from using drip irrigation.

The large-scale adoption of drip irrigation in the West also contributes to the livelihoods of the market players – the manufacturers and dealers of drip components, and local assemblers/ distributors. With market expansion, there is additional business for agriculture-input dealers (fertilisers and pesticides) and traders in fruit produce.

4.3 The Market Approach

IDE promotes the sale of AMIT at a price that reflects direct production and sales costs i.e. excludes the cost of product and market chain development. In the east, which is in the early stages of technology diffusion, it is mainly non-poor farmers who have paid directly for AMIT. The majority of poor farmers using AMIT have usually been identified by NGOs who have tended to pay the cost of AMIT and not to pass it on to the users. In the West, too, where there is already an established base for technology diffusion, NGOs have played a significant role in assisting the diffusion of AMIT to the poorer farmers with credit assistance. NGOs

represent an additional resource i.e. a subsidy to the approach. This may be both a constraint and an opportunity for the market creation approach. Other farmers, including a significant number of borderline categories, bought AMIT directly from local assemblers.

The market-oriented approach for AMIT is not entirely market based, but involves the following:

- Start-up costs (product and market development) provided through external grant assistance.
- Users – or facilitating intermediaries such as NGOs – pay for the product (they do not pay cost of product and market development).
- NGO costs provided through external grant for its ongoing programmes.
- The price of the product includes a fair margin for the supply chain.
- Kit assemblers or distribution agents at the local level interact directly with potential users on a commercial basis and are expected to provide after-sales (technical) service.

The theory underlining the approach is that those innovative farmers should be targeted first of all. These early adopters of the new technology will not be the poorest but will be the wealthier farmers. IDE, the promoter of the market approach, believes that once the rural poor see how these farmers are benefiting they will also take-up the technology. If the product meets the needs of the farmers, considerable market growth should result, creating a sustainable supply channel for the product. The envisaged increased demand for the low-cost technologies, it is purported, will create employment on the supply side and result in consumer satisfaction on the demand side.

The constraints and opportunities of this approach in terms of sustainable adoption of AMIT by the poor are as follows:

4.3.1 Opportunities

- NGO intermediaries working with the poor as their target group support the identification of this category of farmers and facilitate their adoption of AMIT. **Without such mediation the poor would probably not access the technology**.
- Payment for a product represents a stake in making it work.
- Profit-making distribution systems based on open transactions support distribution efficiency and enhance farmer access. By comparison, in west India the subsidy regime of the government introduced inefficiencies in the user price and tended to benefit larger farmers only.
- Potential to stimulate a competitive and therefore a better service environment resulting in active after-sales service to farmers.
- Works well when markets for produce are well established and easily accessible.

4.3.2 Constraints

- NGO orientation is towards subsidies or grants for enabling the poor to obtain kits. This is clearly not sustainable and the experience in the east has been that this can result in insufficient attention or interest on the part of the 'beneficiary' farmer. NGOs should be guided to provide kits on credit.
- Due to ongoing programme commitments NGO staff may not have the time or expertise

to address farmer concerns in use of the technology – nor are they provided additional resources to do so.

- It is not clear who provides follow-up support, especially agronomic, which is what poorer farmers need – nor who will pay for it. This is another vulnerability of the approach which, if not sorted out, will undermine the process.
- Market players might shift away from very small scale (homestead) kits since their profits would be higher with larger scale kits.
- If there is no market for the produce then there is little value or incentive beyond homestead level for the poor.

4.4 Transferability

The different operational contexts of the East and West locations (in terms of technology diffusion and application, market development, established supply systems) are already reflected in the varied approach adopted by the AMIT promoter in each area.

In the East, a focus on farmer and village clusters (rather than a more dispersed approach) was the more practical strategy. This is likely to be effective if it is backed up by careful planning, co-ordination and investment of staff time to ensure timely delivery and installation of kits as well as technical and agronomic follow-up to farmers. A range of products will be appropriate, with flexibility of payment terms.

In the West the focus has shifted to promoting a package of practices through Business Development Services (BDS) in which AMIT represents just one amongst a number of components required to support successful horticulture. The BDS approach has considerable potential for promoting AMIT in existing locations as well as transferring AMIT to different locations, given the following context:

4.4.1 Enabling conditions for <u>AMIT technology</u>

- Farmers face water scarcity – actual and perceived – for at least one season (summer). Those who have enough water normally prefer to flood irrigate even if drip irrigation has higher yield potential. On the other hand in extreme water scarce conditions drip irrigation is one of a few possibilities to sustain crop growth.
- The water source for AMIT should be within 50-100 feet and should not become completely dry during the summer.
- Access and rights to suitable land
- Farmers have access to adequate markets for the food crop products (vegetables and fruits).
- Farmers have access to agricultural input suppliers – including supply of liquid fertilisers (These inputs are usually readily available in both East and West).
- Ability of the poorest to pay investment costs can be enhanced by NGO presence or high paid wage labour in nearby urban areas.

4.4.2 Enabling conditions for the <u>Market Approach</u>

- Presence of plastic manufacturing capability within the country. Whilst this is not necessarily essential it is anticipated that presence of such skills locally would help to

keep the costs of kit production low and below that of imported kits. However this of course may not in reality be the case and actual component costs will be a reflection of global market conditions, transport costs, importation duties, local taxes etc.

- Presence of NGOs in the local area with independent access to resources to support AMIT dissemination, and who ensure that farmers pay for AMIT (often on a credit basis). Helps if NGO staff are trained in appropriate agronomic practices.
- Micro-credit available to farmers.
- Farmers do not expect hand-outs or subsidies.
- Product price supports fair margins for different players in the supply chain.
- External funds available to support initial dissemination phase.
- Dissemination team has appropriate skills – technical, social, agronomic, economic, communication and local language.
- An agency or organisation available and with sufficient resources to support initial set-up phase.

5 ZIMBABWE STUDY

The Government of Zimbabwe's strategy to increase food production through irrigation has faced a number of challenges. The performance of most irrigation schemes has been heavily compromised by management problems mainly emanating from the communal ownership and management of the irrigation infrastructure. In some cases farmers have failed to meet electricity and water bills. Some of the water sources, mainly dams, have been heavily silted as a result of poor catchment management up-stream. The dominant irrigation system in use in Zimbabwe is flood irrigation with low water-use efficiency yet water is the main limiting factor to irrigation development in Zimbabwe.

Low-head drip irrigation systems that are affordable, more water efficient and give control and ownership to an individual farmer are seen to have the potential to reduce poverty and improve the livelihoods of the smallholder farming communities in Zimbabwe. It is in this context that the Affordable Micro-Irrigation Technologies (AMIT) research project was implemented in Zimbabwe.

5.1 Sustainable Technical and Financial Benefits?

Little water saving but higher water productivity in Zimbabwe: (See Table 6 in annex 3, page 15) The water use ratio (WUR) of 0.74 indicates that on average farmers apply a greater depth of water using the AMIT kits than they apply when using buckets to irrigate small beds. However, the crop yields under AMIT are greater than those seen in the 'control' plots so water productivity is greater under AMIT. Thus, where AMIT replaces small-scale bucket watering of vegetable beds there is little scope for water 'savings' as the conventional methods only use small volumes of water and often lead to unintentional, deficit irrigation. By following the recommended irrigation schedules provided with the AMIT kits farmers apply slightly more water than 'normal' and benefits from increased yields.

Whilst AMIT systems offer a feasible alternative to manual, bucket irrigation of small beds, where water use is already low, they are not an alternative to large-scale surface irrigation where irrigation efficiencies are generally much lower.

Higher water uniformity: Higher water application uniformity and maintenance of a better soil moisture regime were achieved under AMIT when compared with the conventional irrigation of beds by bucket.

AMIT produces higher yields of better quality crops: According to all farmers who used the kits the greatest strength that the AMIT system had over the flood system lay in the production of higher yields of better quality food crops.

Shorter time to crop maturity: The overall time to maturity was shorter for all crops grown under AMIT and farmers reported that AMIT crops seemed to be less vulnerable to incidents of pest attack.

AMIT crops fetch better market price: Such better quality crops contain greater nutritional value and also allow AMIT-grown produce to fetch a higher price at market. Both these factors are important benefits of kit usage to improve user livelihoods, provided that a viable produce market exists.

Best suited for vegetables: The most suitable crops for AMIT were cabbages, maize and tomatoes.

Potential Income: The income from the experimental (AMIT) plot was an average of US $24 more than that obtained from the control plot.

Need for Technical and Agronomic Support: Farmers require close technical support for at least two seasons. The support staff should have a good appreciation of the principles of AMIT to be able to give useful technical guidance regarding potential under or over irrigation during the season. Such guidance was not always available during these trials due to the remoteness of the trial sites and logistical constraints preventing project staff from visiting the sites frequently. This highlights an important cost associated with any potential marketing of AMIT technology.

Cost of kits beyond farmers' means: Due to the recent collapse in the value of the Zimbabwean Dollar the cost of the kit is now beyond the reach of even the richest in the rural communities. Assuming the kit is imported from India at a cost of $30 US it would cost about Z$45 000 based on a parallel market exchange rate of Z$1,500 to the US Dollar. This is about the cost of 3 heifers on a community market!

The AMIT kit is technically capable of supplying crop water requirements and with good management it can produce yields greater than those seen on bucket irrigated beds. However, farmers require considerable training and on-going support and encouragement to allow them to work through the understandable perception that the drip system does not apply enough water. Farmers also perceived that each individual plant required its own emitter. They were reluctant to plant two or three plants per emitter and therefore their plant density was reduced when compared with the control plots. Again, this perception can only be overcome by close technical support and training, helping farmers to test the kit and learn for themselves. There is a need for numerous well managed demonstration sites that are operated by the farmers themselves. This project was not able to provide that level of sustained support.

Degree of Sustainability not assessed: It was not possible within the Zimbabwe research component, to ascertain the degree of sustainability of such benefits that are offered by the AMIT kits. However several farmers had problems with components such as taps and plastic tees breaking, which could render a kit completely useless. Making low cost spares readily available to farmers in these relatively remote village communities would be an important logistical challenge for any market-led introduction of this technology.

5.2 Whose Livelihoods?

Not necessarily the poorest: Those farmers who had greater interest in, and success with, the kits tended to be those who were more innovative. The ability to trial, test and adapt the kits was highlighted by the farmers as important. However it is often <u>not</u> the poorest who have this ability, or if they do they are often unable to take onboard the risk factors involved because of a lack of security. This is consistent with a standard model of technology uptake, which suggest that the early adopters will be those more able to withstand risk. Work in Zimbabwe was not sufficiently extensive, over time or location, to determine whether poorer users might adopt AMIT at a later stage, but more importantly there is no conclusive evidence of this occurring yet in India where AMIT has been promoted for more than 5 years.

Financial support for the poor is required: Without some kind of financial support or credit system many, not least the poorest, in Zimbabwe would be unable to afford to start using AMIT. This however is more a reflection of the political and socio-economic context currently prevalent in Zimbabwe, <u>not</u> of the technology itself.

5.3 The Market Approach

Excess AMIT produce must have a market: It will be essential to address the current bottlenecks in marketing facing small-scale food producers *before* a technology for increasing production such as AMIT could have any positive impact on the livelihoods of rural communities. The shortage of such markets is a serious constraint facing all forms of irrigated production in the region.

Poor infrastructure undermines the market approach: Infrastructure plays an important role in the market creation approach. The approach relies on good networking between the supply chain and the demand chain. In most parts of Zimbabwe the transportation and communication networks are poor – a factor that has scared away the private sector from directly working with smallholder farmers. At the same time mobility of most farmers in rural areas has been severely constrained by exorbitant bus fares.

Markets often do not reach the poorest: There is therefore little guarantee that the technical and agronomic support required by the demand chain could be given. Public extension services are 'retrenching' and donor support is in decline. NGOs with donor funds will be the major players in any future programme which is a distortion of a true market approach. However, NGOs in Zimbabwe are currently struggling to operate in an environment where development is heavily politicised and donor funds are dwindling.

Macro-economic forces result in high costs, which make AMIT unaffordable: The acute shortage of foreign currency in Zimbabwe has paralysed most industries during the past four years and has fuelled a parallel market, which is exacerbated by government control of the exchange rate. Potential manufacturers will have to purchase foreign exchange on the black market resulting in very high costs of production. Most farmers will thus be unable to afford the AMIT kits.

5.4 Transferability

Enabling environment: Once water becomes perceived as a very critical limiting factor in horticulture production, and if a market for AMIT produce develops (there is currently low demand for the vegetable and horticultural produce for which AMIT is most suited), and the economy stabilises, the market approach has potential to achieve sustainable technology dissemination and to put donor funds to more effective use, and to create job opportunities for many unemployed Zimbabweans.

A market approach is not currently viable in Zimbabwe: Without these enabling factors and without overcoming the constraints noted above a market approach to getting AMIT technology to the poor seems unlikely to be viable in Zimbabwe.

The poorest require some sort of credit facility: As part of the market creation approach it is vital that farmers purchase AMIT products without direct subsidy. Yet in the absence of credit very few farmers will be able to afford AMIT products under prevailing economic conditions. Whether the market chain, if established, would be willing and able to provide such credit in Zimbabwe is not clear.

Water scarcity must be perceived: Farmers' perception of water scarcity may be a critical factor in influencing their adoption of AMIT technologies. Unless aggressive marketing of the technology is done, or farmers' awareness of the need to conserve water is raised, its adoption will be low as long as farmers continue to access sufficient water to produce a crop using conventional irrigation. It may be as important to promote the benefit of improved water productivity rather than the simple idea of 'water saving'.

6 CONCLUSIONS – LESSONS FROM AMIT RESEARCH

This concluding chapter highlights the main findings that have come out of the AMIT research project structured around the four research questions on which the study has been founded. Using the market approach as a dissemination system to get complex technologies to the poorest sectors of the community is also discussed.

6.1 Sustainable Technical and Financial Benefits?

Research Question 1 – Do AMITs offer sustainable technical and financial benefits to the users when compared with existing irrigation practices?

Of particular interest to a consideration of the technical and financial benefits achieved using AMIT in comparison to existing irrigation practices are the impacts of AMIT in relation to gender, labour, income, food security and water saving.

Use of AMIT changes the labour profile since irrigation is required twice daily (see section 4.1 for further explanation) rather than once every 7-8 days (refer to section 2.4, p8). Where the plot is close to the homestead the need for daily attendance can be readily met but this is not always the case where the plot is some distance from the home. Those users of AMIT bucket and drum kits interviewed did not comment on significant benefits from a reduced labour requirement (Annex 1, 4.1.3, p16; Annex 3, 3.2.2). There is not a very significant saving in labour when comparing AMIT bucket and drum kits to other manual methods of applying water to crops – it may even be slightly higher (Annex 1, section 9, p26). However, this will vary depending on the distance from the location of the kit to the water source, with a shorter distance of around 15-30 metres favouring AMIT slightly above traditional practice. In contrast the customised systems dominant in West India which are pump-fed did reduce labour requirements (Annex 2, 4.12, parts 1,2 & 3).

Women tend to like the smaller bucket kits because they provide a supply of nutritional fresh vegetables to the household at a time when these food items are scarce (hot dry summer) (AMIT Report 2000-2001, Annex 2, p16). For the most part produce from the AMIT bucket plots in the homestead garden is usually consumed by the household, with occasionally a small surplus being marketed for a cash income. It is usually the women that are involved in the selling of produce in local markets and this may provide them with a greater source of income (assuming there is adequate market for the AMIT produce). AMIT therefore provides some potential to support women in the sale of vegetables. Bucket kits may, in comparison to other systems of irrigation, serve to increase the food security and family nutrition intake and thus have particular positive benefits for women and children (refer to section 2.4, p8). The favoured crops tend to be vegetables of which the cucurbits (bitter gourd, ridge gourd, cucumber and pumpkin) are the most popular, primarily because of their drought tolerance. Other crops favoured by the household are Lady's finger, egg plant and tomato (refer to Annex 1, p28).

In comparison to traditional irrigation practices the small AMIT bucket kits tend to put slightly more demands on the women and children rather than the men, especially when they are located near to home in the kitchen garden, which tends to be the woman's domain (refer to section 2.4, p10). Men normally take care of the traditional flood irrigation regimes.

However, whilst small bucket kits may add to women's labour demands the technical benefits in terms of improved yield of vegetables and improved family nutrition and food security and possible small income generation (refer to section 4.1, p24; section 5.1, p30) may outweigh

this, and be an improvement over traditional practice. The drum kits and the larger AMIT customised systems, however, tend to remain in the domain of men as the filling of the water container can require hard physical effort (refer to Annex 3, Figure 2, p18). Men, as evidenced in West India tend to prefer the new and larger customised pump-fed micro-irrigation systems over and above traditional practice because the labour demands were lower than the traditional practice (refer to Annex 2, section 5, p34). The perceived water use efficiency and improvement in crop quality from customised systems provided technical and financial benefits above existing irrigation practice (refer to Annex 2).

There is potential for AMITs to provide greater cash income than existing irrigation practice provided a market for the agricultural products exists. This benefit is most significant for the larger customised micro-irrigation systems which generates production above household consumption requirements (refer to Annex 1, p30), rather than the bucket and drum kits. There have been methodological problems in the AMIT study when trying to make direct comparisons between farmers using AMIT with those using other irrigation methods. Timing, crop type, cropping patterns, cultural practices, location, etc. can all differ greatly. There are however, a number of impacts that can be attributed to customised micro-irrigation systems, these being the tendency for: (a) higher input costs, (b) slightly reduced labour requirements, and (c) an increase in productivity both in yield, crop quality and duration of cropping period.

Water savings with AMIT are difficult to quantify. Fieldwork in India did not attempt to compare water use in AMIT against control plots of traditional practice based on field records over a season. Thus, the only indication of the magnitude of water savings is based on farmers' opinion and recall. Examples of these appear in Annex 1, page 26 and Table 4.5, and page 32 of Annex 2. These two examples suggest water savings of 50-60% when compared with traditional irrigation methods. In Zimbabwe, where water consumption under AMIT bucket irrigation was compared to traditional flood irrigation, the volume of water used was almost the same but the water productivity under AMIT was greater due to higher yields, and better quality produce.

Larger customised systems combined with a high value product (such as horticultural crops) provide the most favourable combination of technology and cropping system with the highest likely benefit to livelihoods. This farming system with larger customised kits with a pumped water supply and horticulture has taken off in West India due to the conducive enabling environment as described in Chapters 3 and 4, and later in section 6.4. Furthermore, the keener adopters of AMIT in East India are also requesting larger tanks (presumably filled by pumps) so as to irrigate larger areas (refer section 3.5, p19; section 4, p20). Larger systems, combined with a high value agricultural product, offer the most major visible improvement for livelihoods, over and above traditional practice, through their increased production, improvement in crop quality, lengthening the duration of the cropping period, water use efficiency, and through their potential contribution to cash income. However, the viability of this farming system is almost solely dependent on the cultivation of high value fruit crops which have a ready market in the accessible urban areas of the state (refer to section 3.3; and Annex 2). It is also possible to conclude that this farm system and the scale and cost of the micro-irrigation technology involved is a long way removed from what is described as affordable micro-irrigation technologies (AMIT) in the form of small bucket and drum kits. These small AMITs are <u>not</u> what has taken off in West India.

These smaller kits mainly provide food and nutrition security at the family level. Larger kits may facilitate a total change in livelihood strategy and/or wealth status however it is not possible to segregate this impact to any one specific component (to Annex 2, section 4.14). The level of such change and the resultant impact is dependent on the market potential for produce, the availability of technical and agronomic support, and a variety of enabling conditions described under the transferability sections throughout this report (refer to section 2.5, p10; section 3.5, p16; section 4.4, p25). However, if small AMIT kits can bring food

security, nutritional benefits and greater water productivity to the poor then this is a real and credible technical benefit of AMIT.

The level of technical and financial benefits is greatest with the larger customised kits, and these have seen the greatest uptake (refer to Section 3.5). Yet these do not easily reach the poorest. The numbers of drum and bucket kits being utilised are quite low which suggests that they are not really meeting a need. The larger customised systems are less accessible and therefore offer fewer benefits to the poorest. The poor must earn and save hard cash from other activities for a period of years, and/or pool resources, in order to benefit from customised systems (refer to section 3.5, p21; and Annex 2).

This section has described some of the technical and financial impacts that AMIT can offer to users over and above existing irrigation practice. There are important nutritional and social benefits from the small kits, with some advantages over traditional systems. The larger kits can provide direct yield and cash flow benefits in a specific context. The degree of sustainability of such technical and financial benefits, in common with most irrigation systems (as mentioned in Sections 4.1 and 5.1), will depend on the availability of spares, of technical and agronomic support from the supply chain, continuing availability of the minimum water requirements, the presence of a viable market for produce, the ability to access that market, and (not least) the effectiveness and efficiency of the supply chain. The lack of any one of these can negate the whole viability of the sustained extension of the technology using a market approach.

6.2 Whose Livelihoods?

Research Question 2 – Whose livelihoods can be enhanced by purchasing AMIT, in what way and by how much?

In eastern India, where there was no familiarity with the technology, limited technical training and support, and only local markets for produce the wealthier farmers were the main beneficiaries of AMIT, largely gaining in financial terms (about 5–8% increase in annual income, refer to Annex 1, section 9). The very poorest seldom purchased the technology as it was too expensive for them, and they could not afford to take the risk. Where they were given a kit, usually as a grant through an NGO, they do see a benefit from an improved food supply. They are rarely able to grow sufficient produce to sell and thereby obtain cash income. This enhancement of food security for the poorest, however, is a desirable, beneficial and important livelihood benefit from AMIT.

In western India, however, where enabling conditions were more favourable, micro-irrigation technology fits as part of a larger investment in horticultural production. This whole technology and farming system package can contribute a significant beneficial impact on livelihoods (in terms of food security, yield, nutritional value, time savings, water use) and can also help to raise annual household income (Annex 2, section 3.8) in the West Indian context. The poorer farmers were able to benefit from this practice by saving earnings from wage labour over a period of years, and/or pooling resources with family and friends (see section 3.5, p21; and Annex 2, section 4.14, p38-39).

Experience in Zimbabwe found that it was households of average or above average wealth, with access to their own water source (refer to Chapter 5, sections 5.1 and 5.2, and Annex 3) who showed greatest interest in using AMIT kits. The poorer families did not have private land or water resources to exploit, and were thus least likely to be able to enhance their livelihoods via AMIT. The absence of an accessible produce market also reduced interest in the technology (Annex 3, section 4.3.1).

It was found that women benefit directly from the use of the smaller kits which are used predominantly in the homestead gardens, while the larger drum and customised kits are favoured by the men. As explained in the previous research question AMIT did not significantly disturb or change the gender roles and pattern of labour in the Indian context (refer to Chapter 2, Section 2.4, p10; and Annexes 1 and 2). However, in Zimbabwe gender roles and the pattern of labour was altered by AMIT resulting in an increase in the workload of women, sometimes significantly (refer to Annex 3, section 4.2, p25). It is likely that the benefit to livelihoods offered by AMIT will be less if it causes significant and unsustainable disruption to traditional gender roles and to family labour distribution.

In no case was it found sufficient to simply establish a marketing chain and merely sell the hardware to farmers, due to the novelty and complexity of the AMIT farming system. It was deemed important to ensure that users have the following to have any hope of enhancing their livelihoods through use of AMIT and customised micro-irrigation technology:

- Technical agronomic support for the initial couple of seasons at least because of the changes required to traditional cropping systems[2].
- The ability to access and transport sufficient water.
- Availability of credit.
- Assured supply of quality production inputs.

The possibility of livelihood improvement via AMIT (through, either food security benefits, nutritional gains, or income generation) therefore will only be open to those farmers who have access to (or can be supported to have access to) the above points. In general this will not be the poorest farmers.

6.3 The Marketing Approach

Research Question 3 – What are the constraints and opportunities of a market-oriented approach to support the sustainable adoption of AMIT by the poor?

A summary of the market approach is given below, prior to an analysis of the constraints and opportunities of the approach. The general procedure for the AMIT marketing approach pioneered by IDE studied and researched in this project follows a five step process from conceptualisation of an idea, all the way through to commercialisation and withdrawal. These steps are as follows: (1) identification of a problem or need or market opportunity; (2) research and development; (3) field testing and technology refinement; (4) commercialisation and market development; and (5) withdrawal.

The market approach is based on the following considerations: (a) users able to pay for product; b) the price of the product includes a fair margin for the supply chain, and the cost of regular promotion and marketing; (c) users do not pay the cost of product and market development; (d) another entity pays the cost of product development and initial market creation and supply chain development; (e) relies on the presence of NGOs to provide credit (not subsidy) to the poorest farmers; (f) provides mechanisms to ensure after-sales services for the technology; and (g) provides mechanisms to provide agronomic and crop

[2] There are issues associated with who should provide this support, what the constraints are, how sustainable the market approach's method is, and the costs involved. It is possible that NGOs, the private sector, or the local/regional government (not subsidy) could provide such technical support. Such costs must be considered in any strategy to roll out the technology and the approach to other countries.

management support (refer to Chapter 3, Section 3.4; Annex 1, Sections 3 & 12; Annex 2, Section 5).

The commercialisation of AMIT products through the market approach occurs using two types of collaborators, namely Business Development Service (BDS) Facilitators and BDS Providers (refer to Annex 2, section 5, p46). The BDS Facilitators kick-start the process for a limited period of time, with donor funds/grants paying for their input. IDE and the collaborating local NGOs are examples of such facilitators and where IDE has the role of a national facilitator and the NGOs are local facilitators. BDS Providers are the commercial entities (for example, manufacturers, assemblers, dealers, distributors, fruit and vegetable merchants) where the product and services which they provide needs to be paid for completely by including a fair margin for their services. The market approach assumes that the profit motive will ensure their long-term presence in the market.

There are four main **constraints** to the market approach for technology dissemination to the poor (refer to Annex 1, Sections 12 & 13; Annex 2, Section 5.7 & Chapter 6; and Annex 3, Section 4.3.1):

- The market approach can bring technology and technical support to relatively poor farmers but cannot reach the poorest of the poor without further support.
- Local NGOs play an essential role in reaching the very poorest but they can distort the market development process if they provide direct subsidies to farmers. Well-managed credit, rather than subsidy is the preferred option.
- BDS Facilitators must finance the provision of technical and agronomic training for users. It is unrealistic to expect commercial service providers to fulfil this essential role.
- The highest potential livelihood benefit from AMIT is applicable mainly to high value crops where a market must be available to the growers.

The opportunities of the market approach for supporting the adoption of AMIT technology by the poorest are fourfold:

- The approach may offer a more efficient and sustainable use of donor funds, but it remains unclear how readily a BDS facilitator (the consumer of donor and/or investment funds) can withdraw without the system collapsing.
- Under optimum conditions the market-led approach may achieve sustainability faster than other methods of technology uptake, but the presence of a BDS facilitator should be ensured for at least 5 years.
- The market approach facilitates farmer access to micro-irrigation products more quickly and efficiently than via the government subsidy systems (refer to Section 3.5, p20).
- The market approach can provide job opportunities within the market chain e.g. assemblers, dealers etc. and therefore may serve to stimulate the local and regional economy and private entrepreneurship (evidence not yet clear).

This research study was, however, unable to confirm that a sustainable marketing system that remains viable once the primary facilitator withdraws can be established (refer to section 2.7, p12). This appears to be a serious drawback to widespread adoption of a market approach to technology dissemination. This is particularly the case when complex technologies, like AMIT (which require a change in farming system) are to be extended.

The AMIT study has revealed some interesting findings in relation to the market approach and risk. It was found that farmers, who have some wage labour opportunities as back-up support, were less risk-averse and more willing to invest in new technologies particularly in

larger, customised systems (refer to Annex 2, 4.15, p39). In Maharashtra the technological risk is reduced because drip has already been proven to be 'appropriate'. In this region risk is more related to farmers' ability to access and repay finance. Upper economic categories are most likely to be early adopters of kits and accept risks (refer to Annex 1, p5 & p27; Annex 3, p5). Reduction of risk for the poor can be achieved by ensuring the enabling conditions and support factors are present (sections 2.5 & 2.6, p12; 3.4 & 3.5 p17-18; 4.3 & 4.4, p26-29).

6.4 Transferability – what is the enabling environment?

Research Question 4 – How transferable are the technologies and the approach to other locations?

The AMIT study undertook research in three major locations (east and west India, and Zimbabwe) and from this a number of enabling conditions have been identified which will be necessary for transfer of both the AMIT technologies and the market approach to other locations. Consideration here must be given to the transferability at three levels, namely village, project or programme, and regional levels.

The seven important criteria (refer to section 3.5, p16; and Annex 2) which are necessary to ensure transferability of AMIT technology disseminated via the market at a **village level** are to work in areas where: (a) existing agricultural practice includes irrigated cropping of vegetable, horticultural or other high value crops; (b) water is available but limited. In addition the water source must be adjacent to the plot unless the growers are able to invest in pumps and pipe systems to convey water from source to field - in this case AMIT becomes part of a much larger investment; (c) field plots can be observed from the homestead or the culture is such that equipment theft from the field is uncommon (Annex 3, section 3.3.3); (d) households have some, though limited, cash earning opportunities besides the sale of agricultural produce, in order to cushion the risk (Annex 2, 4.16, p42); (e) markets for produce exist and can be readily accessed; (f) farmers have access to good quality agricultural inputs and credit; and (g) NGOs or other agencies are present for at least 3 years to provide the necessary technical and agronomic support to adopters of AMIT.

These conditions, by their very nature, have a tendency to exclude individual poor farmers. Unless they pool their resources the poorest of the poor will unlikely be able to demonstrate these enabling factors. Areas not exhibiting these requirements are less likely to be viable areas for the AMIT market approach to be transferred to.

Other enabling conditions necessary to transfer the technology and approach to other areas are to ensure that at the **project and/or programme level** the implementing team is multi-disciplinary with a spread of skills including irrigation technology and design, irrigation agronomy, marketing, local language skills, understanding of specific local socio-economic conditions, and sensitivity to gender issues. Secondly there must be adequate financial and human resources to plan and implement awareness raising and promotional campaigns in a manner sensitive to the local context. Finally the strategy must be present in the area for at least 5 years to ensure take-off of the scheme and give a chance for sustainability of the technology and the market chain.

To ensure transferability at the **regional level** drip irrigation should already exist amongst the commercial farming sector at a sufficient scale to ensure a supply of basic drip irrigation components and repairs within the region. Furthermore, the technology's price must support fair margins for the supply chain, there should be a free market or at least some degree of liberalisation, and government policies should be supportive.

6.5 Conclusions on the Market Approach to getting AMIT to the Poor

It can be concluded that in the right context and with adequate investment in establishing supply and demand, the market-oriented approach appears to offer benefits in terms of potential for efficiency of crop production and water use. Developing and marketing a lower price micro-irrigation product aimed specifically at the poorer farmer can overcome the problems of state and federal subsidy systems. However, such an approach cannot be 100% reliant upon commercial forces and the approach, therefore, should not be purported as such. Major reliance is placed on local NGO staff and other agencies, and these, in turn, are reliant upon donor funds.

AMIT does not sell itself. The investment in personnel and marketing is very large and relies on supportive local NGOs, at least to reach the poorer farmers. Furthermore, the BDS Facilitator (such as IDE) has high costs usually borne by a donor organisation (note that quantification of these costs was not possible during this study).

The research has shown that there are a number of issues concerning the marketing approach and its appropriateness to extending micro-irrigation technology to the poor, as described below:

- There is not currently conclusive evidence of a market sustaining itself after the BDS Facilitator pulls out.
- There are a large number of quite specific enabling conditions that must be in place before AMIT can be delivered to the poor as a potential channel out of poverty.
- Technical and agronomic support and training for users must be provided at least for the first two seasons of use and preferably beyond this. This cost must be supported or the technology will not be used and the approach will fail. It is not enough simply to get the technology to the user. The user must be supported and trained in how to use it and how to take the greatest advantage of a whole new farming system.
- The technology offers greater benefits and is more attractive when used to irrigate larger areas usually owned by the better-resourced farmers (still poor, but not the poorest), or occasionally by groups of poorer farmers who have saved for some time. So customised kits and pressurised systems, more akin to conventional drip technology, may see wider adoption using the market approach than small drum and bucket kits, provided the context is right.
- From the Indian and the Zimbabwean experience (and knowledge of similar findings in other African states; Winrock et al 2000) drum kits are not perceived by farmers to offer sufficient benefits over existing practice to merit farmer investment. The labour and water savings made are evident but not huge in significance and improved yield and quality seem not to attract much interest from farmers unless there is a real market for the AMIT crops, and/or the many obstacles to get that crop to market can be overcome.

The pre-conditions for this approach are that there are development funds supporting it on a large scale. In the example of Maharashtra where AMIT is working well the programme costs US$5 per family (Annex 2) to establish and support the AMIT programme and yet that is an area where there was already in existence a supportive enabling environment. In other areas or countries the costs are more likely to be in the region of US$8 per family. However this may be considered an effective use of donor funds if positive impact can be achieved and sustained. The market approach, if appropriate to an area and well implemented, may present a better way of providing extension and a better way of technology dissemination. The emphasis on market forces being the driver of the approach and the disseminator of the technology however, is slightly misleading, at least in the initial phases, as the facilitator must maintain a presence for at least 5 years to create and sustain an effective marketing chain.

The cost of their presence is also not covered by technology sales and therefore represents a subsidisation of the approach.

6.6 Implications of Project Findings

The project purpose was to identify and address constraints to adoption of low-cost, improved, non-surface irrigation technologies by resource poor farmers on a commercially sustainable basis.

The project has succeeded in identifying and understanding the constraints to adoption of AMIT technologies by the poor using a market approach to dissemination and uptake. The project has gathered considerable understanding and analysis of the tenets of the market approach and of the specific enabling environment required to support such an approach. IDE has taken account of some of the research team's early findings and shaped their marketing efforts accordingly – thereby overcoming some of the constraints to AMIT adoption in East India. It is less likely that the market will continue to function in East India if the promoter (IDE) withdraws at this stage. Addressing and overcoming constraints to the market approach was not an objective in the West India and Zimbabwe components of this project but a good understanding of the constraints and the enabling conditions required in the West Indian and Zimbabwean context has been obtained. After 4 years of research and an even longer presence of the main implementing partner, in West India there is a lack of conclusive evidence of commercially sustainable markets in micro-irrigation being developed that will continue to function if the promoter (IDE) withdraws.

The larger customised and pressurised systems, more akin to conventional drip technology, proved more attractive to farmers, particularly those who could make the required investment – these people are usually not in the poorest wealth categories (Annex 2, sections 4.12, 4.18). The technology is attractive in the Indian context because it places a low cost product in the market place that competes directly with the price of other 'commercial' hardware after state or national price subsidies have been claimed. AMIT makes drip irrigation available to the many thousands of farmers who cannot satisfy the requirements of the subsidy system in India. It may prove difficult to transfer such a context to many African states.

The changes in the farming systems required by adopting this type of technology are fairly substantial, often requiring a significant input by farmers in order to master AMIT use. Furthermore, the promoter, NGO or private sector organisation, have also to expend considerable resources (human and financial) in follow-up and after sales service. Without this input the sustainability of the technology is in question.

The market-oriented approach itself can offer advantages in getting technology to poorer farmers, in a specific enabling environment. The approach certainly overcomes the constraints of state and federal subsidy systems that exist in India. However, it is not 100% sufficient with market forces alone. Major reliance is placed upon a promoting body that must provide considerable and lengthy investment in product development, market chain establishment, promotion and on-going technical and agronomic support. The costs of this agency are not recouped from the commercial marketing of the technology but represent the 'aid' input into the process. Furthermore, there is heavy reliance also on local NGOs. They play an essential role in increasing access to the poor but their subsidising of the 'market approach' must be recognised.

One of the original intentions of this project was that "irrigation products would be sold and in use in West and East India earning manufacturers income and farmers cash returns, using water more effectively and improving yields" (Output 4 of logframe). However from the findings described in Chapters 2-5 of this report such as:

- the difficulties encountered in starting up a market and ensuring a demand for the product, particularly in East India;
- the small bucket and drum kits not being sellable and desirable on a large scale in the East Indian context; nor were they in West India where it was the larger, pump-fed customised kits that were popular; and
- the failure to find conclusive evidence that AMIT products will be used, can be sold, can provide income for manufacturers, and can provide viable returns to the poorest farmers

it became apparent that this expected output was set at an over-ambitious level and also contained an inherent assumption of saleability and desirability on a large scale. Such an output is dependent on factors out of the control of the project such as farmers perceiving a value in the kits and thus demanding them, manufacturers who are willing and able to sell kits, and to make enough money out of them for it to be worthwhile etc.

It became clear at the beginning of the research that the team's belief that they already had a proven technology that could be, and was being, readily marketed was not quite accurate. In reality in East India the project had to start from scratch with the introduction of the technology and the establishment of a demand structure and a market supply chain; whilst in the West the project found that most of the marketing was being undertaken by NGOs and did not conform to the type of market strategy that had originally been implied (ie. where subsidies are not used). All these factors meant that it was impossible to achieve the task output 4 originally envisaged.

The project has however been successful in testing claims that AMIT technology can be delivered through market forces to millions of poor farmers throughout the world offering them water-saving kits and providing significant livelihood benefits. Our findings are of relevance to this lobby and should be used to qualify such claims and to improve the targeting and implementation of such on-going work. Of particular importance here is the recently established Global Network for Low-Cost Micro-Irrigation.

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