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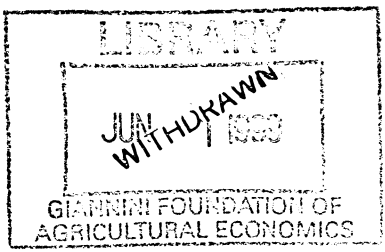

SEED REGULATORY FRAMEWORKS AND RESOURCE–POOR FARMERS: A LITERATURE REVIEW

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ABSTRACT*

This literature review examines the role of seed regulatory frameworks in current attempts to improve the performance of the seed sectors of developing countries. The seed regulatory frameworks discussed in this study include the rules and regulations, and the norms, guidelines and standard practices, that govern: variety development, variety release, seed certification, and seed distribution and sale. The hypothesis explored is that these seed regulatory frameworks are neither sufficiently responsive to the needs of resource-poor farmers nor adequately adapted to changing institutional environments. After a brief examination of the rationale for attention to improving seed systems, the review discusses the institutional environment of national seed sectors, including the changing roles of the public and private sectors and the contributions of NGOs, and summarises the characteristics of seed regulatory frameworks in developing countries. The major part of the review is devoted to an examination of the current conduct and problems of seed regulatory frameworks, a presentation of alternative strategies, and a summary of unresolved issues that need to be addressed. The findings indicate that there are significant biases in the way that varieties are developed and released, such that resource-poor farmers are less likely to be able to benefit from the products. Similarly, seed certification and distribution regulations often hinder farmers' access to seeds and varieties that would be useful to them. There are already a number of possible improvements being tested. No solution will be perfect, but regulatory frameworks that take account of farmers' conditions, allow for more farmer participation in their definition and conduct, are more transparent, and allow broad institutional participation, are likely to represent steps in the right direction.

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INTRODUCTION

Seed and Agricultural Development

In any discussion of agricultural development strategies, the subject of seed has a unique capacity to draw attention and interest. Seed is the primordial input, the embodiment of past harvests and the promise of future ones. It is not surprising that seed is a prominent feature of many proposals and projects concerned with improving the productivity of resource-poor farmers. Donor-funded agricultural development projects often include improved seed supply as a major element in their strategies. Seed is also a focus for many local level initiatives supported by NGOs that promote agricultural self-sufficiency or the protection of biodiversity. In addition, efforts to strengthen the private sector in developing country agriculture often target the seed industry. These various seed initiatives have had relatively little impact on the majority of resource-poor farmers, however. There are several possible explanations for the slow progress; this paper proposes to examine only one of them. It is focused on the rules and regulations, and the norms, guidelines and standard practices, that surround varietal development, seed production and seed distribution in developing countries. The paper explores the hypothesis that these "seed regulatory frameworks" are neither sufficiently responsive to the needs of resource-poor farmers nor adequately adapted to changing institutional environments. This review is an attempt to set the scene for a series of country case studies that examine the hypothesis in more depth.

The Organisation of the Review

The remainder of this introductory section explores the rationale for attention to seed systems. The next section discusses the changing institutional environment of national seed sectors, introduces the seed regulations that are the subject of this review, and summarises the characteristics of seed regulatory frameworks that justify a closer examination of the subject. The third, and major, section of the review, explores challenges and options for seed regulatory frameworks. It is presented in four parts: variety development, variety release, seed certification, and seed distribution and sale. For each of these areas the discussion is divided into a review of the current situation, an exploration of possible alternatives, and a summary of unresolved issues. The following section of the review attempts to place the discussion of regulatory frameworks in a more general context, and briefly examines the role of law and the characteristics of institutions that develop products, define standards, and regulate those standards. The final section presents the conclusions of the review.

The Rationale for Improving Seed Systems

Before examining the nature of seed regulatory frameworks, it will be helpful to review the rationale behind the diverse and growing interest in seed systems. Although the arguments in favour of improved seed systems may seem straightforward, they deserve a brief examination. In particular, we should bear in mind that there are two different, and at times quite separate, justifications for being concerned about an improved seed supply. The first is related to the provision of new varieties. Farmers' access to varieties that have desirable characteristics is best promoted by a seed system that can deliver at least small quantities of seed of new varieties. The second concern is farmers' ability to maintain varieties (local or introduced), and to produce adequate quality seed, through their own efforts. If farmers do not have this capacity, then there is also justification for a more organised seed system.

New Varieties

If the focus is on the provision of new varieties, there must be evidence that these will make a difference to the productivity and well-being of farm households. The case is not always as obvious as it first appears. Many rural development projects, for instance, have been overly optimistic about the availability of improved germplasm to replace what farmers are growing. The history of the Puebla Project in Mexico (Redclift, 1983) in the 1960s and 70s, where new maize varieties failed to prove themselves more productive than the local varieties, is a case in point. In addition, it is widely recognised that yield potential *per se* is only one of a number of criteria that farmers use in considering new varieties. Zeigler (1986) describes the case of an improved maize variety in Burundi that outyielded the local variety, but whose late maturity made it unacceptable for the predominant crop rotation patterns. The acceptability of new varieties depends on a range of environmental and socioeconomic factors (Ashby, 1982). Improved crop varieties have been widely adopted by resource-poor farmers in many areas. The rice and wheat varieties of the Green Revolution (Herdt and Capule, 1983; Byerlee and Moya, 1993), are the most commonly cited example, but improved varieties of many other crops have been adopted in a range of environments (Edmeades *et al.*, 1991; Pachico and Borbon, 1987). But there are also instances where no superior improved varieties are yet available, as Cromwell and Zambezi (1993:117) found for groundnut and bean varieties in Malawi, and the establishment of a seed system as a conduit for new germplasm in these cases is premature.

New varieties do not have to be the product of formal plant breeding, of course, as the resilience, range, and innovation of local crop systems attest (Richards,

1986). Several recent projects promote and strengthen farmers' capacities to select, exchange and improve local crop varieties (Mushita, 1993; Worede, 1992), and adequate systems of seed supply will be important for achieving wide access to these varieties.

Seed Quality

Improved seed systems also offer the possibility of access to better quality seed (of traditional or introduced varieties), but again, justification rests on comparison with farmers' practices and priorities. Farmers often manage their own seed supply, and after acquiring seed of a new variety they may be able to maintain it indefinitely. Approximately 30% of seed used in the UK is farmers' own saved seed (Kelly and Bowring,1990:147), and more than half of the wheat, barley and oats sown in the U.S. is from saved seed (Jaffee and Srivastava, 1994:108). The proportion of farmer-saved seed for developing countries is much higher; Almekinders *et al.*, (1994) estimate it to be on the order of 90%. Even in areas affected by the Green Revolution, seed replacement rates are low (Groosman *et al.*, 1991:19). Wheat farmers are often able to manage their own seed until a new variety is required and Brennan and Byerlee (1991) show a range of 5–10 years as the average turnover rate for wheat varieties for a sample of both developing and developed countries.

There are, however, a number of factors that argue for improving seed quality. Climatic or technological difficulties may challenge farmers' seed storage capabilities and may make it more economic to rely on a formal seed system. Seed potato production and storage is difficult in tropical environments, for instance, and the viability of soyabean seed is difficult to maintain for long periods anywhere. Osborn (1992) discusses bruchid infestation in groundnut seed in Senegal. Sattar and Hossain (1986), on the other hand, found farmer-saved rice seed in Bangladesh to be of good quality. Seed-borne diseases may be difficult for farmers to detect or control, but each case requires evidence. Janssen *et al.*, (1992) review a number of farm level studies from Latin America, the majority of which show no advantage in yield for clean bean seed when compared to farmer saved seed, and Crissman and Uquillas (1989) report no clear advantages for clean potato seed in Ecuador under current farmer management. Scheidegger *et al.*, (1989), on the other hand, demonstrate that the purchase of clean potato seed in highland Peru, without any other change in production practices, can make an economically significant difference to farmers, and Trutmann and Kayitare (1991) show that bean seed managed by farmers in Rwanda may yield less than clean seed. Cross-pollinated crops (such as maize or pearl millet) make variety maintenance more difficult in the field and often justify a seed system that provides periodic replacement of the same variety, and

of course the seed of hybrid varieties must be purchased fresh each year in order to take full advantage of their yield potential. Farmers may not be able to maintain sufficiently clean seed in all circumstances; Fujisaka *et al.*, (1993) discuss farmers' inability to recognise certain weed seeds in rice in the Philippines. For certain crops, farmers may not save the most appropriate part of the harvest for seed, as Louwaars (1994) discusses for some vegetable production and Rhoades (1985) illustrates for potatoes in Nepal, and improved seed systems(formal or informal) are a possible solution, if they can successfully address the economic exigencies that cause farmers to sacrifice seed material in the first place. Severe production losses due to periodic climatic factors such as droughts, or household level poverty that forces farmers to use saved seed for home consumption (Sperling and Loevinsohn, 1993), will also affect seed supply, and are additional justifications for strengthening formal seed systems.

A Pragmatic Approach

These two issues, better varieties and better quality seed, often are not sufficiently distinguished from each other in discussions of improving seed systems. Proposals for more private sector involvement in the seed sector (Jaffee and Srivastava, 1994; Pray and Ramaswami, 1991) are often predicated on the availability of improved varieties, for instance, but may not devote sufficient attention to the limited commercial possibilities for providing varieties of self-pollinated crops whose seed farmers are able to maintain themselves. On the other hand, analysts who are more interested in the diffusion of local varieties may focus on variety development when seed maintenance and supply would seem to be higher priorities (Ferguson and Mkandawire, 1993). The provision of better varieties and better quality seed both may be justifications for investment in an improved seed system, but the approach taken in this study keeps in mind the potential independence of these two elements of seed supply, as an aid to considering the widest possible set of institutional alternatives and regulatory arrangements.

SEED INSTITUTIONS AND REGULATIONS

Seed Systems and Institutions

The formal seed sector

Any discussion of improvements in current seed systems must take account of the range of institutions that are included in the formal seed sector (Cromwell, *et al.*, 1992:6). Our interest is in those institutions responsible for agricultural

research and for seed multiplication, processing, storage, and marketing. The actions and responsibilities of these institutions are regulated by seed legislation, established procedures, and norms of quality control. Country case studies that will follow from this review will examine the effects and responsiveness of those regulations and norms. It will be useful first to describe the research and seed production institutions that are involved in the formal seed sector. The public sector, NGOs and local groups, and the private sector may all play a role.

The public sector

The public sector has for many years been the dominant actor in seed systems in developing countries, although that situation is changing rapidly. Public sector predominance is greatest in plant breeding and varietal development. National agricultural research institutes and universities are responsible for the development of the majority of the new varieties that are released in developing countries, although in some countries there is a trend for national programmes to sell breeding lines or materials to local private seed companies who then develop finished products. The budgets of the national agricultural research institutes have stagnated or declined in recent years (Pardey *et al.*, 1991) and this has affected their breeding programmes. Indeed, many national breeding programmes are finding their staff leaving for the private sector. In addition, national breeding programmes have been criticised for not orienting their work to the environments of the majority of resource-poor farmers. In response, there have been a range of efforts in on-farm research and farmer participatory research targeted towards the conditions of these farmers (Merrill-Sands *et al.*, 1991).

The experience of the public sector in seed production and distribution has been much less successful than that in plant breeding. Pray and Ramaswami (1991:27) cite several examples of effective national seed programmes, but conclude that in general publicly supported seed programmes have not been good investments. Jaffee and Srivastava (1994:109) describe the demise of state seed farms in several countries in favour of contract growers as a first step towards privatisation, and conclude (1994:107) that public sector involvement in seed production and processing is only justified under certain circumstances, such as support to the early stages of national seed capacity development or the production of seed of minor crops or for isolated areas on equity grounds. Although the weight of opinion now favours a disengagement of the public sector from many of its previous seed production and distribution activities, there is as yet only limited evidence of how alternative systems might operate.

NGOs and local groups

The past decade has seen a rapid increase in seed activities of many NGOs. As Cromwell and Wiggins (1993) point out, part of this activity has been directed toward relief and rehabilitation efforts, where refugees or victims of drought or other disasters need seed to begin planting again. But an important part of NGO efforts has also been directed toward the development of sustainable local level capacity in seed production. This move toward more decentralised seed supply has at times been almost purely an NGO initiative, while in other cases it has been supported as part of government policy. There have been at least a dozen separate projects in the hill regions of Nepal aimed at providing an alternative to the public seed sector (Cromwell and Wiggins, 1993: 65), for instance. NGOs in the Gambia play a leading role in seed multiplication (Henderson and Singh, 1990). NGO activities in seed production have attracted considerable interest from all sides; Jaffee and Srivastava (1994:110) mention NGOs as an alternative in situations where the private sector cannot meet the requirements of specific groups of farmers. The most comprehensive examination of the subject (Cromwell and Wiggins, 1993) has raised concerns about the fact that most NGO seed production projects are selling their seed at well below the actual production price, and offers a number of suggestions for improving the long-term viability of local level seed projects.

In some countries, NGO efforts also include variety testing and selection. This may involve interactions with national breeding programmes and arrangements to test new varieties at the local level (Osborn, 1990), or it may be directed more specifically at the utilisation of local varieties (Mushita, 1993). This interest in local variety development has attracted great attention in certain countries; in the Philippines there are over 100 NGOs working on the conservation of local rice varieties (Cromwell and Wiggins, 1993:76).

The private sector

Private sector seed activities have been limited in many countries until recently by government restrictions. In some cases, government seed companies maintained a monopoly on seed production and distribution. In other cases, private companies found it difficult to get their varieties approved. The climate has changed recently, however, and the private sector is seen as offering advantages to public management of seed supply (Pray and Ramaswami, 1991; Jaffee and Srivastava, 1992; Chopra and Reusche, 1993). There has been a corresponding increase in support from several donors for private seed initiatives. The private sector includes everything from multinational seed companies to local level entrepreneurs who may be producing seed for only a few hundred farmers (Bal and Rajbhandary, 1987). Although some larger private

companies have their own research capacity, in many instances private seed companies continue to depend on varieties from the public sector. Current participation of the private seed sector in developing countries varies by crop and by region. In the case of maize, for instance, the private sector accounts for the majority of seed use in countries such as Brazil and Zimbabwe, but much less in Mexico or Tanzania (CIMMYT, 1994). A principal concern about the private sector is its ability to reach resource-poor farmers. Private seed companies usually concentrate on more commercial farmers and on hybrid varieties whose seed can be sold each year. There are some interesting cases of the private sector reaching resource-poor farmers, as with hybrid pearl millet in India (Pray *et al.*, 1991), but these examples are not common enough to provide assurance that private initiative will be sufficient to meet the overall seed requirements of resource-poor farmers.

Institutional linkages

Certainly the most consistent conclusion to emerge from most analyses of the seed sector in developing countries is the necessity for effective collaboration among various types of institutions. This was emphasised as long ago as 1980 in Douglas's comprehensive treatment of the organisation of seed systems, in which a range of types of public and private sector collaboration in the development of seed enterprises was described (190:83–92). Kelly (1989) devotes a chapter of his book on seed planning and policy to the possibilities for private–public cooperation. Most observers agree that public sector contributions will more likely be found at the plant breeding and varietal development end of the spectrum, while private and community-level initiative will be predominant in seed production and distribution. Many recent analyses of seed production options have emphasised community level, farmer association, and small-scale entrepreneurial efforts (Ferguson and Sauma, 1993:1754; Garay *et al.*, 1988: 48–49). Such efforts themselves may require initial public sector support or policy change, or may be the focus of development assistance, and hence the balance of public and private sector becomes even more complex. Thirtle and Echeverría (1994) argue that the distinction between public and private in agricultural institutions is often unclear and may depend on several dimensions, such as ownership, source of funds, the importance of the profit motive, and the exercise of private property rights. They urge a more flexible approach to considering the most effective institutional mix for supporting agricultural development.

Change and uncertainty in the formal seed sector

The formal seed sectors of most developing countries are in a state of change and uncertainty:

- Resource-poor farmers have not been well served by national seed systems, and it is recognised that in many cases a wider range of crop varieties and better access to good quality seed will make important contributions to their livelihoods.

- The public sector is suffering from budget cuts, often as part of structural adjustment, and its role in the seed sector is now being debated, although it is widely expected to continue to play an important role in support to plant breeding, as well as in the supervision of seed regulatory frameworks.

- A range of community level efforts in seed production and distribution are being supported by NGOs and donor projects, raising expectations that they may represent a significant alternative for resource-poor farmers, but with only limited evidence as yet of their capacity to create viable seed systems.

- Policy changes have seen an opening to private sector seed initiatives in many countries. It remains to be seen if the recent flush of activity is converted into stable seed enterprises, however, and what proportion of those enterprises serve resource-poor farmers.

- There is widespread agreement on the need to share responsibilities among the different sectors and to search for the optimum division of labour. Many possibilities have been discussed, but few concrete examples have been established on the ground.

Much work remains to be done in more clearly identifying what resource-poor farmers should expect of innovative seed systems, testing different institutional arrangements, and working towards long-term stability and growth of seed system capacity. Underlying any consideration of institutional innovations in seed systems are the seed regulatory frameworks that are the subject of this study. These are the laws, rules and operating procedures that determine how varieties are tested and selected; when varieties can be released to farmers; how seed is produced and certified; and how seed can be sold. These frameworks, and their applications, differ among countries. In some cases they are barely noticeable, while in others they have already come into direct conflict with proposals for institutional change in the seed sector. In all cases they help set

the tone for debate over seed system alternatives and ultimately provide parameters for the breadth and pace of possible change. The following section summarises the principal characteristics of these regulatory frameworks.

Seed Regulations

Seed legislation

Seed regulatory frameworks usually derive from national legislation. In a review of seed legislation, Bombin-Bombin (1980) points out that the technical nature of seed legislation often requires a two-tier system, where some type of basic seed act is established that provides general policy and an institutional framework which then vests authority for specific regulations in various government bodies or committees. Bombin-Bombin emphasises that one advantage of such a system is its dependence on subsidiary legislation that can be managed by the most appropriate (often technical) authority and can be amended or changed more flexibly than the basic seed act itself (Clayton, 1990:131). There is often a specific body responsible for seed regulations; that body may perform an advisory role or may have considerable authority of its own. Douglas (1980:120–132) outlines the range of types of seed legislation that may be established, and points out that such legislation may address any of the following issues: (1) crop research and evaluation systems; (2) seed certification programmes; (3) marketing requirements, including imports or exports; (4) seed testing responsibilities; (5) plant variety protection or a breeders' rights system; and (6) plant quarantine (1980:120). This paper focuses on four types of activities: plant breeding procedures, variety release, seed certification, and seed distribution. These activities are briefly introduced in this section and then more fully described in the fourth section. Plant variety protection is discussed only in its relation to the other activities that are the subject of the study.

Plant breeding

Although seed laws usually do not include explicitly the procedures and methods that plant breeders use to develop new varieties, it is important to begin an examination of seed regulatory frameworks at this point. First, although they do not have a specifically legal character, plant breeding procedures within national research institutions are usually firmly established, especially with respect to how and where materials are to be tested. Second, these rules are usually controlled by authorities (such as committees) whose composition and actions are similar to those of authorities related to other seed regulations such as those for variety release. Indeed, plant breeding procedures are so closely tailored to

what is or is not likely to be acceptable under variety release rules that it is difficult to talk about one without including the other.

Plant breeding is a lengthy and demanding task. Beginning with a wide range of potential materials, plant breeders engage in a sequence of decisions and recombinations that carry them forward, season by season, with an ever more select set of germplasm that will hopefully lead to one or more useful varieties that are approved and released. Plant breeders naturally tailor their work to the expectations of the national variety release system. They know what standards must be met for the approval and release of a new variety, and this knowledge guides the decisions taken at each step of the breeding process regarding the relative importance of particular plant characteristics as candidates for further improvement and selection, and the conditions under which the materials are tested and selected or rejected.

Plant breeding is a scientific endeavour, guided by principles of genetics, physiology, pathology, and other disciplines. But many of the goals and assumptions that underlie the process of plant breeding are not the subject of scientific consensus. Agricultural research planning is governed as much by institutional and national politics, the values and beliefs of individual scientists, and administrative requirements, as it is by the rational application of objective scientific knowledge (Busch and Lacy, 1983). The objectives, methods and outputs of plant breeding are therefore likely to be influenced both by political, social, economic, and institutional factors, and by expectations of what will or will not perform well under prevailing testing and release procedures.

Variety release

Seed regulations specify under what circumstances a new variety may be made available for seed multiplication and distribution. These decisions are often in the hands of a variety review and release committee that can:

> *"establish guidelines for considering varieties from public and private plant breeding programmes; determine whether varieties are to be recommended, considered 'suitable,' or listed as 'unsuitable'; establish criteria for accepting varieties as eligible for seed certification; and assume responsibility for an allocation policy for seed of new varieties"* (Douglas, 1980:57).

In most countries a testing procedure is defined (at least for major crops) through which a proposed variety must pass before it can be released. In the EEC countries, many crop varieties must undergo compulsory tests before they

are marketed (Kelly, 1989:42). The Directives on Seed of the Council of European Communities establishes a catalogue of varieties that may be produced as certified seed. For agricultural crops, the criteria used for inclusion on such a list include evidence of distinctness, uniformity and stability (DUS) as well as evidence that the new variety has value for cultivation and use (VCU) (Kelly and Bowring, 1990:145). In many countries where such catalogues exist, there is also an effort to remove older or no longer appropriate varieties, so that the catalogue does not become unwieldy.

The private seed sector in most developed countries must also test and register its varieties. In many cases, private and public sector varieties are treated equally. Kloppenburg (1988:139) describes the efforts of the US private seed industry to impose its viewpoint on variety release, where registration is contingent on tests of novelty, uniformity and stability, but not of quality, which is left to the consumer. On the other hand, in countries where the private seed sector is less well developed, seed companies may find themselves at the mercy of state variety release procedures that are biased against privately bred varieties.

Seed certification

Most national seed regulations define procedures and standards that are to be met before seed of a particular variety can be marketed. These regulations are usually referred to as seed certification, and they involve two distinct sets of issues. As originally conceived, seed certification is concerned with assuring that the seed in question is of adequate genetic quality so as to preserve the characteristics of the particular variety (Kelly and Bowring, 1990:139). In addition seed certification usually now includes seed quality as well, including germination percentage, purity (e.g. freedom from weed seeds), seed health, and moisture content (Cromwell *et al.*, 1992:57). Thus seed certification usually involves both genetic purity and seed quality.

The certification process includes field inspection (to check on the varietal characteristics as well as assess weeds, diseases and growing conditions, such as proximity to possible genetic contamination), sampling of the processed seed, and laboratory testing. In some cases genetic purity is assessed by growing out samples and comparing them with the original breeder seed (Douglas, 1980:115–117). Certified seed is marketed in sealed bags or containers that include a label specifying the seed quality and varietal integrity. The Organisation for Economic Cooperation and Development (OECD) has established certification procedure related to varietal purity for seed that enters international commerce (Douglas, 1980:271–3). The most widely used procedures for laboratory testing of seed are those of the International Seed

Testing Association (ISTA), which was organised in 1924. ISTA promotes uniformity in seed testing procedures and authorises seed testing stations in various countries to certify seed under its guidelines (Douglas, 1980:269–70).

Seed certification is mandatory in many countries, while in others (such as the United States) it is voluntary, and emphasis is placed on "truth in labelling", where seed inspection is concerned with verifying that the seed sold conforms to the description provided on the label (Bombin-Bombin,1980:9). In the United States, seed may pass through a voluntary certification scheme under the Association of Official Seed Certifying Agencies (AOSCA).

Seed marketing

Seed marketing is usually dependent on some type of seed certification, and most seed legislation specifies the type and quality of seed that may enter the market. In many countries, both seed producers and seed sellers must be registered or licensed (Bombin-Bombin, 1980). In some countries a marketing control system inspects seed dealers' facilities and monitors seed quality at various points in the distribution channel. In countries where seed production is carried out by a government agency, seed sales may be organised through appointed distributors and dealers or through the government extension service. In many developing countries the price of seed is also regulated.

Plant variety protection

Most developed countries have established a legal system of plant breeders' rights that provides protection for new plant varieties, allowing only the breeder or breeding institution, or those to whom rights or licences have been assigned, to sell the seed commercially. These laws are for the most part related to the International Union for the Protection of New Varieties of Plants (UPOV) convention (Thiele-Wittig, 1992). The convention came into force in 1968, with an important revision in 1991; it currently has 22 signatories, with more countries expected to join. The recently concluded GATT negotiations require member countries to provide intellectual property protection for plant varieties, based either on patent law or on an effective *sui generis* system based on one of the two UPOV conventions or on an equivalent national law. The moves toward increased plant variety protection have been a source of debate for some time (Kloppenburg, 1988; Keystone Center, 1991; Crucible Group, 1994). Among the concerns that are relevant for this study are: (i) increased plant variety protection may decrease the number and range of varieties available to farmers; (ii) farmers' customary practices of saving and exchanging seed ("farmers' privilege") may be challenged, as it is in the 1991 revision of the

UPOV convention; and (iii) plant breeding procedures and priorities may change under the influence of plant variety protection.

These concerns about plant variety protection are of great importance. They will not, however, be given separate treatment in this study of seed regulatory frameworks in developing countries, but will rather be examined within the discussion of the conventional regulatory process. There are several reasons for limiting the discussion in this way. First, the type of plant variety protection to be instituted in response to the GATT requirements is still being discussed in many developing countries and it will be several years until the results are clear. Second, plant variety protection will have its main effect initially on the commercial agricultural sector in developing countries, and even in those situations there is as yet little evidence that the private sector is interested in strictly limiting the interpretation of farmers' privilege, for instance (van Wijk, 1994). Finally, and most important, the potential consequences of the debate on plant variety protection over the next decade lend greater urgency to a comprehensive examination of the "conventional" seed regulations that are already being applied in developing countries and that are the subject of this study. Innovations in the conception and interpretation of current seed regulations to better represent the needs of resource-poor farmers would greatly strengthen national capacity to then deal with the challenges of the plant variety protection debate.

Characteristics of Seed Regulatory Frameworks in Developing Countries

The rules and regulations governing variety development, seed quality control, and seed distribution vary considerably among the developing countries that are the subject of this study. Nevertheless, they share certain characteristics that help determine their effect on resource-poor farmers:

- The seed laws and plant breeding protocols of most developing countries are based on European or North American models. Because these models have been available, it has been relatively easy to draft such legislation and provide what appears to be appropriate and technically precise guidance for national seed systems, without always examining the particular social, economic and technological circumstances of the country (Grobman, 1992). Such transfer of laws from one country to another has often proved unsatisfactory (Allott, 1980).

- Seed regulatory frameworks often have the appearance of permanence and inviolability, which means that they may not be subject to questioning or modification. The conception and management of the frameworks may

give precedence to ideals of varietal uniformity or seed purity that are aesthetically attractive but impractical. Sufficient attention may not be given to the evolution of seed regulatory frameworks, nor to the fact that efforts have been made in some countries to adjust the regulations and their interpretation to local conditions.

- Seed regulations in many countries are not well established, widely understood, or consistently interpreted. This leads to uncertainties and confusion regarding possible options that institutions might explore to improve varietal development or seed availability.

- Most seed laws have been established with the rationale of consumer protection, but if there are insufficient resources to manage the enforcement of standards the seed system may be severely constrained. Where plant breeding, seed certification and seed production are all in government hands, there are also opportunities for collusion and production of substandard products. Yet where markets are not well developed and there is insufficient information flow, dependence on market regulation of seed standards may not be feasible either.

- The management of variety development and the interpretation of seed regulations are often in the hands of small groups or committees whose composition and exercise of authority are rarely subject to appeal. This arrangement provides for needed flexibility and the application of expert judgement, but it also may be subject to abuse of power. Bureaucratic discretion can either be used to make decisions with more agility than conventional legislative processes, or it can be used to mute and frustrate legitimate public concerns.

- Seed systems often serve particular interest groups (Cromwell *et al.*, 1992:10), and the interpretation of seed regulations will often be consistent with the priorities of the predominant group. Srivastava and Jaffee (1993:29) point out that particular variety or seed characteristics may be valued differently by farmers, consumers, processors and plant breeders, which causes problems in applying the regulations in a neutral fashion. Seed regulatory frameworks are the product of a political debate in which resource-poor farmers usually have not had an adequate voice.

There is widespread concern and discontent with current frameworks heard from public sector plant scientists, NGO and community organisation workers, and private seed company representatives. Our objectives in this study are to see to what extent these regulatory frameworks actually hamper attempts to bring better

planting materials to resource-poor farmers; and to see if changes in the frameworks can be affected that actually serve to strengthen the goals of seed legislation "to create the conditions in which trade in good-quality seed can be carried on and to encourage the development of a strong research capability, a well-established seed growers' organisation and a quality-minded seed trade" (Kelly, 1989:115).

CHALLENGES AND OPTIONS FOR SEED REGULATORY FRAMEWORKS

Earlier sections have outlined the general characteristics and problems associated with seed regulatory frameworks. We have introduced the hypothesis that these frameworks may be incongruent with current political, social, economic and technical conditions in many developing countries. We have also suggested that it will be useful to explore options based on local conditions and resources. These possibilities will be explored through a series of country case studies, and it is expected that general principles and concrete proposals will emerge from a synthesis of the case studies. In preparation for the case studies, the following discussion reviews the available literature on seed regulatory frameworks in developing countries. The discussion is divided into: (i) variety development; (ii) variety release; (iii) seed quality control; and (iv) seed distribution and sale. For each of these activities, the discussion is organised around a description of the current situation, an examination of alternative strategies, and a reminder of unresolved issues.

Variety Development

Current situation

RESEARCH POLICY. We focus here on the plant breeding and selection procedures used by public sector agricultural research institutions. Although these procedures are not governed by a legal framework, they are closely tied to variety release regulations and are subject to fairly strict rules within research institutions. Our concern is that the procedures followed by a research institution may not result in the optimum range of varieties being made available to farmers. Plant breeding in a public sector research institution is subject to several forces that determine the degree to which its output is relevant to resource-poor farmers. First, scientists are directed in setting their research objectives by the policies and goals of the research institution, which may in turn be determined by national agricultural development policy. A clear national policy that is effectively translated to the research institution is a prerequisite for

directing research to particular groups of farmers (Merrill-Sands *et al.*, 1991). But policies often are not clearly articulated either at the national or institutional level, and even clearly stated policies towards the small farm sector may be compromised by the political influence of larger farmers or the commercial sector. In Zimbabwe, plant breeding priorities became better focused on smallholder concerns after independence, but the fact that the Seed Coop (dominated by commercial farmers) is a crucial source of support for plant breeding programmes partially explains a continuing concentration on hybrids and wide adaptability (Friis-Hansen, 1992:72). It is rare to find that the output of plant breeders is measured and assessed in relation to its relevance to resource-poor farmers.

RESEARCH PRIORITIES. Even if policy dictates that agricultural research should be directed towards resource-poor farmers, there is often little information available to plant breeders regarding farmers' circumstances. Farmers have little opportunity to test varieties as they are being developed, and their opinions about needs and priorities are generally not sought. Varietal development and testing are done in conditions that are not representative of those of resource-poor farmers. Most trials are conducted on experiment stations where crop management is at much higher levels than those of average farmers, and the sites themselves may be in more favoured environments than those of the majority of small farms. Breeding trials are evaluated using criteria that may have little relevance to farmers. Attempts have been made to address these problems through a wide range of research methods, including those of farming systems research and on-farm research (Tripp, 1991) and farmer participatory research (Farrington and Martin, 1988)

PLANT BREEDING THEORY. The situation is further complicated by the fact that science grows and thrives on the controversy generated by opposing theories and schools of thought. The field of plant breeding is no exception, and plant breeders will become attracted to particular theories and develop research programmes to pursue them. These in turn interact with the competing ideologies of research policy. An important example is the nature and extent of genotype by environment (GxE) interaction, the way in which the performance of particular varieties is influenced by the environment in which they are grown. The degree to which one believes that widely adapted varieties can be developed, on the one hand, or that plant breeding must take very careful account of specific environmental conditions, on the other, obviously has a tremendous influence on how a breeding programme is conceived and organised. There are certainly advantages to breeding for as wide adaptation as possible, and part of the success of the Green Revolution in rice and wheat was the development of day-length neutral varieties that were responsive to fertilizer

(Simmonds, 1979:357). But there are limits to the ability to develop varieties that perform well across a wide range of environments (Ceccarelli, 1989; Simmonds, 1991). One of the factors that makes the GxE debate even more complicated is a frequent lack of precision in the definition of "environment" (Westcott, 1986), which contributes to variable interpretations of the same set of data. Plant breeding programmes may have any number of goals related to environmental adaptability, including tolerance of low soil fertility or drought, or compatibility with farmer management practices such as intercropping (Francis, 1990). A breeding programme might also be aimed at producing varieties adapted to variability in a particular condition, such as soil moisture (Francis, 1990), or at producing varieties or varietal mixtures that possess sufficient variability themselves to tolerate year to year differences in a condition such as disease pressure (Berg *et al.*, 1991). The complexity of these goals is reflected in the choices that have to be made for the management of a breeding programme, including the degree of control over the breeding environment, the degree of farmer management of the sites, the number of environments that are chosen, and the factors that are used for making selections.

IDEOLOGY. The debates over issues such as GxE interaction not only derive from honest differences of opinion about the interpretation of biological data, but involve broader aspects of research policy as well. A plant breeder's opinion on whether more resources should be devoted to understanding local environments (through "farmer-centred" approaches) or to changing those environments (through "technocratic" programmes such as the promotion of higher input use) will likely be tied to her position on the GxE debate. The terms "farmer-centred" and "technocratic" are of course themselves subjective and politically loaded, but are used to show how quickly "objective" science becomes tangled in political factors. There is much scope for scientists to choose research problems and methods that correspond to their own personal political visions. Commenting on the range of perceptions held by US agricultural scientists about low-input agriculture and the future of the family farm, Buttel *et al.*, (1986) asked how "presumably capable, well-trained scientists ... come up with such diametrically opposed results." The objectivity of science can easily be exaggerated, forgetting that both personal and political battles can be fought using the weapons of supposedly value-free science. (Levins and Lewontin, 1985).

Alternatives

RESEARCH POLICY CHANGE. Research policy can always be expected to represent a compromise between various political interests, but there is certainly room for

a more precise definition of the target groups of farmers for a research institution, and the development of research programmes that reward researchers for technology that is taken up by those groups. There is a considerable literature on priority setting in agricultural research (e.g. Binswanger and Ryan, 1977; de Janvry and Sadoulet, 1989).

ZONING. Plant breeding programmes can increase the precision of their targeting for particular conditions and farm types through better zoning of breeding plots and field trials (Gill, 1992). Strategies used by the national rice breeding programme of Sri Lanka are a case in point (Pain, 1986). As the techniques of geographical information system analysis become more accessible, there is scope for more careful definition of agroecological zones for organising breeding programmes and more efficient selection of testing sites.

ADAPTIVE RESEARCH. The use of adaptive research methods by national agricultural research programmes has helped provide information to plant breeders about farmers' circumstances and the performance of varieties under farmer management. Farm surveys often provide valuable information about farmers' priorities that can be used by a plant breeding programme. Byerlee *et al.*, (1987) illustrate how survey data combined with on-farm trial results were used to reorient wheat breeding priorities for the cotton-wheat system of Pakistan. On-farm variety trials have served to help identify the most appropriate varieties and have contributed to their subsequent adoption (Graf *et al.*, 1991; Janssen *et al.*, 1991).

FARMER PARTICIPATION IN PLANT BREEDING. On-farm research usually tests varieties in their later stages of development. A number of researchers have suggested alternatives that allow farmers earlier access to breeding material (Galt, 1989). Ashby *et al.*, (1987) have developed research methods where breeding materials are selected, planted and managed by farmers, who then evaluate the results. Sperling *et al.*, (1993) describe a bean research programme in Rwanda where farmers visited the research station and helped make selections. Maurya *et al.*, (1988) describe how lines from a rice breeding programme in India are tested on farmers' fields, under their management, with farmer participation in evaluation; the authors lament that further application of this breeding strategy would require changes in Indian seed law (1988:319). The notion of farmers participating in formal plant breeding programmes is not confined to developing countries, however. Young (1990:49) reports on "hobby breeders" in the Netherlands, commercial potato farmers who participate in variety selection on their farms before professional breeders develop the finished varieties. Some authors propose an expanded role for farmers in plant breeding; Berg *et al.*, (1991), for instance, describe an "integrated plant breeding" system,

that draws on farmers' skills and on their landraces, and Wórede (1992:90) describes a programme in Ethiopia where farmers do mass selection on local landraces.

Unresolved issues

THE EFFICIENCY OF LOCATION-SPECIFIC BREEDING STRATEGIES. Closer targeting of breeding programmes certainly makes sense, but much is yet to be learned about which techniques and methods are most effective. Issues such as selection methods and criteria, site selection, and farmer responsibilities have yet to be defined for farmer participatory plant breeding (Montecinos, 1992). Despite some hopeful preliminary results, there is as yet little firm evidence of the outcome of more participatory breeding methods. The advantages to be gained from a more specifically targeted breeding programme, involving more disaggregated data analysis and farmer participation, must be balanced against any additional costs of the decentralised research. Very little analysis has yet been done on the cost effectiveness of location-specific agricultural research (Martinez and Sain, 1983).

LOCAL CAPACITY. Farmer participatory plant breeding requires an increased investment of farmers' time and skills. The degree to which farmers are willing to invest this time is unclear. This will require efficient interaction between plant breeders and farmers, and the effective contribution of local level organisations that work with farmers. The potential role of NGOs in this process has been examined by Farrington and Bebbington, (1993).

Variety Release

Current situation

JUSTIFICATIONS FOR RELEASE PROCEDURES. In most countries, the varieties from public sector (and often private sector) plant breeding must pass through an official release procedure before they can be made available to seed multiplication agencies. These release procedures are meant to fulfil several functions. Some of these functions are aimed at ensuring the quality and appropriateness of varieties. First, they help ensure that only superior varieties are made available to farmers. Second, the release procedures help guard against the release of varieties that may have attractive characteristics but whose susceptibility to particular pests or disease might put farmers at risk. In some countries, variety release is a key component in the design of extension service recommendations as well. The release procedures also provide a way of

registering and controlling the types and number of varieties of a crop that are available, so that a fairly accurate inventory is maintained. Finally, standardised release procedures help facilitate international commerce in seed.

PROCEDURAL PROBLEMS. But variety release procedures in their current form may also be denying farmers access to appropriate varieties. The variety testing procedures that are required by a release committee are usually not very relevant to the conditions of resource-poor farmers. Although some type of farmer representation may be included on variety release committees, they often do not consider trial data under representative farmer conditions. Even when release procedures officially include field level data, such as that from the "minikits" distributed in India, the data rarely carry much weight in the release committee's final deliberations (Singh, 1992). Complaints are often voiced about the length of time required for a variety to be released, as data from several years of tests are required. Three years of evaluation are required in the All India Coordinated Crop Improvement Programmes, and the release and notification procedures are very time consuming (Groosman *et al.*, 1991:75). In Kenya, a promising variety must be included in three years of national performance trials before being considered for release (Ruigu, 1988:138). Given the fact that it takes several cycles of seed multiplication from breeder seed to produce sufficient quantity of seed for sale, it may be five years or more from the time that a promising variety is first identified to the time it is available to farmers. In some countries, lack of resources keeps the variety release committees from meeting as frequently as they should. The desire for more agile release procedures must be balanced against concerns that investment in variety testing before release may at times be inadequate (Ferguson, 1994:176; Baumann, 1992:116), however.

Variety release procedures in most developed countries require evidence that a new variety be "distinct, uniform and stable,"[1] and these requirements are expected to become more widespread with increasing plant variety protection. The justification for only registering uniform varieties is understandable, but a number of doubts remain. Because of plant variety protection laws, increased effort is now devoted to identifying characteristics that distinguish a new variety from similar ones (Smith, 1992), rather than make it agronomically superior. The costs of testing for DUS can be very high, and some type of limits need to be imposed (Bould and Kelly, 1992:147). It is interesting to note that when certification procedures were being debated in the UK in the late 1940s, many plant breeders believed their responsibility was to continue to improve their varieties (under the same names) rather than maintain them as originally released (Kelly and Bowring, 1990:142). Even without a plant variety protection law, Berg *et al.*, (1991) argue that a considerable proportion of the breeder's time before variety release is spent in achieving a degree of uniformity that is not

useful for resource-poor farmers and may in fact limit farmers' ability to further adapt the variety to specific conditions.

A further problem with variety release is that the release procedure itself does not guarantee that seed of the new variety will be available to farmers. In India, for example, the state seed companies do not necessarily have an incentive to begin production and sale of a new variety that will only replace one that they are currently producing. Farmers will only know about, and demand, a new variety if they have seen it in a demonstration, and the proportion of released varieties that appear in extension demonstrations or minikits may be very low.

Although variety release procedures may be defined for major crops, they are often not established for crops such as forage species (Ferguson, 1994). The uncertainty associated with this lack of definition often serves as a disincentive to national programme breeders to develop new varieties.

PUBLIC WELFARE. Variety release procedures may help guard against the development of varieties that would cause losses to farmers or the public at large, as in the case of materials shown to be susceptible to particular diseases or pests. But there are also cases of excessive caution or adherence to bureaucratic procedure slowing down the release of materials that address the same problems. Plant pathologists and breeders may have information that indicates an impending disease problem and wish to promote resistant material into seed production as quickly as possible, but find that excessive caution from the release committee slows the process. On the other hand, when susceptible varieties are banned, this often gives rise to strong protest from farmers, who have little information about potential disease problems and want access to familiar varieties. For crops that are grown for export, governments may exercise control over variety release based on their knowledge of export market requirements. At times governments try to justify variety release regulations on the basis of protecting the economy. Open-pollinated maize varieties are not released in Zimbabwe, based on the belief that such varieties will always be lower yielding than hybrids and that their availability would put at risk the nation's food supply (Friis-Hansen, 1992:60). Whether this argument holds for all possible open pollinated varieties in all growing conditions of Zimbabwe is open to doubt, however. Ulrich *et al.*, (1987) analyze the effects on Canadian farmers of restrictions on the release of new wheat varieties that did not conform to Canada's wheat export policies.

RELEASE COMMITTEES. Debates over the magnitude of threat of a particular disease, or the production potential of certain varieties, are based on honest disagreements over the interpretation of scientific data, and as such will always

be part of the deliberations of variety release committees. But we have already discussed how quickly scientific objectivity gets confounded in political battles. Variety release committees are subject to professional biases and jealousies, interpersonal rivalries, and ideological stances.[2] Ferguson (1994) argues for transparency on release committees, but admits that personal and prestige factors often play a role in decisions. Douglas (1980:57) cautions against appointing variety release committee members on a political basis, but this may be difficult to avoid. Senior plant breeders on the committee may have considerable power in determining which of their junior staff are rewarded by facilitating the release of their varieties. The viewpoints of particular disciplines, such as plant pathology, may be in or out of favour on a committee. Varieties from institutions outside the public sector may receive less than favourable treatment. Cromwell and Wiggins (1993:57) describe the delays in release of a soyabean variety in Bangladesh that had been tested by an NGO, and the problems faced by the private sector in India are well known (Delouche, 1990; Pray and Ramaswami, 1991). Most private sector varieties have not been tested under the All India Coordinated Crop Improvement Projects (as is required for all public releases) and are marketed as "truthfully labelled seed", without having been officially released or notified (Agrawal and Tunwar, 1990:166). Variety release regulations may severely limit the possibility of seed imports. On the other hand, variety release committees in some countries may be more lenient than normal in the case of a national release if it can substitute for imported seed.

Alternatives

MODIFYING STANDARDS. One possible reform is to re-examine the standards and criteria used by the release committees. It is worth exploring how the voices of resource-poor farmers can have more influence. Their priorities must be included from the beginning of the plant breeding process, of course, rather than only at the release stage, when many appropriate materials may already have been eliminated. If a plant breeding programme has developed a variety that is appropriate for a significant group of farmers but does not meet all of the official release standards, there should be mechanisms for bringing the farmers' concerns to the attention of the committee. This is a question of developing the political power of these farmers. Negotiating changes in release committee standards is not confined to developing countries, of course. Canadian variety release standards originally dictated that commercial hybrid maize varieties be tested and assessed under management conditions appropriate for older, public sector maize varieties rather than the higher planting densities for which the hybrids were bred. Several years of negotiations between the seed companies and the government authorities were required to arrive at a protocol for collaborative testing between the companies and the government that facilitated the release of new hybrids (Duvick, pers. comm.).

FARMER PARTICIPATION IN BREEDING AND TESTING. Pursuit of some of the participatory plant breeding strategies described in the previous section can make an important contribution, as long as the data from the farmers' fields are accepted as valid by the release committee. Plant breeding activities carried out with farmer participation also increase the probability that farmers will have more rapid access to materials that they may multiply and distribute on their own. Green (1987) describes how a local rice variety from one area of Nepal that was included in minikits distributed to farmers in another area of the country gained popularity and was multiplied and distributed without any type of formal release. Such "escapes" may be frowned upon officially, but there are a number of examples of farmers selecting or improving upon discarded breeding lines to develop popular varieties (Maurya,1989; Salazar, 1992). These examples illustrate the lack of congruence between official release standards and farmer priorities. Zambia has instituted a release policy that allows varieties that have been tested and found popular with farmers to be multiplied and distributed as non-certified seed while they undergo the full four year testing scheme that is required for official release (DANAGRO, 1988, cited in Cromwell *et al.*, 1992: 60). Ruigu (1988:139) reports that experimental varieties of certain crops may be provided to farmers in an agricultural development programme in Kenya while they are still being tested. Such modifications are not a substitute for agile and consistent release systems, however.

Unresolved issues

IDENTIFYING AND MONITORING PLANT BREEDING CONTRIBUTIONS. Moves to put more breeding material in farmers' fields, and to allow farmers more freedom of access to that material, depend to a large extent on the cooperation of public sector plant breeding institutions. Greater farmer access must be balanced by some type of system in which plant breeders are given due credit for their contributions. Whatever release procedures are instituted, more emphasis needs to be placed on monitoring farmers' actual use of varieties. This is crucial for providing feedback to the formal breeding system regarding progress and problems. An accurate record of actual varietal use by farmers, rather than a list of released varieties, is a much more reasonable method to gauge and reward breeders' progress as well (Singh, 1992).

POLITICAL REPRESENTATION. Variety release will always be based on a set of criteria that are subject to debate (Haugerud and Collinson, 1990). There is no way in which the political element of the debate can be eliminated. The challenge is to devise mechanisms that allow the majority of farmers to add their voice to that debate in the most effective manner. Farmers will rarely speak with one voice, and there will continue to be debates about which sectors are most

deserving of attention. Effective methods are required for expanding the representation of various classes of resource-poor farmers and consumers in variety release decisions.

Seed Certification

Current situation

SEED CERTIFICATION AGENCIES. Seed certification usually involves both the control of varietal purity and seed quality control. Most seed that is sold to farmers through formal channels has been certified, either by an agency of the state or by companies, farmer associations, or other bodies that have been licensed by the state to certify seed. In many European countries, the certification process was originally handled and financed by the government, but there has been a gradual evolution towards having the seed producing enterprise bear the costs and often assume responsibility for the actual inspection (Bould, 1992:198). In Canada, seed growers pay for the services of the government inspectors (Clayton, 1990), and in the USA seed certification is carried out by nongovernmental associations at the state level (Jaffee and Srivastiva, 1994:111).

PUBLIC SECTOR CERTIFICATION. In most developing countries, seed certification is still carried out by public agencies. These agencies are usually poorly funded and are often unable to meet all of the demands placed upon them, as Cromwell and Zambezi (1993) describe in Malawi. This means that the certification agencies often concentrate their efforts on a relatively few crops. These may not include all crops of importance to farmers, and the knowledge that there is not the capacity to certify seed for all crops can be a powerful disincentive to both agricultural research institutions and seed production enterprises. Lack of funding may also bias the location of seed production activities, so that most of it takes place near to the certification agency offices, in the capital or larger cities, to the disadvantage of farmers in more remote parts of the country. In India, individual state certification procedures inhibit seed from moving from one state to another (Pray and Ramaswami,1991:29), and the lack of uniformity in certification procedures among states is an additional impediment to seed industry development (Chopra, 1986).

There are cases where the public sector is able to recover at least part of the costs of certification. In India, seed certification responsibilities are divided among 19 state agencies that are able to levy a charge for their services (Agrawal and Tunwar, 1990). In Zimbabwe, the Seed Coop, which produces all seed of public sector maize hybrids, is responsible for its own seed certification, following government standards and guidelines (Rusike and Donovan, in press).

State certification may be biased against the private sector. There may be a reluctance to provide the service to private companies, and even if private sector varieties are available, their lack of certification will mean that they are less likely to be recommended or demonstrated by extension agents (Pray and Ramaswami, 1991:29). The maize seed certification procedures described above for Zimbabwe have placed the Seed Coop, which markets public sector hybrids, in a conflict of interest with applicants for seed certification from the private sector (Rusike and Donovan, in press). Some private seed companies in India have their own seed laboratories, but they are not allowed to certify seed (Agrawal and Tunwar, 1990:170).

PUBLIC SECTOR COLLUSION. The state certifying agency may also be tempted to cut corners, leading to seed of low quality. This is especially a danger in those cases where seed production is in the hands of a government enterprise, offering possibilities for collusion between government agencies (Srivastava and Jaffee 1993:30). When this happens, certified seed (and at times the crop variety itself) acquires a bad reputation among farmers, making further efforts at seed provision even more difficult.

VARIABLE STANDARDS. Variable interpretation of standards is not always detrimental, however. Chaudhry *et al.*, (1990:47) report that high demand for seed for rural development projects in Pakistan sometimes means that the certification process is curtailed. Even EEC directives permit exceptions to certification standards in cases where a country's seed supply may be threatened (Kelly and Bowring, 1990:146). These examples serve as a reminder that seed certification regulations always need to be interpreted in the light of farmer and consumer welfare.

SEED GROWERS' ASSOCIATIONS AND CERTIFICATION. The emergence of seed producer associations is often an important step in the development of a strong seed system (Kelly, 1989:79–85; Clayton, 1990). These associations often collaborate closely with seed certification agencies, or are licensed to take responsibility for seed certification. Their self-policing capabilities may improve the quality and reliability of seed offered on the market (Srivastava and Jaffee, 1993:30). Isolation requirements for seed production plots have led to the establishment of "seed villages" in India, where a seed company contracts with all farmers in a community (Turner, 1994:8); such seed villages might evéntually be the basis of seed grower associations. Development of viable seed producer organisations is not guaranteed, however, and Crissman (1989) reports on the failure to promote potato seed grower associations in the Philippines.

Seed grower associations may work to the disadvantage of resource-poor farmers, however, by concentrating seed production and certification powers. In Zimbabwe, the Seed Coop has exclusive rights to all national maize varieties, in return for a guarantee to produce the nation's annual maize seed requirements plus a 20% strategic reserve. It also must bear the costs of seed certification, and has restricted its membership in order to minimize the costs of certification and inspection (Rusike and Donovan, in press). Although there are economic justifications for this arrangement, it fosters a restricted view of maize variety and seed priorities and eliminates or strongly discourages other entries into maize seed production – such as those relevant to farmers located in agroecologically difficult areas – which lie outside these priorities. Seed producers may wield considerable political power, and Delouche (1990:36–7) describes inefficiencies in the rice seed certification system of the Philippines, where seed producers are able to exert influence on seed inspectors. A similar situation is reported by Crissman and Uquillas (1989) for seed potato production in Ecuador.

THE EVOLUTION OF CERTIFICATION STANDARDS. As seed systems evolve, producers themselves may demand higher standards. Stricter seed certification standards may provide a marketing advantage to producers, who may elect to impose such standards on themselves, as Makus *et al.*, (1992) discuss for potato growers in the USA. The commercial attraction of being able to offer seed of higher certification standard is also discussed by Kelly and Bowring (1990:144). This experience points the way towards an evolutionary strategy for seed certification in developing countries. Garay *et al.*, (1988) describe the development of seed systems in Bolivia involving the participation of a range of seed producing organisations, including private growers, cooperatives, and NGOs. Regional seed boards were formed to regulate certification and coordinate the various institutions. In the initial stages, several types of certification options were provided, and as farmers and seed producers gained more experience, there was a gradual shift to higher standards.

SEED CERTIFICATION AND EXPORT MARKETS. There has been considerable growth in seed production in developing countries for the export market, brought about by the need to lower the considerable labour costs of seed production and the search for favourable seed production environments. Local private companies and multinationals are both participating in this trend. In addition, the desirability of regional seed marketing and exchange has been recognised by many countries as part of a food security strategy. The growth of export markets for seed is to be encouraged, but this has implications for seed certification standards. The danger is that the standards required for the export market may influence the certification recommended for local seed consumption, with the

result that the standards of seed exporting farmers may be unreasonably imposed on their poorer neighbours.

Alternatives

DECENTRALISATION. One possibility for making seed certification agencies more responsive is to decentralise their operations (Cromwell *et al.*, 1992:55), posting staff and establishing testing facilities in regional centres. Licensing of private certification facilities is also an option.

FLEXIBLE CERTIFICATION STANDARDS. There is fairly widespread agreement that certification standards are often unnecessarily strict (Cromwell *et al.*, 1992:55; Bal and Douglas, 1992:20). Crissman (1989) and Crissman and Uquillas (1989) report on the adjustment of potato seed certification standards to more reasonable levels in the Philippines and Ecuador, respectively. There are a number of examples of alternative certification standards. Seed produced by the Smallholder Seed Multiplication Scheme in Malawi does not receive the same amount of supervision as seed produced by the National Seed Company, and is hence sold as 'approved seed' (Cromwell and Zambezi, 1993:113). In Nepal, a system of local seed production being tried is based on three categories of certification. *Certified* seed is produced under supervision at the district level; this is then used by medium size farmers to produce *source* seed, which is supervised by technicians and extension agents; the source seed is then used by village level producer-sellers to produce *improved* seed that is sold to neighbouring farmers (Rajbhandary *et al.*, 1987, cited by Cromwell *et al.*, 1992:54). In Bolivia, as seed production capacity developed, two intermediate types of certification were used; 'classified grain', which was produced without a record of its parental material and without field inspection, and 'fiscalized seed', which received field inspections but no generation control (Garay *et al.*, 1988:31). Seed sold by farmer associations in Colombia receives some technical supervision from the national research institute (Diaz, 1994). The seed certification process in Brazil is managed by each state and would appear to be more agile than most (Cardozo, 1994).

FAO (1993) has produced a set of guidelines for "quality declared seed" that suggest procedures for: national lists of varieties eligible to be produced as quality declared seed; registers of seed producers; government monitoring of seed producers; and a certain level of government supervision of seed sale. The effect of the quality declared seed system is to place responsibility for seed quality in the hands of seed distributors, and it provides scope for the evolution of more rigorous certification procedures as conditions permit (Kelly, 1989:171–4).

COMMUNITY LEVEL CERTIFICATION. If seed is produced and sold within a small community, farmers' familiarity with the seed production conditions and management may obviate the need for more formal certification. Scheidegger *et al.*, (1989) describe 'neighbour certified' potato seed produced as part of a project to increase the availability of good quality seed by selling small quantities of basic seed to farmers who then multiplied it and sold the resulting seed to their neighbours. Lof and Nchemba (1994) describe how farmer groups in Western Zambia multiply and distribute seed of new varieties with minimal supervision from local researchers. Such seed movement among neighbouring farmers is of course practised in most farming communities, although increasing legal restrictions make it more difficult, as Kahre (1990:189) describes for the seed certification system of Sweden. Where seed producers are located at a distance from seed purchasers and market information is not always available, informal "certification" may be difficult, however, as Crissman (1989) discusses for potato seed in the Philippines

Unresolved issues

FINDING THE RIGHT LEVEL OF CERTIFICATION. Since there is apparently a range of seed certification levels that may be applied in particular circumstances, the challenge is to identify the appropriate level. On the supply side, Srivastava and Jaffee (1993:30) point out that levels that are set too high will discourage seed production enterprises, while levels that are too low may result in inadequate quality control and unacceptable products. The same dilemma appears on the demand side; although resource-poor farmers will be unlikely to be interested in seed that has been through an expensive production and certification process that provides no marginal increase in seed value for their growing conditions, they will also not be attracted to formal seed schemes that offer seed or varieties that are barely distinguishable from their own.

COSTS OF LOCAL LEVEL CERTIFICATION. If seed certification is to be decentralised, or delegated to local farmers, technicians or other authorities, there will be costs in training and supervision. A small-scale seed production scheme in Malawi has not worked as well as planned, partly because the seed certification authority has not been able to decentralise its operations (Cromwell and Zambezi, 1993:69). The highly decentralised seed system in the hills of Nepal would appear to demand a fair degree of subsidy (Bal and Rajbhandary, 1987). Decentralised seed certification systems may well be more efficient than present systems, but the costs of making the change should not be overlooked. Decentralisation does not necessarily reduce bureaucracy, however; Rutz (1990) describes the coordination of Germany's 16 different seed certification authorities.

ACCOUNTABILITY. If a range of seed certification authorities is to be established, it must be decided who is ultimately accountable for seed quality. Is all certification to be authorized by a public sector agency, and if so what is their liability for seed quality? One of the most attractive answers to this dilemma is placing responsibility with the seller, although this is not without its own problems, as discussed in the following section.

Seed Distribution and Sale

Current situation

DISTRIBUTION OF PUBLIC SECTOR SEED. Cromwell *et al.*, (1992:48) provide a useful summary of the wide range of methods of seed delivery. In many cases, seed produced by the public sector is distributed through a network of licensed agents. Douglas (1980:241) describes the organisation of India's Terai Development Corporation and its appointment of seed dealers and distributors. Agricultural cooperatives are also commonly used for seed distribution. In Kenya, the parastatal Kenya Seed Company distributes seed exclusively through the Kenya Grain Growers' Cooperative Union, which in turn distributes seed through its branches and to other retailers (Ruigu, 1988:178). In Pakistan, the Punjab Seed Corporation markets its seed through its own outlets, retail outlets of the Punjab Agricultural Development and Supply Corporation, private dealers, and branches of the Provincial Cooperative Bank (Chaudhry *et al.*, 1990:42). As distribution networks get broader and more complex there is usually a wider access to seed, but control of questionable seed marketing practices becomes more difficult.

Seed from public sector enterprises may also be distributed through extension offices or through agricultural or rural development projects. Distribution of seed of improved varieties is sometimes part of a credit package, as Delouche (1990) describes for the "no seed/no credit" policy adopted for rice in Indonesia and the Philippines. These policies may be motivated by the conviction that farmers need incentives to adopt new varieties (or, in the case of Indonesia, as part of a strategy to control the continued use of pest and disease susceptible varieties), but they may unnecessarily restrict farmers' choices. In any case, if the new varieties are not superior, farmers are often only lukewarm adopters of the credit package.

SALES REGULATIONS. Seed sale can be regulated by limiting the type and quality of seed to be sold and/or by licensing the vendors (Bombin-Bombin, 1980). The USA is the principal exception, where the truth in labelling concept does not

limit what seed may be sold, or by whom. In some countries seed of non-registered varieties may be sold, although it cannot be described as certified, while in other countries only listed varieties can be sold as seed (Bombin-Bombin, 1980:10). A seed marketing law that licenses all seed sales outlets in India and provides for seed monitoring at the point of sale has just come into effect (Turner, 1994:13–14). Seed prices may also be regulated by the government, although when price limits extend to seed producers they may seek more attractive terms in the open market (Crissman and Uquillas, 1989:36).

LOGISTICAL PROBLEMS. Many public sector seed distribution systems suffer from the problems of over-centralisation. Poor management of inventories often leads to losses, or the sale of poor quality seed. Seed packages are often too large for the needs of resource-poor farmers. High transport costs from central storage facilities may add to seed costs or mean that seed does not reach remote areas. An additional problem is that of adequately assessing demand for these remote areas. Cromwell and Zambezi (1993) describe the problems for maize in Malawi and Chaudhry *et al.*, (1990) outline the problems of estimating demand for different wheat varieties in Pakistan. Even in Zimbabwe, where maize seed distribution is relatively efficient, local retailers often do not have seed of the varieties that farmers request because they wait until the last minute to assess demand and purchase their stocks (Friis-Hansen, 1992:126).

PRIVATE SECTOR DISTRIBUTION. Private sector seed distribution is often much more efficient than that of the public sector, but the private sector usually operates in circumstances where there is a strong and assured demand for seed. Such demand is a characteristic of hybrid varieties of crops such as pearl millet (Pray *et al.*, 1991) or maize (Friis-Hansen, 1992; Gerhart, 1975) which are usually associated with relatively large scale seed enterprises. But there are also a number of interesting examples of local market response to demand for seed. In situations where climatic factors preclude the local production of seed, as with potatoes in more tropical areas of Peru (Scheidegger *et al.*, 1989) and Nepal (Rhoades, 1985), or soyabeans in Indonesia (Siemonsma and Linnemann, 1988) seed supply networks have been developed that often cover considerable distances. Bebbington (1993) describes how farmer organisations in Ecuador are often more effective at producing and distributing seed than the Ministry of Agriculture. Sperling (1992) describes local market trade in bean seed for Burundi, Rwanda, and Zaire, in response to chronic seed shortage among poorer households. Private sector seed distribution does not function perfectly, of course, and requires some regulations. Cromwell and Zambezi (1993:67) describe how unauthorized dealers in Malawi attempt to sell grain as seed. Merchants are important sources of information about new varieties in the Sudan, but are also capable of unscrupulous practices (Coughenour and Nazhat,

1985:67). Kloppenburg (1988:107) describes the proliferation of companies in the USA in the late 1940s selling hybrid maize seed, often with multiple names for one variety, with the failure to enforce the Federal Seed Act.

Alternatives

FARMER-TO-FARMER EXCHANGE OF NEW VARIETIES. If the problem is the provision of seed of new varieties that farmers then can maintain themselves, recent work points to the possibility of taking better advantage of local seed exchange and distribution mechanisms. Despite all of the investment in programmes and promotion of the Green Revolution, a considerable proportion of the wheat and rice MVs used by farmers today is derived from seed obtained from other farmers and not from official sources (Tetlay *et al.*, 1990). Brush *et al.*, (1981) describe how certain farmers in Peru maintain local potato varieties and are involved in seed exchange networks. Grisley (1993), using the example of bean seed in Zambia, goes so far as to suggest that in cases where there is unlikely to be strong and consistent demand for seed, but where new varieties are periodically released, the free distribution of small quantities of seed to selected farmers is probably more cost effective than attempting to set up a formal and permanent seed infrastructure. The strategy is related to that used by the US Department of Agriculture in the late 19th century, when it distributed hundreds of thousands of seed packets free of charge (Kloppenburg, 1988:61).

There is no doubt that better use can be made of farmer-to-farmer seed exchange (Scheidegger *et al.*, 1989), but some caution is warranted. Only a few studies have looked at this issue in any detail, and most show, not surprisingly, that seed exchange is influenced by kinship, economic and ethnic factors (Green, 1987; Coughenour and Nazhat,1985). Seed exchange networks may be more likely to be used by relatively wealthier farmers. Sperling and Loevinsohn (1992) studied bean variety diffusion in Rwanda, and point to the need to ensure that any seed distribution programme adequately understands where resource-poor farmers are likely to turn when they look for seed.

BROADENING THE NETWORK OF SALES AGENTS. The distribution of seed of new varieties through local networks may serve a useful purpose, but it requires some type of subsidy. In some cases a more sustainable method of developing widespread access to seed is to form better links between local level entrepreneurs and public or private seed enterprises. Seed systems that achieve wide coverage are usually characterised by a network of local sales agents, such as the case for maize in Kenya and Zimbabwe. In the USA, approximately 70 percent of maize seed sales are through local farmer dealers who act as agents for seed companies (Zulauf and King, 1985).

DECENTRALISATION OF SEED PRODUCTION AND DISTRIBUTION. An alternative to broadening the scope of distribution from a national level enterprise is to decentralise seed production and sale. Cromwell and Wiggins (1993) reviewed a number of NGO seed projects, including several that promote seed production and distribution at the local level. In some cases, such as the work of CESA in Ecuador, community seed production is at the initiative of the NGO, with some input from government agencies or universities. In other cases, local NGO efforts are recognised as an important complement to public sector seed activities (Nepal), or have essentially replaced the state seed system (The Gambia). In The Gambia, although several NGOs promote decentralised seed production by smallholders, most of the seed is still collected centrally for redistribution. In Nepal, however, there are several examples where seed is locally produced and distributed. One project, which now involves the Department of Agriculture, supports "private producer sellers" (Bal and Rajbhandary, 1987), farmers who are trained in seed multiplication and provided with foundation seed and technical advice and are then responsible for marketing their seed. Another project has established local seed producer groups that sell seed at fixed prices. Most of these NGO projects are working towards the establishment of self-sustaining local seed provision, but none has yet reached that stage.

VENDOR RESPONSIBILITY. The options for local level seed production and sale add weight to the idea of vendor responsibility for seed quality, as in the FAO (1993) 'quality declared seed' concept. If seed production and distribution are moved to the local level, there is greater possibility that farmers will be able to identify the source of a seed problem and seek compensation or at least avoid the problem the next season. In very small-scale projects, where the producer is also the seller, this may be even more straightforward. But it should be borne in mind that decentralising to this extreme has yet to be shown to be a viable alternative for many circumstances. Local management offers many clear advantages, but it is also possible to err on the side of romanticising "community" control; deception and shoddy practices are possible at this level as well. Seed certification and sales regulations may be made more flexible, but there still needs to be a clear understanding of responsibility for seed quality. Poor quality seed may be the product of errors or oversights in the production process, or faults in storage or management once the seed has entered the distribution channel. Problems such as poor germination may at times be traced to farmer management rather than seed quality (Centner, 1989), which makes the assignment of responsibility even more complicated. In a well-established market, seed vendors will have the opportunity to build up trust with farmers, but resource-poor farmers may not buy seed every year, and they are likely to buy small quantities of various crops and varieties, which makes the establishment of vendor reputation particularly difficult.

Unresolved issues

ACCOUNTABILITY. The assignment of responsibility for seed quality to the vendor is an attractive idea, but leaves several questions unanswered. What level of state supervision or inspection of the vendors will take place? How can vendors be assured of the quality of seed consigned to them, and what recourse do they have if the seed producer is at fault? Clear-cut liability procedures for defective seed have yet to be perfectly established in the USA (Centner, 1989), and in developing markets the problems are likely to be even more challenging (Chopra, 1986). There has been a recent increase in activity in small claims courts in India where farmers are pursuing compensation for defective seed (Turner, 1994:14).

SEED DEMAND AND SEED STOCKS. A second issue involves assessing demand for seed at the local level. In any option that places more seed in the hands of local, small-scale vendors, who is to bear the risk for unsold seed stocks? Farmer demand for seed is likely to be fragmented and uneven (Cromwell *et al.*, 1992:45) and seed vendors do not want to end up with unsold stocks. The Kenya Seed Company is willing to accept returned seed from its agents (Ruigu, 1988), while the Zimbabwe Seed Coop does not allow its seed to be returned by dealers. Uncertain seed demand and its effect on the size and range of vendors' stocks is a serious problem even in the highly commercial seed sector of the USA (Houston *et al.*, 1988). Options that emphasise decentralised seed distribution must provide as accurate information as possible on potential demand to seed vendors or establish some type of protection for the liability of unsold stocks.

THE BROADER LEGAL AND INSTITUTIONAL CONTEXT OF REGULATORY CHANGE

Before presenting the conclusions of this review of seed regulatory frameworks and considering the next steps, it will be useful to take a step back and look at the problem of regulatory change in a broader context. This section presents a brief summary of the role of law in seed regulatory frameworks and then moves to consider the range of institutional responsibilities that may contribute to regulatory definition and change.

The Role of Law in Seed Regulatory Frameworks

After an examination of the problems and some of the possible solutions to current seed regulatory frameworks, it will be helpful to review a few points related to legal change and interpretation.

First, it is well to remember that there are limitations to what can be accomplished through legislation.[3]

> *"Seed legislation must be kept in proper perspective: it does not create seed."* (Douglas, 1980:8).
>
> *"Seed legislation and quality control are easily overemphasised."* (Ibid, 1980:34).
>
> *"New Zealand has a prosperous agricultural sector, including considerable participation in international seed trade, without ever having had any type of seed law."* (Hampton and Scott, 1990).

Laws must respond to societal needs and be able to be enforced.

There are many theories that relate law to society, economy and political interests (Newman, 1983), and it is widely acknowledged that laws are established and modified as a result of a mixture of forces and interests in society. Kloppenburg (1988) gives a detailed account of the establishment of seed laws in the United States, and places particular emphasis on the efforts of private companies, ultimately successful, to reduce regulation to a minimum. The histories of the establishment of seed certification in the UK, France, and Germany each follow quite different paths (Kelly and Bowring, 1990; Serpette, 1990; Rutz, 1990).

Seed laws have evolved in response to particular circumstances. Legal innovations and modifications have been fostered at various times by technical considerations, national security concerns, pressure from farmers or from the seed trade, or the interests of plant breeders. Changes in technical capacity may also bring about changes in seed law, as the increased ability to distinguish among similar lines has sharpened the debate over the definition of "essentially derived varieties" for plant variety protection (Smith, 1992:193).[4] Changing economic conditions may also precipitate pressure for changes in seed law; "identity preserved varieties" (those developed with specific characteristics and contracted for by a food processing company) are incompatible with current Canadian seed law, for instance (Leask, 1992). Acknowledging that seed laws

and their modifications are often the outcomes of imperfect compromises and debates also allows acceptance of the fact that there is no such thing as model seed legislation (Bombin-Bombin, 1980:4). Douglas (1980:120) emphasises this point as well in his guide to the establishment of seed programmes.

We should approach seed law with a view towards the social, economic and technological conditions that may justify changes. Governments and regulatory bodies should be able to establish, modify and interpret seed law to improve the welfare of their citizens. This is consistent with legal theory that assumes that law should be treated pragmatically, that it should

> *"be viewed instrumentally, not as a doctrine deriving worth from its integrity or normative unity as a system of abstract ideas but as a means to practical ends ..."* (Cotterrell, 1989:185).

An important current in legal theory favours an economic interpretation of the law and sees law as functional.

> *"[I]n areas where the social function is the efficient allocation of resources, law appropriately takes its cue from economics... It has yet to be shown that law changes people's attitudes toward compliance with social norms, as distinct from altering their incentives."* (Posner, 1990:460).[5]

The hypothesis that has been examined in this study is that current seed regulatory frameworks often do not provide adequate incentives for the provision of seed and germplasm to resource-poor farmers.

Institutional Responsibilities

Seed regulatory frameworks must be considered within an institutional context. By "institution" we mean, "the regular, patterned behaviour of people in a society ... and the ideas and values associated with these regularities" (Hodgson *et al.*, 1994:402). Thus by this definition, variety release committees, markets, and courts of law are all institutions. For our purposes, it will be useful to consider which institutions will be most effective at: (i) managing the development of a product (new varieties or seed); (ii) establishing standards for that product; and (iii) enforcing those standards. In any given country a combination of institutions will be likely to participate in the definition of seed regulations. The challenge is to identify the most effective institutional arrangements in each case.

THE PRODUCT. Farmers themselves have traditionally controlled the development of varieties and the provision of seed in developing regions. Farmers are certainly in the best position to identify local needs, but have limited access to the resources required for variety development or large scale seed production. But there are some problems in proposing a model in which the public sector merely responds to farmer demand. It is legitimate to ask the degree to which a particular farmer preference corresponds to actual public welfare, for instance. The balance between immediate gain and long-term environmental or biodiversity conservation is perhaps the most common example of this dilemma. In a similar vein, Shah (1984) discusses the problem that poor people's food preferences do not always conform to nutritional priorities. Although seed is a key element in farmers' subsistence, it also often plays legitimate cultural roles that go beyond the possibilities of formal sector response (Richards, 1986; Zimmerer, 1991) .

The public seed sector provides significant plant breeding capacity, and should be in a position to analyse and respond to national needs for varieties and seeds. But the public sector is not always responsive to the needs of farmers, and its capacity to define the public good is limited. The many biases of the public sector against rural populations is the subject of a large literature, for instance (Bates, 1981; Lipton, 1975). Even local groups and NGOs that claim to speak for farmers may misrepresent farmers' aspirations (Bebbington, 1992).

Private sector participation in the seed sector offers possibilities for improving seed system efficiency, but there are few guarantees that it will respond to the needs of the poorer sectors of the farming community that are not effectively represented in markets. But even where there is widespread market participation, markets can be used to contrive demand rather than respond to it.[6]

As institutions develop in a country, it can be expected that both private and public sector research and seed production will be more responsive to the needs of the majority of farmers. In addition, local level organisations may take charge of certain tasks, such as seed multiplication and distribution. But there will always be a balance between meeting the current demands of farmers, and developing products that respond to problems and possibilities beyond the purview of local farming communities.

THE STANDARDS. The establishment of standards and regulations, whether in the seed industry or elsewhere, is often interpreted as an example of consumer protection by the public sector. The development of pesticide regulations in the USA in the early part of this century came in response to demands from farmer organisations, for instance (Boardman, 1986:78). Kelman (1983) discusses public preference for regulation, and sees many government regulations as a response

to the private cost of information processing. In cases where mandatory regulation is undesirable, the alternative of government certification may be attractive (Kelman, 1983:234).

But the origins of public sector regulatory agencies and standards are often much more complex than a benign response to consumer demand. Eisner (1993) identifies four distinct "regulatory regimes" that have characterised US regulatory activities in the past one hundred years. These regimes are the product of a combination of ideologies and interests that have held sway at particular times. Needham (1983) discusses the roles that market and transaction failures, on the one hand, and interest group pressures, on the other hand, have played in defining regulatory politics. Mitnick (1980) presents an extended discussion of theories of regulatory origin, including consumer protection, industry protection, bureaucratic behaviour, and public interest initiatives.

If standards and regulations are left to the private sector, on the other hand, these will likely be the minimum that the market will bear. Where markets are sophisticated, standards may be correspondingly complex. In the UK, a recognised standard for quality management that is applied to a range of enterprises, from engineering firms to legal offices, is managed by a group of independent certification agencies (Bryant, 1994). The adequacy of private sector standards for seed in developing countries will depend on farmers' ability to contribute to the development of those standards, through market participation, pressure groups or public interest representation. As institutions develop in a country, opportunities increase for greater farmer participation in the definition of adequate seed standards.

ENFORCEMENT OF STANDARDS. The mere existence of standards and regulatory agencies does not guarantee that the consumer protection function will be adequately fulfilled. Bernstein (1955, cited in Mitnick, 1980:45) has analyzed the life cycles of regulatory agencies in the USA, showing that many tend to be captured by the very interests they are supposed to regulate. Eisner (1993:11) discusses the possibility of regulators following their own self interests, and Mitnick (1980:94) discusses examples of regulation failing to serve the public interest when regulators become venal, incompetent, or allied with private regulated interests.

The informality of many regulatory agency processes may provide an invitation to corruption (Rose-Ackerman, 1978:175). In the seed sector, corruption can occur when regulatory officials demand bribes for the performance of a service, or when payments are made to officials for the approval of substandard products. Rose-Ackerman (1978:181–2) provides advice on alternative strategies for regulatory agencies to deal with the problems of bribes for legal services or

for illegal services. Klitgaard (1988) offers a number of suggestions for limiting corruption in public sector agencies; among the most relevant for the seed sector are the promotion of competition in the provision of service, and the expanded use of information provided by clients and the public.

An alternative to public sector enforcement is to allow the industry to enforce its own standards. A recent outbreak of bacterial contamination in hamburger meat in the USA, which affected beef sales, has led to calls for the meat industry to be allowed more responsibility for its own inspection. (The Economist, 1994). Potato seed certification in the Netherlands is in the hands of the industry itself (Young, 1990:78). Klein and Leffler (1981) show how the market can serve to enforce industry performance through the development of reputations. Their arguments depend on the value of repeat purchases to the firm, a condition that is not yet a characteristic of all developing country seed enterprises. They point out that alternatives to market standards include third party regulation and vertical integration (which in the case of seeds would imply community-based production). In any case, interest in the substitution of market forces for public regulation does not eliminate the need for private and public order institutions; "abstract rules are also necessary" to shape the development and direction of markets (Platteau, 1994:555).

INSTITUTIONAL RESPONSIBILITIES. It should be obvious that there is no single institutional formula for the management of seed regulatory frameworks. Young (1990), for instance, contrasts the relative roles of private and public sector in the potato seed industries of Canada, the United Kingdom, and The Netherlands. The public and private sector as well as farmer organisations will all play an important role, and the development of responsible public institutions, strong markets, and well organised farmer groups and associations are all important in assuring robust and practical seed regulations. In a particular country, the state of development of various institutions, the level of information and skills available to different groups, and the current state of technology, must all be taken into account in designing useful seed regulatory frameworks. Many different institutional combinations are possible to provide effective seed regulation. As the institutional landscape changes, so will the appropriate regulatory strategies evolve.

CONCLUSIONS

The Importance of Seed Regulations

This paper has tried to illustrate how the regulations and laws that direct plant breeding, variety release, seed certification and seed distribution have an effect on resource-poor farmers' access to appropriate plant varieties and seeds. In a number of instances seed regulations appear to be imperfectly adapted to economic, social or technical realities; mechanically enforced; or unevenly applied. The challenge of seed regulatory frameworks is only partially related to the written laws and regulations, however; it is equally concerned with the interpretations of these regulations and the precedents that are established as the regulations are tested and refined; and with the standards and priorities that are transmitted to society as the regulatory frameworks are developed.

The problems that are addressed by examining seed regulatory frameworks are not new. They are concerned with how to direct agricultural research to the needs of resource-poor farmers, how to ensure their access to useful inputs, and how to promote the development of strong local institutions that support more productive farming practices. But the approach through legal frameworks *is* novel. Just as the current debates on national and international laws regarding intellectual property protection and biodiversity have served to focus attention on the rights of the rural poor, so too can a closer examination of seed regulatory frameworks make an important contribution to strategies for agricultural development.

Options and Commitment

To say that seed regulatory frameworks are often ineffective or counterproductive for resource-poor farmers is not to say that arcane laws and inept bureaucrats stand between farmers and a flood of new agricultural technology. The regulatory frameworks are part of a much more complex panorama. The cases of regulatory ineffectiveness are balanced by at least an equally large number of examples of committed civil servants, imaginative scientists, and innovative local groups that try to work within, or to modify, the regulations so that they support a more productive small farm agriculture. Many of these options have been described in this paper. It is worthwhile to examine these options in greater depth, through case studies, and to synthesize the experience to date. This synthesis can be expected to identify principles and guidelines that will help those who are working on seed regulatory issues to

collaborate more effectively, and to help policy makers understand how the formulation of seed regulations can make a difference to rural welfare.

The Farmers' Voice

Seed regulatory frameworks are the product of debate and compromise involving a wide array of actors from the public and private sectors, scientists, farmers, merchants, and consumers. The scope of the frameworks and the complexity of modern seed systems means that the debate may draw upon concerns ranging from the theories of molecular genetics to the bylaws of a farmer cooperative. Various interest groups, ideologies, and points of view will all make their contributions to the debate, and the only reasonable goal is progress towards a more efficient and equitable agriculture, rather than some static set of ideal regulations. The process will necessarily be complicated and imperfect. The concern of this study is that the voices of resource-poor farmers are not adequately represented in the debate.

Symptoms and Causes

It is important to see progress in seed regulations in the context of a wider perspective. It would be misleading to claim that inadequacies in seed regulations, by themselves, are a major factor explaining low farm productivity. The fact that the voices of resource-poor farmers are not adequately represented in debates on seed regulations is part of a larger problem. For the farmers' voices to be heard, simultaneous improvements in political institutions, markets, information and education need to be brought about. Farmers' lack of representation in the seed debate is in a sense a symptom of these wider deficiencies. But efforts to increase the level of farmer participation in debates over appropriate seed regulations are one way of moving forward. Farmers' increasing experience in testing new options for seed systems and seed regulations will help develop stronger local civil and institutional structures.

The Viability of Seed Systems

The introduction to this paper emphasised the necessity of identifying where improved seed systems are a priority and specifying what precisely needs to be done in those cases. Improved seed systems are only one way of improving rural welfare, and priority must be given to those areas where the greatest impact is expected. It is widely agreed that public sector involvement in the formal seed sector needs to be reconsidered, and much emphasis is currently given to the

private sector, especially for seed production and distribution. It seems likely, however, that these analyses underestimate the extent of the "exceptions" that qualify for NGO or public sector input on equity grounds (e.g. Jaffee and Srivastava, 1994:110). The only way forward is to test various options over the next several years, to see which ones are most promising. The goal is not the provision of subsidies for unprofitable activities just because seed for poor farmers may be an attractive theme, but rather the exploration of the most appropriate institutional mixes to support seed systems that can make an important difference to rural welfare. As this experience grows, it is likely that the participating institutions will themselves grow and evolve, leading to further changes in the mix of support and responsibility.

The Relationship to Plant Breeding

This analysis of seed regulatory frameworks has included plant breeding procedures. Although plant breeding may seem to be in the arena of science, while seed certification is in the arena of legislation, the two are closely linked. Current debates about the future of public sector plant breeding, including breeding strategies for marginal environments, farmer participatory alternatives, and the implications of intellectual property rights, all hinge on a conception of the national seed sector. That conception, in turn, is dependent upon seed regulatory frameworks.

An Evolutionary Perspective

Many analyses of seed regulations emphasise their evolutionary nature. We have seen how seed regulations change as circumstances change, as part of a continual series of debates and compromises among various elements of society. Our objective in this study is to examine how incongruities between current seed regulations, on the one hand, and social, economic and technical conditions, on the other, may adversely affect resource-poor farmers, and to suggest practical solutions. These solutions may at times entail simpler or less rigorous seed regulations, or what seem to be less "scientific" plant breeding procedures. But the adoption of effective, if simpler, rules and procedures should be seen as part of an evolutionary process. Once farmers and plant breeders have a more comfortable working relationship, their collaboration will grow. Once farmers have access to more reliable seed systems, their demands for an increased range and quality of products will also expand. Further change in seed regulatory frameworks will then emerge from farmers' participation in more effective agricultural institutions.

REFERENCES

Agrawal, P.K. and Tunwar, N.S. (1990). "Seed Certification and Quality Control in India." Plant Varieties and Seeds 3(3):165–171.

Allott, A. (1980). The Limits of Law. London: Butterworths.

Almekinders, C.J.M., Louwaars, N.P and de Bruijn, G.H. (1994). "Local Seed Systems and Their Importance for an Improved Seed Supply in Developing Countries." Euphytica 78:207–211.

Ashby, J.A., Quiros, C.A. and Rivera, Y.M. (1987). "Farmer Participation in On-Farm Varietal Trials." Agricultural Administration (Research and Extension) Network Discussion Paper No. 22. London: Overseas Development Institute.

Ashby, J.A. (1982). "Technology and Ecology: Implications for Innovation Research in Peasant Agriculture." Rural Sociology 47(2):234–250.

Bal, S.S. and Douglas, J.E. (1992). "Designing Successful Farmer-Managed Seed Systems." Development Studies Paper Series. Morrilton, Arkansas: Winrock International Institute for Agricultural Development.

Bal, S.S. and Rajbhandary, K.L. (1987). "A Model for Seed Production in Remote Areas of Nepal." Seed Science & Technology 15:625–632.

Bates, R. (1981). Markets and States in Tropical Africa. Berkeley: University of California Press.

Baumann, M. (1992). "Promoting Local Conservation in Ecuador." In Cooper, D., Vellvé, R. and Hobbelink, H. (eds) (1992). Growing Diversity: Genetic Resources and Local Food Security. London: Intermediate Technology Publications.

Bebbington, A.J. (1993). "Peasant Federations, Development Institutions, and Technological Change in the Andes." In Glade, W. and Reilly, C.A. (eds) Inquiry at the Grassroots: An Inter-American Foundation Fellowship Reader pp 153–176. Arlington, Virginia: Inter-American Foundation.

Bebbington, A.J. (1992). "Searching for an 'Indigenous' Agricultural Development: Indian Organizations and NGOs in the Central Andes of Ecuador." Working Paper No. 45. Cambridge: University of Cambridge Centre of Latin American Studies.

Berg, T., Bjoernstad, A., Fowler, C. and Kroeppa, T. (1991). "Technology Options and the Gene Struggle." NORAGRIC Occasional Papers Series C.; Development and Environment No. 8. As: Agricultural University of Norway.

Bernstein, M. (1955). Regulating Business by Independent Commission. Princeton: Princeton University Press.

Binswanger, H. and Ryan, J. (1977). "Efficiency and Equity Issues in *Ex Ante* Allocation of Research Resources." Indian Journal of Agricultural Economics 32:217–231.

Boardman, R. (1986). Pesticides in World Agriculture: The Politics of International Regulation. London: Macmillan.

Bombin-Bombin, L.M. (1980). "Seed Legislation." Legislative Study No. 16. Food and Agriculture Organization of the United Nations, Rome 1980.

Bould, A. and Kelly, A.F. (1992). "Plant Breeders' Rights in the UK." Plant Varieties and Seeds 5(3):143–150.

Bould, A. (1992). "Models for Plant Variety Registration and Grant of Plant Breeders Rights in the European Community and the Developed World." In ICAR, Proceedings of the Group Discussion on Management of Change in All India Coordinated Crop Improvement Projects. New Delhi: Indian Council of Agricultural Research.

Brennan, J. and Byerlee, D. (1991). "The Rate of Crop Varietal Replacement on Farms: Measures and Empirical Results for Wheat." Plant Varieties and Seeds 4:99–106.

Brush, S., Carney, H. and Huaman, Z. (1981). "Dynamics of Andean Potato Agriculture." Economic Botany 35:70–88.

Bryant, N. (1994). "Tick Here for Quality Management." The Times (London). October 12 1994 p. 38.

Busch, L. and Lacy, W. (1983). Science, Agriculture and the Politics of Research. Boulder, Colorado: Westview Press.

Buttel, F., Gillespie, G., Janke, R., Caldwell, B. and Sarrantorio, M. (1986). "Reduced-Input Agricultural Systems: A Critique." Rural Sociologist 6: 350–370.

Byerlee, D. and Moya, P. (1993). Impacts of International Wheat Breeding Research in the Developing World. 1966–90. Mexico, D.F.: CIMMYT.

Byerlee, D., Akhtar, M.R. and Hobbs, P.R. (1987). "Reconciling Conflicts in Sequential Cropping Patterns Through Plant Breeding: The Example of Cotton and Wheat in Pakistan's Punjab." Agricultural Systems 24:291–304.

Cardozo, E.P. (1994). "Producción y Mercadeo de Semilla de Forrajeras Tropicales en SEMEL Ltda., Brasil." In Ferguson, J.E. (ed.) Semilla de Especies Forrajeras Tropicales, Conceptos, Casos y Enfoque de la Investigación y la Producción. Memorias de la octava reunión del Comité Asesor de la RIEPT, Noviembre de 1992 pp 291–306. CIAT.

Ceccarelli, S. (1989). "Wide Adaptation: How Wide?" Euphytica 40:197–205.

Centner, T.J. (1989). "Imposition of Liability and Allocation of Damages for Defective Seed." Agribusiness 5(6):597–606.

Chaudhry, M., Heisey, P. and Ahmad, M. (1990). "Wheat Seed Production and Marketing in the Punjab and NWFP." In Heisey, P. (ed.) Accelerating the Transfer of Wheat Breeding Gains to Farmers: A Study of the Dynamics of Varietal Replacement in Pakistan. Mexico, D.F.: CIMMYT.

Chopra, K.R. (1986). "Problems in Seed Production, Certification and Quality Control" in the Proceedings of the First National Seed Seminar, Seed Association of India. New Delhi, 27–28 December 1986.

Chopra, K.R. and Reusche, G.A. (1993). Seed Enterprise Development and Management: A Resource Manual. Bangkok: FAO Regional Office for Asia and the Pacific.

CIMMYT (1994). 1994 CIMMYT World Maize Facts and Trends. Maize Seed Industries Revisited: Emerging Roles of the Public and Private Sectors. Mexico, D.F.: CIMMYT.

Clayton, O. (1990). "The History of the Canadian Seed Growers' Association." Plant Varieties and Seeds 3(3):127–138.

Cotterrell, R. (1989). The Politics of Jurisprudence. London: Butterworths.

Coughenour C.M. and Nazhat, S.M. (1985). "Recent Change in Villages and Rainfed Agriculture in North Central Kordofan: Communication Process and Constraints." Report No. 4 of International Sorghum/Millet Collaborative Research Support Program. Lincoln: Institute of Agriculture and Natural Resources, University of Nebraska.

Crissman, C.C. and Uquillas, J.E. (1989). Seed Potato Systems in Ecuador: A Case Study. Lima: International Potato Centre.

Crissman, C.C. (1989). Seed Potato Systems in the Philippines: A Case Study. Lima: International Potato Center.

Cromwell, E., Friis-Hansen, E. and Turner, M.. (1992). The Seed Sector in Developing Countries: a Framework for Performance Analysis. London: Overseas Development Institute.

Cromwell, E. and Wiggins, S. with Wentzel, S. (1993). Sowing Beyond The State. London: Overseas Development Institute.

Cromwell, E. and Zambezi, B. (1993). The Performance of the Seed Sector in Malawi. London: Overseas Development Institute.

Crucible Group (1994). People, Plants and Patents: The Impact of Intellectual Property on Biodiversity, Conservation, Trade and Rural Society. Ottawa: IDRC.

Delouche, J.C. (1990). "Seed Industry Development in Asia – Selected Case Studies." Draft Report to USAID/Bangladesh. Mississippi State: Seed Technology Laboratory, Mississippi State University.

Diaz, A.L. (1994). "Desarrollo de Pequeñas Empresas de Semillas Basado en la Experiencia del ICA en Colombia." In J.E. Ferguson (ed.) Semilla de Especies Forrajeras Tropicales, Conceptos, Casos y Enfoque de la Investigación y la Producción. Memorias de la Octava Reunión del Comité Asesor de la RIEPT, Noviembre de 1992 pp 210–219. CIAT.

Douglas, J. (1980). Successful Seed Programs. A Planning and Management Guide. Boulder, Colorado: Westview Press.

The Economist (1994). "To Zap or Not to Zap." The Economist. July 23 1994, pp 47–48.

Edmeades, G., Dankyi, A.A., Marfo, K. and Tripp, R. (1991). "On-Farm Maize Research in the Transition Zone of Ghana." In Tripp, R. (ed.) Planned Change in Farming Systems: Progress in On-Farm Research. Chichester: John Wiley.

Eisner, M.A. (1993). Regulatory Politics in Transition. Baltimore: The Johns Hopkins University Press.

Farrington, J. and Martin, A. (1988). "Farmers' Participation in Agricultural Research." ODI Occasional Paper No. 9. London: ODI.

Farrington, J. and Bebbington, A.J. with Wellard, K. and Lewis, D.J. (1993). Reluctant Partners? Non-Governmental Organisations, the State and Sustainable Agricultural Development. London and New York: Routledge.

Ferguson, A. and Mkandawire, R. (1993). "Common Beans and Farmer Managed Diversity: Regional Variations in Malawi." Culture and Agriculture 45–46:14–17.

Ferguson, J. and Sauma, G. (1993). "Towards More Forage Seeds for Small Farmers in Latin America." Proceedings of the XVII International Grassland Congress, 13–16 February 1993, Palmerston North, New Zealand.

Ferguson, J. (1994). "El Proceso de Liberación de Nuevos Cultivares de Forrajeras: Experiencias y Perspectivas." In Ferguson, J.E. (ed.) Semilla de Especies Forrajeras Tropicales, Conceptos, Casos y Enfoque de la Investigación y la Producción. Memorias de la Octava Reunión del Comité Asesor de la RIEPT, Noviembre de 1992, pp 167–187.

Food and Agricultural Organization of the United Nations (1993). "Quality Declared Seed." FAO Plant Production and Protection Paper 117. Rome.

Fowler, C. and Mooney, P. (1990). Shattering: Food, Politics, and the Loss of Genetic Diversity. Tucson: The University of Arizona Press.

Francis, C. (1990). "Breeding Hybrids and Varieties for Sustainable Systems." In Francis, C. (ed.) Sustainable Agriculture in Temperate Zones. New York: John Wiley.

French, J. and Raven, B. (1960). "The Bases of Social Power." In Cartwright, D. and Zander, A. (eds) Group Dynamics – Research and Theory, pp 607–623. New York: Harper & Row Publishers.

Friis-Hanssen, E. (1992). Seeds for African Peasants. A Case Study from Zimbabwe. Copenhagen: Centre for Development Research.

Fujisaka, S., Guino, R.A., Lubigan, R.T. and Moody, K. (1993). "Farmers' Rice Seed Management Practices and Resulting Weed Seed Contamination in the Philippines." Seed Science & Technology 21:149–157.

Galt, D.L. (1989). "Joining FSR to Commodity Programme Breeding Efforts Earlier: Increasing Plant Breeding Efficiency in Nepal." Agricultural Administration (Research and Extension) Network Paper No.8. London: Overseas Development Institute.

Garay, A., Pattie, P., Landivar, J. and Rosales, J. (1988). "Setting a Seed Industry in Motion: A Non-Conventional Successful Approach in a Developing Country." Working Document No. 57. Cali, Colombia: CIAT.

Gerhart, J. (1975). The Diffusion of Hybrid Maize in Western Kenya. Mexico, D.F.: CIMMYT.

Gill, K.S. (1992). "Zonalisation *vis-à-vis* Varietal Evaluation" In ICAR, Proceedings of the Group Discussion on Management of Change in All India Coordinated Crop Improvement Projects. New Delhi: Indian Council of Agricultural Research.

Graf, W., Voss, J. and Nyabyenda, P. (1991). "Climbing Bean Introduction in Southern Rwanda." In Tripp, R. (ed.) Planned Change in Farming Systems: Progress in On-Farm Research. Chichester: John Wiley.

Green, T. (1987). Farmer-to-Farmer Seed Exchange in the Eastern Hills of Nepal: The Case of 'Pokhreli Masino' Rice. Dhankuta, Nepal: Pakhribas Agricultural Centre.

Grisley, W. (1993). "Seed for Bean Production in Sub-Saharan Africa: Issues, Problems, and Possible Solutions." Agricultural Systems 43:19–33.

Grobman, A. (1992). "Fostering a Fledgling Seed Industry." In Anderson, J.R. and de Haan, C. (eds) Public and Private Roles in Agricultural Development. Proceedings of the Twelfth Agricultural Sector Symposium. Washington, D.C.: World Bank.

Groosman, T., Linnemann, A. and Wierema, H. (1991). Seed Industry Development in a North–South Perspective. Wageningen: Pudoc.

Hampton, J.G. and Scott, D.J. (1990). "New Zealand Seed Certification." Plant Varieties and Seeds 3(3):173–180.

Haugerud, A. and Collinson, M. (1990). "Plants, Genes and People: Improving the Relevance of Plant Breeding in Africa." Experimental Agriculture 26:341–362.

Henderson, P.A. and Singh, R. (1990). "NGO-Government Links in Seed Production: Case Studies from The Gambia and Ethiopia." Agricultural Administration (Research and Extension) Network Paper No. 14. London: Overseas Development Institute.

Herdt, R.W. and Capule, C. (1983). Adoption, Spread and Production Impact of Modern Rice Varieties in Asia. Manila, Philippines: IRRI.

Hodgson, G., Samuels, W. and Tool, M. (eds) (1994). The Elgan Companion to Institutional and Evolutionary Economics. Aldershot, Hants: Edward Elgan Publishing.

Houston, J.E., Centner, T.J. and Morgan, W. (1988). "Uncertainty and Structural Issues Facing the Seed Handling Industry." Agribusiness 4(4):347–357.

Jaffee, S. and Srivastava, J. (1994). "The Roles of the Private and Public Sectors in Enhancing the Performance of Seed Systems." The World Bank Research Observer 9:97–117.

Jaffee, S. and Srivastava, J. (1992). "Seed System Development: The Appropriate Roles of the Private and Public Sectors." World Bank Discussion Paper No. 167. Washington, D.C.: World Bank.

Janssen, W., Luna, C.A. and Duque, M.C. (1992). "Small-farmer Behaviour Towards Bean Seed: Evidence From Colombia." Journal of Applied Seed Production 10:43–51.

Janssen, W., Ruiz de Londoño, N., Beltran, J.A. and Woolley, J. (1991). "On-Farm Research in Support of Varietal Diffusion: Bean Production in Cajamarca, Peru." In Tripp, R. (ed.) Planned Change in Farming Systems: Progress in On-Farm Research. Chichester: John Wiley.

Janvry, A. de. and Sadoulet, E. (1989). "Investment Strategies to Combat Rural Poverty: A Proposal for Latin America." World Development 17(8):1203–1221.

Kahre, L. (1990). "The History of Seed Certification in Sweden." Plant Varieties and Seeds 3:181–193.

Kelly, A.F. and Bowring, J.D.C. (1990). "The Development of Seed Certification in England and Wales." Plant Varieties and Seeds 3(3):139–150.

Kelly, A.F. (1989). Seed Planning and Policy for Agricultural Production. London: Belhaven Press.

Kelman, S. (1983). "Regulation and Paternalism." In Machan, T.R. and Johnson, M.B. (eds) Rights and Regulation: Ethical, Political and Economic Issues. Cambridge, Massachusetts: Ballinger Publishing Company.

Keystone Center (1991). Final Plenary Report of the Keystone International Dialogue on Plant Genetic Resources. Oslo, Norway: Keystone Center.

Klein, B. and Leffler, K.B. (1981). "The Role of Market Forces in Assuring Contractual Performance." Journal of Political Economy 89(4):615–641.

Klitgaard, R. (1988). Controlling Corruption. Berkeley/Los Angeles/London: University of California Press.

Kloppenburg, Jr., J. (1988). First The Seed. Cambridge: Cambridge University Press.

Krattiger, A.F. and Rosemarin, A. (1994). Biosafety for Sustainable Agriculture: Sharing Biotechnology Regulatory Experiences of the Western Hemisphere. Stockholm: Ithaca and Stockholm Environment Institute (SEI): International Service for the Acquisition of Agri-Biotech Applications (ISAAA).

Leask, W. (1992). "The Third Wave of Development." unpublished paper.

Levins, R. and Lewontin, R. (1985). The Dialectical Biologist. Cambridge, USA: Harvard University Press.

Lipton, M. (1975). "Urban Bias and Food Policy in Poor Countries." Food Policy 1:41–50.

Lof, H. and Nchemba, A. (1994). "Seed Banks: Enhancement of Farmers' Control over Seed Supply." Paper presented at 2nd SADC Seminar on Seed Research and Certification. 17–20 May 1994, Maseru, Lesotho.

Louwaars, N.P. (1994) "Integrated Seed Supply; A Flexible Approach." Paper presented at the ILCA/ICARDA Research Planning Workshop on Smallholder Seed Production. 13–15 June 1994, Addis Ababa.

Makus, L.D., Guenthner, J.F. and Lin, B-H. (1992). "Factors Influencing Producer Support for a State Mandatory Seed Law: An Empirical Analysis." Journal of Agricultural and Resource Economics 17(2):286–293.

Martinez, J.C. and Sain, B-H. (1983). "The Economic Returns to Institutional Innovations in National Agricultural Research: On-Farm Research in IDIAP, Panama." CIMMYT Economics Program Working Paper 04/83. Mexico, D.F.: CIMMYT.

Maurya, D.M. (1989). "The Innovative Approach of Indian Farmers." In Chambers, R., Pacey, A. & Thrupp, L.A. (eds) Farmer First. Farmer Innovation and Agricultural Research. pp 9–13. London: Intermediate Technology Publications.

Maurya, D.M., Bottrall, A. and Farrington, J. (1988). "Improved Livelihoods, Genetic Diversity and Farmer Participation: A Strategy for Rice Breeding in Rainfed Areas of India." Experimental Agriculture 24:311–320.

Merrill-Sands, D., Biggs, S., Bingen, R.J., Ewell, P., McAllister, J. and Poats, S. (1991). "Institutional Considerations in Strengthening On-Farm Client-Oriented Research in National Agricultural Research Systems: Lessons from a Nine Country Study." Experimental Agriculture 27:343–373.

Mitnick, B.M. (1980). The Political Economy of Regulation: Creating, Designing and Removing Regulatory Forms. New York: Columbia University Press.

Montecinos, C. (1992). "Facing the Challenge of Grassroots Conservation." In Cooper, D., Vellvé, R. and Hobbelink, H. (eds) (1992), Growing Diversity: Genetic Resources and Local Food Security. pp 146–154. London: Intermediate Technology Publications.

Mushita, T.A. (1993). "Strengthening the Formal Seed System in Communal Areas of Zimbabwe." In de Boef, W., Amanor, K., Wellard, K. with Bebbington, A.J. (1993). Cultivating Knowledge. Genetic Diversity, Farmer Experimentation and Crop Research. pp 85–88. London: Intermediate Technology Publications.

Needham, D. (1983), The Economics and Politics of Regulation: A Behavioural Approach. Boston: Little, Brown and Company.

Newman, K. (1983). Law and Economic Organization. Cambridge: Cambridge University Press.

Osborn, T. (1990). "Multi-Institutional Approaches to Participatory Technology Development: A Case Study from Senegal." Agricultural Administration

(Research and Extension) Network Paper No. 13. London: Overseas Development Institute.

Osborn, T. (1992), Guide for Developing PVO/PC Seed Activities: The On-Farm Seed Project. Morrilton, Arkansas: Winrock International Institute for Agricultural Development.

Pachico, D. and Borbon, E. (1987). "Technical Change in Traditional Small Farm Agriculture: The Case of Beans in Costa Rica." Agricultural Administration and Extension 26:65–74.

Pain, A. (1986). "Agricultural Research in Sri Lanka: An Historical Account." Modern Asian Studies 20(4):755–778.

Pardey, P.G., Roseboom, J. and Anderson, J.R. (1991). "Regional Perspectives on National Agricultural Research." In Pardey, P.G., Roseboom, J. and Anderson, J.R. (eds) Agricultural Research Policy: International Qualitative Perspectives. Cambridge, England: Cambridge University Press.

Platteau, J-P. (1994). "Behind the Market Stage Where Real Societies Exist – Part I; The Role of Public and Private Order Institutions." The Journal of Development Studies 30(3):533–577.

Posner, R. (1990). The Problems of Jurisprudence. Cambridge, USA: Harvard University Press.

Pray, C., and Ramaswami, B. (1991). A Framework for Seed Policy Analysis in Developing Countries. Washington, D.C.: International Food Policy Research Institute.

Pray, C., Ribeiro, S., Mueller, R. and Rao, P. (1991). "Private Research and Public Benefit: The Private Seed Industry for Sorghum and Pearl Millet in India." Research Policy 20:315–324.

Redclift, M. (1983). "Production Programs for Small Farmers: Plan Puebla as Myth and Reality." Economic Development and Cultural Change 31:343–370.

Rhoades, R.E. (1985). "Traditional Potato Production and Farmers' Selection of Varieties in Eastern Nepal." Potatoes in Food Systems Research Series No. 2. Lima: International Potato Center.

Richards, P. (1986). Coping with Hunger: Hazard and Experiment in an African Rice Farming System. London: Allen and Unwin.

Rose-Ackerman, S. (1978). Corruption: A Study in Political Economy. New York: Academic Press.

Ruigu, G.M. (1988). "The Kenya Seed Industry Evolution: Current Status and Future Prospects." Paper prepared for the seminar on "Technology Development and Changing Seed Supply Systems." Tilburg, The Netherlands, 22 June 1988.

Rusike, J. and Donovan, P. (in press). "Evolution of the Maize Seed Industry in Zimbabwe." Development Southern Africa.

Rutz, H.W. (1990). "Seed Certification in the Federal Republic of Germany." Plant Varieties and Seeds 3(3):157–163.

Salazar, R. (1992). "Community Plant Genetic Resources Management: Experiences in Southeast Asia." In Cooper, D., Vellvé, R. and Hobbelink, H. (eds) (1992). Growing Diversity: Genetic Resources and Local Food Security. London: Intermediate Technology Publications.

Sattar, M. and Altaf Hossain, S.M. (1986). "An Evaluation of Farmers' Technology for Seed Production and Post-Harvest Operations in Aus Rice." Bangladesh Journal of Extension Education 1(2).

Scheidegger, U., Prain, G., Ezeta, F. and Vittorelli, C. (1989). "Linking Formal R & D to Indigenous Systems: A User-Oriented Potato Seed Programme for Peru." Agricultural Administration (Research and Extension) Network Paper No. 10. London: Overseas Development Institute.

Serpette, R. (1990). "The History of Seed Certification in France." Plant Varieties and Seeds 3(3):151–156.

Shah, C.H. (1984). "Food Preference, Poverty and the Nutrition Gap." Economic Development and Cultural Change 32:121–148.

Siemonsma, J. and Linnemann, A.R. (1988). "Seed Supply and Varietal Choice in Low-Input Agriculture; A Case Study of Soybean in Pasuruan, East Java, Indonesia." Seed Industry Development, Developing Countries' Experience in Different Crops. Research Report No. 34. Tilburg: IVO Development Research Institute Research.

Simmonds, N. (1979). Principles of Crop Improvement. Harlow, UK: Longman.

Simmonds, N.W. (1991). "Selection for Local Adaptation in a Plant Breeding Programme." Theoretical and Applied Genetics 82:363–367.

Singh, S. (1992). "Role of On-Farm Testing and Minikit in Varietal Releases" In ICAR, 1992, Proceedings of the Group Discussion on Management of Change in All India Coordinated Crop Improvement Projects. New Delhi: Indian Council of Agricultural Research.

Smith, J.S.C. (1992). "Plant Breeders' Rights in the USA; Changing Approaches and Appropriate Technologies in Support of Germplasm Enhancement." Plant Varieties and Seeds 5(3):183–199.

Sperling, L. and Loevinsohn, M.E. (1993). "The Dynamics of Adoption: Distribution and Mortality of Bean Varieties Among Small Farmers in Rwanda." Agricultural Systems 41:441–453.

Sperling, L., Loevinsohn, M.E. and Ntambovura, B. (1993). "Rethinking the Farmer's Role in Plant Breeding: Local Bean Experts and On-Station Selection in Rwanda." Experimental Agriculture 29:509–519.

Sperling, L. (1992). "Analysis of Bean Seed Channels in the Great Lakes Region: South Kivu, Zaire, Southern Rwanda, and Selected Bean-Growing Zones of Burundi." Paper presented at the 7th Regional Seminar on Bean Improvement in the Great Lakes Region of Africa, Goma, 2–6 November 1992.

Srivastava, J. and Jaffee, S. (1993). Best Practices for Moving Seed Technology. Washington, D.C.: The World Bank.

Tetlay, K., Heisey, P., Ahmed, Z. and Ahmad, M. (1990). "Farmers' Seed Sources and Seed Management." In Heisey, P. (ed.) Accelerating the Transfer of Wheat Breeding Gains to Farmers: A Study of the Dynamics of Varietal Replacement in Pakistan. Mexico, D.F.: CIMMYT.

Thiele-Wittig, M-H. (1992). "Development of Technical Work in UPOV." Plant Varieties and Seeds 5(3):129–142.

Thirtle, C. and Echeverría, R. (1994). "Privatization and the Roles of Public and Private Institutions in Agricultural Research in Sub-Saharan Africa." Food Policy 19:31–44.

Tripp, R. (ed.) (1991). Planned Change in Farming Systems: Progress in On-Farm Research. Chichester: John Wiley.

Trutmann, P. and Kayitare, E. (1991). "Disease Control and Small Multiplication Plots Improve Seed Quality and Small Farm Dry Bean Yields in Central Africa." Journal of Applied Seed Production 9:36–40.

Turner, M.R. (1994). "Trends in India's Seed Sector." Paper presented at Asian Seed 94, Chiang Mai, Thailand. 27–29 September 1994.

Ulrich, A., Furtan, W.H. and Schmitz, A. (1987). "The Cost of a Licensing System Regulation: An Example from Canadian Prairie Agriculture." Journal of Political Economy 95(1):160–178.

van Wijk, J. (1994). "Impact of Plant Breeders' Rights in Developing Countries." Presentation based on research report by Jaffe, W. and van Wijk, J., The Debate and Impact of Plant Breeders' Rights in Developing Countries. Forthcoming.

Westcott, B. (1986). "Some Methods of Analysing Genotype-Environment Interaction." Heredity 56:243–253.

Worede, M. (1992). "Ethiopia: a Genebank Working with Farmers." In Cooper, D., Vellvé, R. and Hobbelink, H. (eds) (1992). Growing Diversity: Genetic Resources and Local Food Security. London: Intermediate Technology Publications.

Ziegler, R. (1986). "Application of a Systems Approach in a Commodity Research Programme: Evaluating Burundi Highland Maize." Experimental Agriculture 22:319–328.

Young, N. (1990). Seed Potato Systems in Developed Countries: Canada, The Netherlands and Great Britain. Lima, Peru: International Potato Center.

Zimmerer, K. (1991). "Managing Diversity in Potato and Maize Fields of the Peruvian Andes." Journal of Ethnobiology 11:23–49.

Zulauf, C.R. and King, K.F. (1985). "Farm Operators Who Sell Crop Production Inputs: The Case of Ohio Farmers Who Sell Seed." Agribusiness 1(2):193–199.

ENDNOTES

1. This is not the case in the United States, unless the variety is to be covered by plant breeders' rights.

2. French and Raven (1960) distinguish five sources of social power: reward, coercion, legitimate (derived from law or custom), expert (reliance on specialized knowledge) and referent (political or charismatic skill). One can imagine possibilities for the exercise of all five types of power in a variety release committee.

3. "You want to prevent soil erosion in Africa?" Allott (1980:vii) asks, tongue in cheek. "Nothing easier. You don't have to hire a single soil expert; all you need to do is slip a piece of paper in the legislative typewriter, headed 'Soil Erosion Eradication Decree. 1980', send it along to the appropriate legislature...and the job will be done."

4. The development of regulatory frameworks to accommodate rapidly changing technical conditions is even more of a challenge for biotechnology (Krattiger and Rosemarin, 1994).

5. See Centner (1989) for an example of the application of economic analysis to the development of seed law.

6. Fowler and Mooney (1990:54-55) provide an amusing example of the potential power of advertising in the seed sector. A magazine article on modern plant breeding was illustrated with mock photos of imaginary plant breeding "miracles", including a "Super Salad plant" that supposedly combined lettuce, onions, peppers and tomatoes. The article stimulated five hundred seed orders from farmers!

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