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The Limits of Farming Systems Research and Development: Should Development Administrators Be Interested?

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SUMMARY

The assumptions of farming systems research and development (FSR/D) are similar to those of the alternative technology movement (ATM). While FSR/D can be a useful research method, it is doubtful if it will succeed as a development strategy where the Green Revolution failed. Much of the criticism of ATM is applicable to FSR/D. This criticism is based upon the eventual tendency of markets to expropriate much of the value created by the introduction of alternative technologies. Other critiques include the implicit technological determinism of FSR as a development strategy and the tendency of FSR advocates to ignore macro-economic and social structures that limit 'bottom-up' development efforts.

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INTRODUCTION

In recent years technical assistance for Third World agricultural and rural development underwent a significant change in form. By form, we are referring to the administration and implementation of technical programs, especially in the area of agricultural research and development. Among these recent efforts, farming systems research and development (FSR/D) has gained considerable legitimacy. An important

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characteristic of this new form is the development of alternative technologies at the farm, or peasant holding, level as a means of sustaining the socio-economic benefits of increased productivity within existing farm cultural practices. While this approach may have attractive research potential for understanding limited resource agriculture, the development dimension can be critiqued from an existing literature on the alternative technology movement. We argue that FSR/D as a development strategy has serious shortcomings that limits its ability to alter either the persistence of rural poverty or the continued marginalization of limited resource cultivators (LRCs). We conclude that agricultural administrators should evaluate the promises of FSR/D critically, so as to avoid the same types of criticism leveled at the technical assistance strategies of the Green Revolution. FSR/D is unlikely to succeed where the Green Revolution failed.

The distribution dilemmas associated with the Green Revolution triggered a multinational call for appropriate or alternative technologies, which has been articulated through the alternative technology movement (ATM). Farming systems research and development (FSR/D) has emerged as an institutional research framework within which alternative technologies that correspond to the needs and capabilities of LRCs can be developed. It is this new form of technical assistance that is critiqued in this paper. The rapid acceptance of FSR/D is evident in its various expressions by international agricultural research and development institutions. Indeed, the ascent of FSR/D is not limited to Third World nations. The University of Florida, in addition to its contract with the United States Agency for International Development (USAID) to provide technical assistance to USAID missions through a network of Land Grant Universities, has adapted FSR/D to LRCs in northern Florida. Moreover, the academic interest in FSR/D can be seen in the increasing visibility of Kansas State University's annual symposium devoted to special FSR/D sub-topics.

The articulation of ATM via the various multi-disciplinary and farm level programs of FSR/D is likely to have social consequences and political functions that are not consistent with its fundamental goals. These goals would include a better quality of life for LRCs, participatory development, decentralized development, diversified commodity production and an enhanced political position for LRCs. The critiques of ATM offered by Dickson[11] and Winner,[34] which argue that the simple introduction of alternative technologies is not enough to accomplish

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ATM's goals, are extended in this discussion. At the root of this critique is the eventual ability of commercial commodity and capital markets to expropriate much, if not all, of the value created by the introduction of alternative technologies. It is proposed that while the development of alternative technologies through on-farm research is clearly consistent with the goals of ATM, the forces of the marketplace may be powerful enough to nullify any temporary gains. This market phenomenon is evident in various forms in advanced societies such as the United States and Japan, as well as in less developed societies. Given the ubiquitous character of this phenomenon in both advanced and less developed societies, the ability of FSR/D to operate as a development program is uncertain.

GOALS AND ASSUMPTIONS OF APPROPRIATE TECHNOLOGY

An understanding of what is meant by an appropriate, or alternative, technology begins with its social origin. ATM is a social movement that has emerged in response to the persistence of poverty and hunger, and in many cases the acceleration of the marginalization of LRCs, despite the good intentions of international and national development efforts. According to Morrison,[24] 'alternative technology is a deliberate attempt to mobilize collective action to advocate and promote change, change that is regarded by those mobilized as both morally right and urgent' (p. 198). A common theme among ATM advocates stresses the immediate need for research and development programs that directly involve the participation of the LRCs who traditionally have been excluded. As a social movement, ATM prefers technologies and their accompanying production systems to be resource conserving, decentralized and small scale. It also encourages self-sufficiency and reliance toward meeting the basic needs of a given society.

Observers and participants of the debate on alternative technology are familiar with long-standing distinctions between capital-intensive versus labor-intensive technology; high technology versus low technology; advanced technology versus intermediate technology, to name a few of these distinctions. If the goals of ATM were initially discussed in such static, once-and-for-all, terms, the discussion has certainly evolved to include more than just technology and hardware as such.

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Writers, such as Morrison[24] and Uphoff *et al.*,[32] have connected it to other issues like 'the quality of life', 'participatory development', 'goals and values in technological development', 'decentralized development', etc. This connection has been made because of the persistent claim that technology is not developed in a social–historical vacuum. It is proposed that technological development, as well as its performance, measured in terms of its social impact, occurs within a complex of social, economic, and political institutions. In DeForest's[9] terms, 'appropriate technology as a *process* has generally been defined as a fundamental alteration in the procedures whereby technologies are selected and implemented in order to give greater weight to social values such as decentralization and individual control and less weight to the relatively unimpeded operation of market forces' (pp. 12–13).

These goals represent an extension of the aims of the Green Revolution, but with a greater focus on the needs of small producers. Pearse[28] argues that the objectives of the introduction of the new Green Revolution technologies by governments, scientific institutions and development agencies were:

'(i) Freedom of nations from food dependence through accelerated increases in food production leading toward food self-sufficiency.

and:

(ii) Freedom from hunger for their populations.' (p. 3)

However, the accomplishment of these laudible goals may require more radical economic and social changes than many development administrators are able or willing to induce. Indeed, these goals remain problematic. ATM advocates have argued that the persistence of hunger and poverty after the introduction of the Green Revolution technologies is due to a maldistribution of benefits and an insensitivity to small-scale technical production needs.[8,28]

This critique of the apparent failures of the Green Revolution, then, involves a critique of form, and not of goals *per se*. As a social movement, ATM, at least implicitly, assumes that social change in the desired direction will occur if there is: (1) widespread participation by LRCs, (2) the development and introduction of appropriate technologies and (3) a reduced dependency on external trade for the technical means of production.

This menu for social change is said to offer an alternative to the more traditional 'trickle-down' development models proposed by the capital

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lending institutions, such as the International Monetary Fund, as well as the development assistance programs associated with the Green Revolution. Yet, it fails to articulate how it is more likely to succeed where the 'trickle-down' model is said to have failed.

Relative to the 'trickle-down' development models, ATM assumes a decentralized 'bottom-up' strategy for social and economic change. This model champions the persistence and dominance of small-scale agricultural production units in achieving the necessary increased productivity for a particular society's agricultural self-sufficiency. However, while advocates appear to understand fully that technological development and performance—the primary instrument for social change—do not occur in a social or economic vacuum, they are vague, if not indefinite, in articulating the relationship between the 'top' and 'bottom' (ATM's terms) of a society's social and economic structure.

It is at this juncture that the ATM becomes exceedingly vague, and consequently incomplete, in its assessment of the production dilemmas faced by LRCs. The apparent reluctance to problematize the 'top' is suggested by Winner:[33]

> 'Saturated by the influence of commercialization, advertizing and bureaucratic co-optation, movements for social change in the late twentieth century often become indistinguishable from fashion trends. In a matter of weeks the radical thrust of a new idea or practice can be absorbed into the ephemera of glossy surfaces of the post-industrial marketplace. It is possible, perhaps even likely, that appropriate technology will encounter this fate.' (p. 27)

Winner[33] presents the reader with the example of the 'appropriate-technologists' hopes for a decentralized policy' that would rely on solar energy. The latter, he correctly observes, 'is already being undermined by the attempts of American corporations and public bureaucracies to shape developments in this field along lines that correspond to existing institutional patterns' (p. 46).

The ATM fails to articulate what is meant by the 'top'; consequently, it is unable to determine how the 'top' may facilitate or impede a decentralized 'bottom-up' development strategy. Instead, ATM tends to substitute nebulous ideal formulations, such as 'the quality of life is inextricably tied to technology', 'government policies and corruption need to be changed', and to what is innocuously coined 'political, economic, and social institutions', for a clear theoretical framework.

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The meaning of these various concepts is left up to the reader or potential ATM activist.

Perhaps, Morrison[24] provides a pragmatic explanation for ATM advocates' inability to articulate a relationship between the 'top' and the 'bottom':

> 'There is a full realization, at least among the more sophisticated proponents of alternative technology, that items of individual technology (e.g. axes and bulldozers) are important, but that they operate in a complex system of social, economic, and political institutions. This implies that both the means of production and the relations of production must be changed to achieve the soft technology society. Nevertheless, there is an implicit notion that since individual technological items are often the most immediately changeable components of the sociotechnical system, they are the logical and, indeed, the only, feasible place to start.' (p. 199)

This begs the question of why the introduction of such 'soft', or alternative, technologies is likely to succeed in achieving the desired goals. The fact that technology exists and functions within a social, political and economic context, as conceded by Morrison, suggests that the relationship between technology and the contextual framework is not a mechanistic and linear one. It is such formulations of social change as offered by Morrison that have prompted commentators like Winner[34] to say that, 'the story of appropriate technology may well turn out to be one in which the inertia of existing sociotechnical systems overwhelms and absorbs a variety of social idealisms that set out to provide modern technology with new designs and directions' (p. 46). As Pearse[29] has stated:

> 'The fact is that, in a market society, unless there is persistent political pressure for the continuation of the strategy [of alternative technology], it can be reversed quite quickly, and the whole impetus of growth may pass to an entrepreneurial sector, articulating itself rapidly out of the larger peasant–producers and into the service entrepreneurs, ex-landlords, and investors from outside the sector.' (p. 244)

In short, Pearse argues that, without a clear understanding of how the immediate gains of alternative technologies for LRCs can be consolidated, such efforts may be doomed to eventual failure.

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TECHNOLOGICAL DETERMINISM

The failure of the ATM to articulate effectively how a decentralized 'bottom-up' development strategy will achieve its goals has forced it to accept the undesirable assumption of technological determinism. Simply stated, the ATM is left with only the assertion that the introduction of alternative technologies will cause the desired social change. This assumption views social evolution from traditional to advanced social organizations as 'determined by the type of technology which a society invents, develops, or is introduced to' (Dickson,[11] p. 44). Essentially, the ATM depends upon the veiled assumptions of technological determinism. (David Dickson's book, *The Politics of Alternative Technology*, provides an excellent historical and theoretical discussion of the legacy of technological determinism as a principal assumption of the alternative technology movement.)

The inherent assumption of technological determinism is apparent even in the terminology employed by ATM advocates, including the self-assigned name (alternative *technology*) and the terms used to delineate key conceptual debates (low *technology* versus high *technology*, capital-intensive *technology* versus labour-intensive *technology*, soft *technology* versus hard *technology*, etc.). Furthermore, there is a virtual absence within the literature of other types of social and economic factors that are of equal or *greater* importance for achieving the proposed social goals of increased well-being and decentralization. These and other nuances all point to an underlying assumption that technology is the key factor in need of change rather than the structural impediments of a particular political economy. There also is the accompanying assumption that the mere tinkering with 'appropriate' technologies will change the entire political economy. While one cannot escape the fact that technology has become an integral part of social organization, it is also evident that 'contemporary problems associated with technology stem as much from the nature of technology as from the uses to which it is put, but that the former is largely determined by social and political factors, of which technology can never therefore be considered independent' (Dickson,[11] pp. 9–10).

Since the proponents of 'trickle-down' development models also operate from the assumption of technological determinism,[30] all that is necessary to be logically persuasive is to provide evidence that 'small is beautiful'. Unfortunately for all involved, technological change alone

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has not yielded the desired results.[8,11,15,17,28] The appropriateness of an agricultural technology depends upon the extent to which it increases the value within the marketplace of the commodity being produced. As we will propose below, technological changes tend to be uneven in their benefits to farmers and tend to be relatively short-lived in their ability to yield a competitive advantage for early adopters. Unless the value created by a technology is retained by the producer, the benefits of any technology, but particularly alternative technologies, will be ephemeral.

ATM AND FSR/D: A CONNECTION

Farming systems research and development represents an institutional response to the critique of assistance programs presented by the ATM and its advocates. The identity between FSR/D and ATM becomes clear when the former is viewed within the socio-historical context of prior assistance programs and their consequences.

The rise of FSR/D followed a brief period of euphoria over the discovery of high-yielding cereal varieties that were developed by the international agricultural research centers. The critics of what became known as the Green Revolution argued that the new technology contributed to widening inequalities and changing social relations that were manifested in the displacement of peasant farmers (e.g., UNRISD studies of the 1970s). Central to the criticisms was the growth of landless wage-labor. This process involves both the loss of land by cultivators, which eliminates subsistence as an alternative, and the entry of the displaced into wage-labor. It also refers to the precarious situation in which cultivators have both off- and on-farm employment or are on the brink of fully entering the ranks of wage-labor. This is expressed in the argument that, to use the new technology, the cultivator must 'reorganize his economy' from subsistence to commercial production to produce a minimum surplus to pay for the biological inputs and interests due to the initial loans for them. This reorganization process, in which cultivators have to become entrepeneurs skilled in market operations, has contributed to indebtedness and, for some, to landlessness.[29]

The international agricultural research centers and their major donors soon began to incorporate certain elements of these criticisms. However, such incorporation merely reflected a partial acceptance of these criticisms, as well as a flawed understanding of the dynamics of technical

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innovation and change. The new form that has emerged from this incomplete assessment of technology and its performance necessarily invites the same kinds of criticisms discussed in relation to ATM.

Developments within the system of agricultural research centers funded by the Consultative Group on International Agricultural Research (CGIAR) indicate acknowledgement and accommodation of the early criticisms. In the mid-1970s, numerous meetings were held on the consequences of new technologies. Socio-economic research units were bolstered, many of which were tied to emerging FSR/D programs.[26,27] Research findings generated statements similar to the following:

> '... if present trends continue ... landless laborers will continue to increase relative to farmers ... [and] ... real wages will decline and the value of the tenancy rights will rise, widening the income gap between farmers and landless workers.' (IRRI,[21] p. 6)

> '... perhaps revolutionary changes in rural institutions that the radical critics of the green revolution for the past ten years have been predicting will occur as a result of increasing immiserization in the rural areas of many developing countries.' (Bingswanger *et al.*,[2] p. 408)

These statements corresponded to policy developments within CGIAR, which began to pay increasing formal attention to the landless labor problem and to the small 'resource-poor' farmer.[6]

The targeting of the small farmer demonstrated the growing interest in the distribution of benefits of new technology. An identical development occurred in the World Bank, which was one of the early proponents of the small farm development theme. According to Montague Yudelman, the director of the Bank's Agricultural and Rural Development Department, the theme arose out of a concern motivated by social scientists. The latter, Yudelman[35] said, demonstrated that, 'rural poverty was growing' in the form of 'substantial numbers of unemployed, landless workers ... especially in Asia' (p. 310). Technical assistance for agriculture had to reach the 'traditional small farm sector' so that it could 'become a producer of an agricultural surplus rather than a provider of surplus labor, as it had been in the past' (Yudelman,[35] p. 311).

Yudelman's assessment is exceedingly important toward an understanding of the rise of FSR/D as an example of ATM. The goal of assistance programs was refined to target a distinct social grouping in

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rural areas to resist, or, at best, to put a check on, polarizing conditions. This social situation essentially summoned an approach that would guarantee benefits to smaller, less endowed cultivators, who must become producers of an agricultural surplus.[26]

The correspondence between general socio-economic conditions and technological research and development strategies is clear in the rise of FSR/D. Like the Green Revolution, its primary goal is adoption. The target grouping must be provided technology suited to its capabilities and needs. Only then can the small cultivator sector expect to gain anything from new technology and to become surplus producers. In this regard, FSR/D is a change in form. It aims to affect those cultivators whom earlier programs failed to touch or benefit. More specifically, it is a change in the implementation of technological development and extension.

The central question for development administrators, then, is how to improve the implementation of agricultural development initiatives. At this conjunction, the tie between FSR/D and ATM becomes apparent. FSR/D advocates argue that the needs of the small cultivator sector can be met by developing technologies suited to the sector's factor capabilities.

Against this background, two features of FSR/D as appropriate technology logically follow. First is the priority given to small and simple production units and technology. Hildebrand,[20] for example, argues for the following:

> '... agricultural research designed for small farms must result in technology that is simple and not complex, to reduce learning costs; use mostly resources available on small farms with a minimum of purchased inputs, to reduce capital requirements; and be evaluated and tested under the resource conditions found on farms of the clientele for whom they are designed....' (p. III-10)

Other advocates are Gostyla and Whyte,[16] who, along with Hildebrand, have noted a new research-and-development prototype in the Guatemalan Government's Institute of Agricultural Science and Technology (ICTA). Gostyla and Whyte[16] have argued that the ICTA operation represented a break from the 'traditional research model' that underlaid the Green Revolution's top-down character, which assumed that 'technology will spread by "trickling down"'. The new alternative model,

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exemplified by FSR/D, 'does not direct itself to maximizing yield at all costs.... Researchers must orient their investigations toward technological alternatives that, though they may display less yield potential than more sophisticated packages, are implementable and *profitable* at the farm level' (Gostyla and Whyte,[16] p. 3, emphasis added).

These described features point to FSR/D's appeal for bottom-up, participatory research that should yield technology appropriate to the needs of the small cultivator. As Norman[25] put it, the bottom-up approach can 'best ensure truly relevant improved technology ...' (p. 815). In this context, research must be decentralized and carried out in cultivators' fields to assess the totality of factors that determine whether or not farmers will adopt new technology. But more central to the bottom-up approach is the participation of FSR/D's clients, the small cultivators, and the incorporation of their goals and values into the research process. To be sure, there is no consensus among advocates over the administration of participatory research and development. Some, like Gilbert *et al.*,[13] say that farmers should be included when researchers are testing possible technological options. Others, like Hildebrand,[19] though, maintain that cultivators should be included in the earlier stage of assessing the general situation before deciding on particular technological options. Hildebrand's formulation is based on the view that the problem of non-adoption is not one of cultivator motivation (or passivity) but 'one of offering "change" which are [sic] *not* appropriate as perceived by the farmers themselves ...' (p. 377). The lack of consensus, however, is compensated for by the common appeal for a two-way communicative relationship between cultivator and researcher that incorporates cultivator goals and values.

Like ATM, FSR/D proponents have dealt with the discredited top-down, trickle-down theory by advocating a bottom-up approach to development assistance. But like ATM, the rise of FSR/D has been based on an incomplete assessment of socio-economic and technical change and, more specifically, of the relationship between the 'top' and 'bottom'. To recapitulate, FSR/D advocates have failed to articulate how their new program will succeed without fundamentally addressing issues associated with the top.

Indeed, advocates are quick to point out that FSR/D and its bottom-up emphasis are not designed to replace 'top' institutions. The new form, instead, is supposed to complement the old. How this complementarity is to materialize, however, is never made clear except to say that farm

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level, participatory research needs laboratory, experiment station investigations, and vice versa. Moreover, the notion of complementarity may ultimately point to a basic unwillingness to problematize the 'top', which, as in the case of ATM, remains unspecified.

To be sure, as with Morrison's[24] review of ATM, the top is referred to, albeit contradictorily. Gilbert *et al.*[13] refer to it in terms of the possible clash between society's goals (i.e. the top) and those of cultivators (i.e. the bottom) but propose to resolve the conflicting goals by calling for 'pre-screening improvement strategies' by government research and planning agencies to determine the compatibility between the two levels before technological options are fully implemented. The following contradiction, however, emerges: 'By placing pre-screening back into the hands of the very institutions that FSR is supposedly designed to "complement", the noble effort to respect farmers' goals and values and to offer technology appropriate to these goals may amount to another attempt to initiate technological improvements from the "top"' (Oasa,[26] p. 23). Another reference to the top is made by Hildebrand,[19] who, contrary to Gilbert *et al.*,[13] suggests that FSR/D practitioners be prepared to recommend nothing, given serious obstacles to small cultivators' adoption of technology. Hildebrand[19] argues that practitioners must fully examine agro-socioeconomic conditions, which 'are all those agro-climatic, economic, social, cultural, or infrastructure factors or constraints which condition whether a farmer needs, desires, or *can* accept any given change' (p. 376, emphasis added).

If these conditions also constitute the 'top', then practitioners are presented with identical problems faced by programs of an earlier vintage. The CGIAR, in fact, has attempted to confront the problematic interaction between technological and social contexts. Its annual Integrative Report of 1978 stated that, 'as long as there is inequality in ownership of productive assets and large farmers own more land than small farmers, larger farmers will gain more income. . . . Therefore, in the absence of widespread and effective distribution of productive factors, absolute income must widen' (CGIAR,[5] p. 3). The same report also discussed the problematic character of appropriate technology. It stated that, 'even if such technology were developed, large producers would very likely adopt whatever attributes of "smallness" were needed to apply such technologies if it were to their advantage' (CGIAR, p. 13). A later report advanced these arguments by stating that, 'all concerned need to take a balanced view and to make an effort to

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understand the impact of technical change *within* the wider frame work of the socio-economic and political forces that both determine and are affected by it' (CGIAR, p. 15, emphasis added).

The CGIAR's analysis, however, repeats the drawbacks of others that acknowledge the dynamic relationship between technology and its context (or, in its own terms, 'socio-economic and political forces'). It repeats it by not elaborating on the specific content and character of such forces. This failure translates into a failure to articulate how the value generated by appropriate, small-cultivator technology will be retained by the cultivator. And, if 'top' conditions are to be viewed as given and permanent, nowhere to be found is a discussion on how impeding conditions can actually be neutralized so as to allow small, resource-poor cultivators to benefit. The next section will attempt to complete this assessment by extending this logic into the realm of production and market structure.

AGRICULTURAL TECHNOLOGY AND THE EXPERIENCES OF DEVELOPED AND LESS DEVELOPED SOCIETIES

An important but contested precept of the social sciences is that technology is a social product and, as such, does not operate as an exogenous factor in influencing the direction of social organizational change.[30] The usefulness of a production technology, including alternative technologies, is determined by the amount of value it will help create for the producer in a given market structure. Consequently, in market societies that are oriented toward profit and the accumulation of wealth by producers, including LRCs, it is not technology that makes it necessary for producers to accumulate capital, 'but the need for accumulation which makes [the producers] adopt the powers of technology' (Dickson,[11] p. 54). Contrary to the assumption of technological determinism, which considers technology to be an exogenous cause of concentration in agricultural production (e.g. mechanization of agriculture causes concentration), technology tends to facilitate the accumulation of wealth by extending the productivity of labor or land through the increased use of capital. This alternative view of the relationship between technology and society is evident in the character of the structure and change of US agriculture.

In the US, the tendency is for agricultural technologies to extend the

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productivity of scarce resources such as labor and land. Friedland *et al.*[12] and de Janvry[10] argue that agricultural technologies also have been used as political leverage by landowners to control agricultural wage laborers both in advanced societies and in less developed societies. The research and development of these technologies, historically, are guided by the priority given to increased productivity without serious concern for the potential social consequences. Busch and Lacy[4] argue that:

> 'Careful studies of beneficiaries [of the research and development process] suggest that certain groups are served to a greater degree than others. For example, the tendency of agricultural research products to be capital intensive tends to benefit those individuals with ready capital to invest, i.e., large farmers and agribusinesses.' (p. 233)

Consequently, US agricultural technology was not developed within a social and economic vacuum but as a response to market structures that maximized the accumulation of capital within a capitalist economy. Therefore, while technology is associated with the concentration of production among US farms, it is primarily the marketplace, for which these technologies are developed, that creates the conditions that make concentration necessary.

As the US farm structure has become more concentrated, a dual structure has emerged. Presently, a small number of very large hired-labor dependent farms produce the bulk of all agricultural commodities, with small producers constituting the largest type of farm structure but contributing the least to overall productivity.[22] Furthermore, the debt–asset ratio of American farmers has steadily increased, as debts incurred in purchasing new, and often requisite, technologies have put stress on their capital fluidity. A similar maldistribution of the benefits of agricultural research and increased capital debt has been observed in less developed societies that experienced the Green Revolution.[15,28]

This relationship among technology, the marketplace and farm structure in the US is often referred to as a 'technological treadmill'. Cochrane[7] sums up this process as follows:

> 'We know now why farmers adopt new and improved technologies and expand their output even though they complain of low product prices and rising input prices. They do so because each farmer sees

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> the adoption of new and improved technology as a means of either increasing his profits or reducing his losses. But in a competitive situation, with many producers, there is no way that an individual farmer can hold onto himself the short-run gains from the adoption of new and improved technology. Such income gains are lost to him in the long run through the competitive process. They are lost in a free-market situation through falling product prices. They are lost in the price-support situation through rising prices for the fixed factors—typically land.' (p. 393)

Furthermore, early adopters with access to the necessary capital tend to get most of the additional profit *before* the market is saturated. The engine of the technological treadmill is the tendency of farmers to overproduce in markets characterized by relatively inelastic demand.[15] While individual farmers may be perceived as acting rationally when expand their scale with the aid of labor- and land-saving technologies, such behavior at an aggregate level has the contradictory effect of producing an excessive surplus. The resulting overproduction contributes to a drop in the price of the commodity, which dilutes much, if not all, of the anticipated gains. Furthermore, both the technological treadmill and the tendency for overproduction are complicated by imperfect market conditions that leave farmers in an unfavorable market position relative to those who sell the factors of production to them and purchase their commodities.* As Tweeten[31] has observed:

> 'The markets in which farmers purchase inputs and sell commodities are generally characterized by some form of imperfect competition. The actions of a single [agribusiness] firm can influence the market price. Whereas the sales of any one farmer have no apparent impact on total output of the farming industry, the sales of one firm supplying inputs or buying farm outputs can perceptibly influence industry output and price.' (p. 190)

Similar conditions exist in other advanced societies and less developed societies. Hayami and Ruttan,[18] in articulating their theory of induced

* Small farms and labor-intensive technologies have tended to persist as the dominant farm type in the US for those commodities under strict production controls. It is not by accident that tobacco is still primarily produced by small-scale family farms. However, should government production controls be eliminated, it is expected that tobacco will eventually be produced on large vertically integrated farms.[23]

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innovation, have noted that in Japan, where, unlike the United States, labor is plentiful, but land is very scarce, the tendency has been for research initiatives that emphasize land-saving technologies.

Numerous authors[1,3,8,28] have analyzed the relationship between technology and agricultural structure among less developed societies, but the clearest theoretical and empirical assessment is that of de Janvry[10] who argues that:

> 'There has been a tendency to look at the problems of agricultural production and the welfare of rural populations as separate issues that can be understood within the realm of the agrarian sector or even at the village or farm level. ... [Consequently], rural poverty has been rationalized as a phenomenon *sui generis*, a problem associated with the stubborn resilience of traditional culture and with dualism and marginality. ... We reject this approach and start our analysis of the agrarian question in Latin America from the postulate that the problem is but a symptom of the nature of class structure in the periphery and of the particular process of capital accumulation it undergoes.' (p. 7)

De Janvry[10] further argues that, by ignoring the ways in which agrarian problems are associated with the structure of the larger economy, the concept of '[development] is reduced to a process of diffusion of innovations' (p. 8).

For de Janvry,[10] improved technology strategies for small cultivators in less developed societies, including FSR/D, are not likely to improve the incomes of their clients.

> 'In terms of the rationality of the individual producer, it is immaterial which type of technology is adopted, provided that the type chosen increases profits. But this does not hold for the generation of technological innovations in agriculture. ... [By] contrast, given an inelastic demand for food, the surplus from the application of [alternative technologies] is automatically extracted from the agricultural sector through a decline in the price of food. In the first instance, the surplus can be extracted from agriculture only by means of tax schemes or forced deliveries at low prices. In the second, surplus extraction is automatically ensured by the market mechanism that imposes a systematic "squeeze on agriculture".' (pp. 170–1)

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Clearly, de Janvry identifies a similar process of the expropriation of value created by new technologies by those who control the economy for less developed countries, as Cochrane[7] and Goss *et al.*[15] found for the United States.

There are multiple lessons to be learned from these experiences, but the most relevant for FSR/D is the inability of agricultural technologies to continue to return a profit to an adopter once all other producers also adopt the same technology. In other words, the 'top' maintains a decided advantage, in the terms of trade, over the 'bottom'.

The US experience, as well as those of Japan and less developed societies, strongly suggests that technology is not an autonomous factor operating in an economic vacuum. Unlike DeForest[9] who argues that ATM (and, by inference, FSR/D) give 'less weight to the relatively unimpeded operation of market forces' (p. 13), we propose that the success of FSR/D is highly associated with its ability to articulate market structures from the 'bottom' to the 'top'.

CONCLUSION

The proponents of FSR/D are confronted with a difficult, but not necessarily problematic, dilemma. How can the initial benefits of FSR/D *not* be nullified by the ability of those who have a favorable position in imperfect markets to expropriate the value created by such technical assistance?

Presently, the success of FSR/D hinges on the assumption that two events will occur that will yield the desired goals: mass participation and the insertion of alternative technologies. Yet, for the moment, FSR/D as a social movement is primarily confined to agricultural researchers and technical assistance administrators. For FSR/D to achieve its goals of increased quality of life, participatory development, decentralized production, etc., the small farmers and peasants for whom the program is designed must also join this social movement. Otherwise, as Pearse[22] has noted above, without the political support at the grass-roots levels, the benefits of technical assistance will be lost quickly.

Furthermore, there is little evidence that the economic benefits of alternative technologies developed by FSR/D will be sustained by the market. On the contrary, the experience of the Green Revolution and

that of agricultural technology in the US suggests that market advantages gained through the insertion of new technologies will be short term. This contradiction suggests two types of problem for the administration of FSR/D programs.

First, such programs, which are very locality specific, will have to be continuous, since new alternative technologies will have to be developed as the older ones are eclipsed by the market. In other words, FSR/D will not be a one-time project for the targeted area, and it is likely to be very expensive.

Secondly, the evaluation of FSR/D programs must allow a time lag for assessing the sustainability of the developed alternative technologies. If the US and Green Revolution experiences are going to be instructive, the long-term effectiveness of the new alternative technologies must be assessed. Experience suggests that the early adopters, such as those farms on which FSR/D alternative technologies are developed, will benefit from the introduction of the new technologies or management strategies. However, once the targeted area also adopts the same alternative technology, there is no evidence that the initial advantages observed for the experimental farm will be sustained. Therefore, the potential benefits of alternative technologies developed on the experimental farm are unlikely to persist under conditions of full adoption. Unless such benefits are maintained by the entire targeted area, assuming no market changes, it is unreasonable to expect small farmers and peasants to become involved in a social movement.

No market exists naturally. The development of market structures that will ensure the retention of the surplus value created by the introduction of new alternative technologies will require the political legitimacy that comes from solid grass-roots support. The interests of the 'top', or those who control and benefit from the status quo, are most often at odds with those of the 'bottom', or the proposed clients of FSR/D. Any value retained by small farmers and peasants is value lost to those who purchase, process and then market, their commodities. Unfortunately, the 'top' has not been problematized.

To be sure, FSR/D advocates are not altogether silent about policies and programs needed for the performance of alternative technologies. But, in calling for these policies, FSR/D proponents, as well as their 'trickle-down' predecessors, rely on a given 'top' that has historically shown no interest in altering market forces and structure.

As a research method, a farming systems approach can make a

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substantial contribution to our knowledge of how LRCs organize their production units. However, as a development strategy, it is likely to experience problems similar to previous development efforts.

For FSR/D to address its goals successfully, it must also examine ways of developing market structures that do not expropriate the value created by the introduction of alternative technologies. Presently, FSR/D programs have gained a degree of legitimacy among administrators of technical assistance programs. But, unless these programs produce the promised equitable distribution of benefits, criticisms similar to the ones FSR/D proponents leveled at the Green Revolution will come home to roost.

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