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Is low external input technology contributing to sustainable agricultural development?

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Low external input technology (LEIT) is a prominent feature of many discussions about the role of agricultural technology in rural poverty reduction. There is a widespread conviction the LEIT is more accessible to resource-poor households and can be the basis for human and social capital formation. This paper summarises a recent review of the subject, presents findings on the outcomes of LEIT, and draws more general implications for donor strategies in agricultural technology generation.

Policy conclusions

- Although many types of low external input technology (LEIT) are able to make significant contributions to improving farm productivity and conserving natural resources, there is no evidence that they are particularly suited to resource-poor farmers.
- The patterns of utilisation for LEIT are quite similar to those for most purchased inputs; better-resourced farmers with better links to markets are more likely to be able to take advantage of these innovations.
- LEIT is not generally characterised by rapid farmer-to-farmer diffusion, nor does it lead to significant improvements in human or social capital unless complementary investments are made.
- The persistence of the notion that LEIT is inherently more suitable for resource-poor farmers derives in large part from inadequate donor investment in monitoring and lesson learning.
- Donor support for any type of technology generation must take better account of significant variations in agricultural resources and potential between and within farming communities; investments for agricultural production should be prioritised and coordinated with other programmes for rural income generation and safety-nets.
- Broad-based farmer organisations (as distinct from ad hoc project-led groups) are required to stimulate a demand-led approach to technology generation and information provision.

Background

Claims that rural development can be based on an expansion of the Green Revolution experience or on the promise of biotechnology, are often met by the response that simpler technologies, more attuned to farmers' traditional practice and more compatible with environmental sustainability, are a more appropriate alternative. This concern is expressed in various forms, but often results in donor and NGO projects that promote the use of low external input technology (LEIT).

The arguments have considerable strength. Pesticides and other chemicals are responsible for extensive environmental problems and for health risks. Over-reliance on synthetic fertilisers may cause soil degradation. In many developing countries input markets are unreliable, inefficient and out of reach for subsistence cultivators. Knowledge-based innovations responding to local conditions with local resources are, it is argued, to be preferred. In addition, such technology can be generated and promoted through learning techniques that build farmers' human and social capital.

However, for some, LEIT represents a set of hopelessly primitive and labour-intensive distractions. No amount of analysis is likely to affect entrenched, often ideologically-based pro- or contra-positions, but the majority maintain a more open-minded view of technological alternatives. Unfortunately, there is relatively little evidence available to examine the aspirations of LEIT. This paper is based on a thorough review of the literature and the results of three carefully designed field studies that examined farmers' practices in areas where major, successful LEIT projects had been carried out. The studies specifically sought to understand the long-term consequences of such projects (Tripp 2006).

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Box 1: Types of low external input technology

There is no strict definition of LEIT, but the following innovations are among the most prominent examples:

Soil and water management
- Terraces and other physical structures to prevent soil erosion
- Contour planting
- Hedgerows and living barriers
- Conservation tillage
- Mulches, cover crops

Soil fertility enhancement
- Manures and composts
- Biomass transfer and green manures

Crop establishment
- Planting pits
- System of rice intensification (see Box 3)
- Intercropping

Controlling weeds and pests
- Intercrops and rotations
- Integrated pest management

The following discussion examines several questions related to the performance of LEIT:
- Is LEIT more likely to reach resource-poor farmers than conventional technology?
- What are the labour implications of LEIT?
- How effectively does LEIT spread from farmer to farmer?
- Dose LEIT help build human and social capital?

The review does not examine the technical performance of LEIT but rather accepts that many of these techniques can contribute to increasing production and conserving resources, if they are compatible with farmers' socioeconomic conditions (e.g. Graves et al, 2004). The term LEIT is used here to include a wide range of crop management techniques that use local inputs and resources and that take long-term environmental consequences into account. This review follows the approach of the majority of agricultural development practitioners who find in LEIT useful components of practical crop management rather than the basis of a separate approach to farming.

But even those who adopt this pragmatic stance often harbour the conviction — which we examine here — that LEIT may be better targeted to the resource-poor, more amenable to farmer-to-farmer diffusion, and more likely to contribute to the development of local capacities.

Who uses the technology?

One of the principal assumptions behind the promotion of LEIT is that poorer rural households who are unable to afford purchased inputs will be able to take advantage of LEIT instead. This pro-poor bias provides a powerful argument for supporting LEIT projects, but studies of technology adoption paint a quite different picture.

In the Kenya case study, uptake of conservation practices was much greater in the high potential area, where users of the conservation practices have both larger farms and more cattle, and those who established conservation structures on their farms earned a higher proportion of their incomes from crop sales. Those Honduran farmers with greater areas of cash crops and access to irrigation were more likely to utilise LEIT, and most in-row tillage was for commercial vegetable production, rather than basic grain crops. In Sri Lanka, the IPM project addressed those with irrigated land, where rice sales contributed an average of 43 percent of cash income. Farmers who worked part-time as casual labour were significantly less likely to participate (and used more insecticide than anyone else).

This experience corresponds to the published evidence indicating that the patterns of adoption for LEIT are quite similar to those for practices relying on external inputs. Despite the fact that LEIT projects often focus on more marginal environments, positive results are more often reported from areas with better rainfall and soils and where farmers are linked to markets. More importantly, there is little evidence that LEIT successfully targets poorer households, and the recent literature on rural livelihood diversity makes these patterns understandable. Many rural households earn a minority of their incomes from agricultural activities and have neither the labour to devote to careful crop management nor the time to learn new techniques (even if labour- or resource-conserving). A study in Western Kenya (Crowley and Carter, 2000) describes the downward spiral of unskilled rural labourers who have too little time or cash to invest in the improvement of their own farms and shows that the better-off farmers are more likely to use both external inputs (fertiliser) and local resources (manure, terracing) to maintain soil fertility.

Labour

The labour component of LEIT has long prompted debate. There are certainly many instances where specific technologies require too much labour to warrant farmer interest, even though they may offer real advantages. The alley cropping of 1980s Africa is a case in point (Carter, 1995). But a characterisation of LEIT as labour-intensive is inadequate. First, farmers are willing to invest additional labour if the pay-offs are adequate. In addition, the timing of labour demands may be as important as the absolute amount. There are also important questions regarding whether the major additional labour investment is only for learning and establishing a technique. Pretty (1995) sees these initial investments as part of 'transition costs' needed to accommodate the new practices.

The case studies demonstrate that to characterise LEIT as labour intensive is to oversimplify. For example, the time that farmers in Sri Lanka spent in learning about pest management in rice enabled them to permanently reduce their time and cash investments in insecticide application, without loss of yield. The use of in-row tillage in Honduras requires some extra initial labour investment but most farmers say that once established it makes weed control easier. Nevertheless, labour remains a factor in the diffusion of many types of LEIT. More Kenyan farmers established soil conservation measures with lower labour requirements (such as unploughed strips) rather than labour-demanding techniques such as terracing.

Perhaps the most important consideration in examining the performance of LEIT in diverse rural economies is the fact that, increasingly, labour itself is a purchased "external" input. The study in Honduras estimated that half of the labour for establishing in-row tillage was hired. In Sri Lanka, 70 percent of the farmers hired labour for spraying insecticide and 64 percent hired labour for planting, even though the average farm size is barely 1 ha. Similarly, more than 60 percent of the farmers in the Kenya study hired labour for weeding. A common defence of LEIT — that it favours those unable to afford purchased inputs - falls away as small farms come to depend increasingly on hired labour.

Technology diffusion

LEIT is a product of local innovation or adaptation and relies on local resources, and so, for some, may be more likely to find an understanding audience among neighbouring farmers. However, there is very little evidence for spontaneous diffusion. In Honduras, there was little adoption of in-row tillage and cover crops by non-participants, although about one-quarter tried out the technologies. In Kenya, farmers in some neighbouring communities established soil conservation techniques a few years after the project, although it is difficult to separate diffusion effects from the impact of similar projects promoting these techniques in Kenya. In Sri Lanka, there was no evidence that participating farmers played any significant role in convincing their neighbours to reduce insecticide use.

Box 2: Case studies included in the review

Honduras. The case examines the experience of several NGO projects that promoted sustainable hillside farming, with particular attention to methods for soil fertility enhancement and soil and water conservation. The projects followed earlier successful experience elsewhere in Central America (Bunch, 2002). The study revisits two areas in central Honduras where previous slash-and-burn agriculture has evolved to permanent cropping on increasingly eroded hillside plots and farmers plant twice a year, with maize as the principle first season crop, followed by beans in the second season. The study examines experiences with techniques such as in-row tillage and the use of cover crops.

Kenya. The case focuses on the National Soil and Water Conservation Programme, which featured a catchment approach where communities were encouraged to learn about and establish soil and water conservation techniques (Pretty et al, 1995). Elected local catchment committees served as major actors in the project. The study examines the aftermath in a set of communities in high- and low-potential areas of Nyanza Province, western Kenya. The principal subsistence crop is maize, but beans, banana, groundnut, sweet potato and sorghum are also grown. The project featured the promotion of vegetative and unploughed strips, simple terraces, and retention ditches.

Sri Lanka. The case examines an example of farmer field schools for introducing integrated pest management (IPM) and other crop management techniques in rice (Pontius et al, 2002). The Sri Lanka programme was managed by the Department of Agriculture, with assistance from FAO. The study was conducted in communities in Southern Province, among farmers with access to irrigated paddy land. The project concentrated on helping farmers lower the use of pesticides, particularly early in the season. It also supported the incorporation (rather than burning) of rice straw and promoted more rational fertiliser management.

Farmers require hands-on experience before they are motivated to utilise many of these techniques. In some cases the techniques are quite visible to neighbouring farmers, who are capable of copying the ideas with a minimum of experience. In other cases farmers need a period to learn and experiment with the technique and the experience is more difficult to communicate. And in cases where complex principles are the basis for a change in practice (e.g. agroecological analysis and the rationale for IPM) farmers may find it particularly challenging to articulate what they have learned to their neighbours. The lack of diffusion of the IPM message for irrigated rice, despite the success of farmer field schools in Asia, is a challenge to conventional assumptions concerning LEIT diffusion (Tripp et al, 2005).

In addition to the assumption of straightforward diffusion, LEIT is also promoted as a way to bring about a shift in attitude towards farming. If the uptake of LEIT involves a change in the perception of farm management, we would expect that those farmers who utilised one type of LEIT would be more likely to lower their use of external inputs in general. This does not seem to be the case, however. Honduran farmers who use in-row tillage and Kenyan farmers who establish conservation structures are both more likely to use fertiliser on their food crops. In these cases, the LEIT provides an environment in which a profitable fertiliser response is more assured. These examples illustrate that there is no necessary connection between the use of one type of LEIT and a general reduction in external inputs.

Human and social capital

LEIT projects often carry with them assumptions that the process of developing and adapting management techniques in a participatory fashion will contribute to building farmers' experimental skills and that project-initiated groups will lead to further instances of farmer organisation. Again, the evidence from examining the long-term consequences of LEIT projects does not support these assumptions.

Our best example is Honduras, where the project put particular emphasis on experimentation. About one-fifth of the participants reported at least one experiment carried out subsequent to the project. Projects that emphasise simple field experimentation can stimulate farmers own investigations, but it would not appear that LEIT projects, on their own, can set off a burst of local innovation. Experience has shown that the development of experimental capacities often requires a longer-term approach (Braun et al, 2000).

Because many LEIT projects feature group methods there is an expectation that successful experiences will lead to further organisational growth and innovation, but again, the evidence does not support this. In Honduras, the project did not lead to any further group initiatives. In the Kenya case, only in one site did part of a catchment committee remain together for further activities. In Sri Lanka, the vast majority of farmer field schools functioned for a season and then disbanded.

This experience is consistent with that of other technology generation projects. Community organisations develop for various reasons, but permanent, autonomous capacity requires particular incentives. The high density of donor projects in certain areas can contribute to an image of organisational growth, as a group from one project is inherited by a successor project. But significant organisational development requires adequate incentives and local commitment, and often depends crucially on outside resources as well.

Implications

The image of peasant households perfecting traditional skills, maintaining their independence from input markets controlled by international capital, and practising environmental stewardship is probably too attractive to overturn, and in any case it represents some reasonable aspirations. But the NGOs and donor agencies that endeavour to support a robust small-farm economy by focusing on such images rather than carefully assessing prospects and outcomes for the projects they devise are doing a disservice to the very people they hope to assist. The review illustrates the dangers of assuming that technology (of any kind) is the appropriate way to address profound inequalities in access to resources. It also demonstrates that any attempt to mandate technological purity, basing practical agriculture on ideological predilections, does not meet the challenges facing farm households.

The implications extend beyond LEIT and call into question the common strategy of funding small pilot projects focused on specific technological innovations with the attendant demonstrations, group formation, participatory exercises and assumptions that somehow there will be a spontaneous diffusion of results. When there is evidence

Box 3: The System for Rice Intensification (SRI)

One of the most interesting examples of LEIT to emerge in recent years, and not without controversy, is the System for Rice Intensification (SRI). The innovation was pioneered by a French priest working in Madagascar who found that if rice is transplanted earlier than normal, with the seedlings very widely spaced and subjected to alternate periods of wetting and drying, remarkably high yields are possible. Farmers must learn a series of management techniques complemented by the use of organic manure and extra weeding early in the season. The innovation has been promoted in various countries in Asia and Africa. The agricultural research establishment was initially quite sceptical of SRI, but it appears that high yields are possible in some cases, with some saving in water use. However, the techniques are very management intensive and their outcomes are quite dependent on specific agronomic conditions. Additional yield variability (and hence risk) is associated with the precise water management required. Initial assessment of farmer experience with the technology in Madagascar has shown relatively modest levels of uptake, with adopters more likely to be larger farmers with more education (and often members of a farmer organisation) who were able to invest extra labour at the time of crop establishment. SRI appears to be an excellent example of LEIT's dilemma: an innovative technology that needs to be studied and promoted in a careful, empirical manner without exaggerated hopes or claims that it is particularly suited to the poorest farming households.

Sources: Stoop et al, 2002; et al, 2004

of at least some success at the pilot stage there are then inevitable calls for 'scaling-up'. This is one of the most imprecise terms in the development lexicon, and it would be worthwhile abandoning its use, unless there is a clear definition of exactly what is expected (policy change, project replication, investment in an extension effort, developing new organisations, etc.)

Steering development funds away from these piecemeal strategies should liberate resources for investment in more sustainable approaches to strengthen small-farm agriculture, relying on a range of technologies. There are at least three candidates for alternative donor activities:

First, whatever agricultural technology development activities a donor supports, more effort must be spent on monitoring, evaluation and lesson learning. The requirements go well beyond the obligatory project reviews, but are distinct from the current fashion for complex impact assessments that attempt to link relatively modest changes in farming practice to an array of 'livelihood' indicators. Instead, donors should develop their own capacities to follow technology generation efforts over time, compare their evaluations with those of others, and understand how policies, markets, and farmer capacities condition the utilisation of technology. Improvements in monitoring capacity should make investment in technology generation much more efficient.

Second, donors can insist that planning for investment in agricultural technology generation include a much better understanding of the variation in incentives for the acquisition of technology (of any kind). Strengthening the small-farm economy is surely a key element for rural development, but it must be adequately targeted. There are many so-called farming households that depend only marginally on agricultural activities. Agricultural technology is only one part of the solution to persistent rural poverty, and technology projects must be linked with broader rural development strategies (Dorward et al, 2004)

Finally, donors should support the development of sustainable modalities that provide farmers a wide range of information about agricultural technology. The crisis in agricultural extension derives in part from the realisation that supply-led strategies should largely be replaced by demand-led alternatives. This has led to generally ineffective attempts at 'privatised' extension rather than focusing on building effective demand by supporting the emergence of various types of farmer organisations (Chirwa et al, 2005). Developing strong, broad-based farmer organisations that can exert pressure for more effective public research and extension will have higher pay-offs than small-group activity in response to a brief donor project. Project activity is not an efficient way of making up for deficiencies in basic education, information, and markets, nor is it a likely strategy for building relevant human or social capital. Farmer organisations will only be sustainable if they address major issues of concern to their members. Access to technology may be one of these, but it is unlikely that technology generation, on its own, will be the basis of a significant growth in viable organisations; it is less likely that specific technological issues would provide such a basis. Organisations need to offer as many advantages to farmers as possible in order to elicit commitment and offer opportunities for varying levels of participation.

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