

ALTERNATIVES FOR SEED REGULATORY REFORM **An Analysis of Variety Testing, Variety Regulation** **and Seed Quality Control**

Robert Tripp, Niels Louwaars, W. Joost van der Burg, D.S. Virk,
and J.R. Witcombe

Abstract

This paper summarises the findings of a recently completed project which examined the conduct of seed regulation in developing countries and produced a set of guidelines for seed regulatory reform. The three areas of seed regulation included in the study were: public sector plant breeding (particularly the management of variety testing); variety regulation (registration, performance testing and release); and seed quality control (seed certification and seed testing). Adjustment to seed regulatory frameworks is necessary because of significant changes in national seed systems. These changes include: reductions in budget for public agricultural research; the failure of many seed parastatals; increasing concern about plant genetic diversity; pressure for the establishment of plant variety protection; the increasing contributions of commercial seed enterprises; and the emergence of innovative local level variety development and seed production initiatives.

There are a variety of reasons why current public seed regulation is unsatisfactory. It is not efficiently organised, often uses inappropriate standards, does not offer opportunities for farmer and seed producer participation, and is not sufficiently transparent. At the same time there are a number of options for regulatory reform. In plant breeding, more emphasis should be placed on decentralising variety testing, breeding for particular niches, and making site selection, trial management and analysis more representative of farmers' conditions. In variety regulation, simpler registration procedures are required, and the demands of plant variety protection should not be allowed to bias or limit the development and use of public and farmer varieties. Variety performance testing for release should be made more

flexible. In seed quality control, standards should be re-examined for their relevance to particular farming conditions, and much of the responsibility for monitoring seed quality should be passed to seed producers and merchants, accompanied by well-defined public oversight and enforcement mechanisms.

Acknowledgements

Support for this study was provided by the UK Overseas Development Administration (Natural Resources Policy Research Programme). The opinions expressed in this paper are those of the authors and do not necessarily reflect those of ODA.

Country case studies were written by.

Jorge Rosales, Gonzalo Romero, Iciar Pavez, Alan Bojanic, Guido Revollo, Jonathan Woolley, S.K. Banerjee, B.G. Jaisani, Y.M. Upadhyaya, K.L. Vyas, Lydia Kimenyi, Hezron Nyangito, Kiarie Njoroge, Jerimiah Kipligat, Krishna Joshi, Kamalesh Rajbhandary, Bhuwon Sthapit, Zahur Alam, A.R. Saleemi, Altaf-Ur-Rehman Rao, Jose Hernandez, Terrisita Borromeo, Manuel Logroño, Nehemia Mashiringwani, Joseph Rusike, Temba Musa, and Christmas Pasipanodya.

John Nelson provided case study management and Paul Balogun developed an economic analysis of regulatory failure.

P.S. Sodhi provided valuable support to case study development in India.

Michael Hayward, Niels Louwaars and W. Joost van der Burg played leading roles in the management of the final workshop.

The Agricultural Research and Extension Network is sponsored by the UK Overseas Development Administration (ODA). The opinions expressed in this paper do not necessarily reflect those of ODA.

We are happy for this material to be reproduced on a not-for-profit basis. The Network Coordinator would appreciate receiving details of any use of this material in training, research or programme design, implementation or evaluation.

Network Coordinator: Diana Carney Assistant Coordinator: John Farrington Secretary: Alison Saxby

CONTENTS

	Page
Abstract	i
Contents	iii
Acronyms	v
1 Introduction	1
2 Changes in national seed systems	1
The elements of national seed systems	1
<i>Plant breeding</i>	1
<i>Seed production</i>	2
<i>Seed distribution</i>	2
Changes in the nature of seed regulation	2
3 Problems with current seed regulatory frameworks	4
Public plant breeding	4
<i>The organisation of variety testing</i>	5
<i>Problems with the management of public variety testing</i>	5
Variety regulation	7
<i>The organisation of variety regulation</i>	7
<i>Problems with variety regulation</i>	7
Seed quality control	9
<i>The organisation of seed quality control</i>	9
<i>Problems with the management of seed quality control</i>	10
Summary: The need for regulatory reform	11
4 Regulatory reform	11
The nature of regulation	11
Regulatory reform	12
5 Alternatives for seed regulation	13
Alternatives for managing variety testing	13
<i>Procedural changes</i>	13
<i>The organisation of variety testing</i>	13
<i>Farmer participation</i>	15
<i>Incentives</i>	15
Alternatives for managing variety regulation	15
<i>Reforming variety registration</i>	15
<i>Reforming performance testing</i>	16
Alternatives for managing seed quality control	18
<i>Standards for seed quality control</i>	18
<i>Monitoring seed quality control</i>	19
<i>Enforcing seed quality control</i>	20
Summary	22

	Page
6 Institutional implications	22
Local level seed activities	22
The commercial seed sector	23
The public sector	23
Conclusions	24
References	24
Text boxes, figures and tables	
Box 1. Problems with the management of variety testing	5
Box 2. Problems with the management of variety regulation	8
Box 3. Problems with the management of seed quality control	10
Figure 1. The past scenario: The regulation of public seed production	3
Figure 2. The current scenario: The regulation of national seed systems	4
Table 1. The evolution of variety testing in public plant breeding systems	14
Table 2. The evolution of variety registration	17
Table 3. The evolution of variety performance testing	18
Table 4. Options for monitoring seed quality control	19
Table 5. The evolution of seed quality control	21

ACRONYMS

AICCP	All India Coordinated Crop Improvement Programmes
CAZS	Centre for Arid Zone Studies, University of Wales, Bangor, UK
CGIAR	Consultative Group on International Agricultural Research
CV	Coefficient of variation
EU	European Union
FAO	Food and Agriculture Organisation of the United Nations
GATT	General Agreement on Tariffs and Trade
GIS	Geographical Information Systems
ICAR	Indian Council of Agricultural Research
ODA	Overseas Development Administration
ODI	Overseas Development Institute
PVP	Plant Variety Protection
QDS	Quality Declared Seed
SEADD	South East Asia Development Division
WTO	World Trade Organisation

Alternatives for Seed Regulatory Reform: An Analysis of Variety Testing, Variety Regulation and Seed Quality Control

Robert Tripp, Niels Louwaars, W. Joost van der Burg, D.S. Virk,
and J.R. Witcombe

1 Introduction

National seed systems in developing countries are undergoing significant change. The role of the public sector is being re-examined, and what were once virtual public monopolies in plant breeding, seed production and seed marketing are now being challenged by a range of commercial and voluntary alternatives. These changes are necessitating serious reconsideration of seed policy and national seed regulatory frameworks. This paper summarises the conclusions of a comprehensive study of national seed regulatory frameworks and presents an analysis of options for seed regulatory reform.

The project has been managed by the Overseas Development Institute (ODI) and the Centre for Arid Zone Studies (CAZS), University of Wales, Bangor. The project was funded by the UK Overseas Development Administration (ODA) Natural Resources Policy Research Programme. Additional funding for a study in Nepal was provided by ODA's Southeast Asia Development Division (SEADD). The project has included the following components:

- A literature review on the conduct of national seed regulation (Tripp, 1995).
- A first phase study in India that included an in-depth examination of seed regulation in three states (Gujarat, Madhya Pradesh and Rajasthan) and an exceptionally thorough analysis of plant breeding data at the national level (Virk, Packwood and Witcombe, 1996; ICAR, forthcoming).
- A study of seed regulation in Nepal (Joshi, 1995; Rajbhandary, 1994; Sthapit, 1995).
- A series of case studies in five additional countries (Bolivia, Kenya, Zimbabwe, Pakistan, and the Philippines). The case studies were managed by local consultants and addressed issues in the management of plant breeding, variety release, and seed quality control.
- A workshop, held in London in May 1996, during which 35 experts on various aspects of seed regulation reviewed the tentative conclusions of the project and discussed the advantages and disadvantages of a series of regulatory options.
- A summary of the status of national seed regulation and a presentation of strategies for seed regulatory reform (Tripp, forthcoming). Much of the material for this Network Paper has been abstracted from this source.

This paper is organised as follows. The next section presents a brief description of the most relevant characteristics of change in national seed systems and

the implications for regulation. This is followed by a summary of the problems with current seed regulatory frameworks. A brief analysis of the nature of regulation and regulatory reform is then presented. The major part of the paper examines options for seed regulatory reform and the final section presents conclusions relevant to the management of national seed policy.

2 Changes in national seed systems

The elements of national seed systems

The three elements of national seed systems that are most relevant to an analysis of seed regulation are plant breeding, seed production, and seed distribution.

Plant breeding

In most developing countries plant breeding has traditionally been in the hands of government agricultural research institutes. These institutes usually have established commodity research programmes for the country's most important food and industrial crops. Often they are also members of international networks of germplasm exchange and variety testing, most notably those managed by the international agricultural research centres that are included in the Consultative Group on International Agricultural Research (CGIAR).

National agricultural research institutes have experienced variable success in breeding new crop varieties. The varieties of rice and wheat that ushered in the Green Revolution are a product of this system, and there are a number of success stories for other crops as well. However, such institutes have received considerable criticism for paying insufficient attention to the crops and conditions of farmers in more marginal areas. The efficiency of public plant breeding for more favoured areas is also being questioned as policy-makers debate the appropriate level of support for agricultural research in an era of declining public budgets.

At the same time, there is increasing pressure from commercial plant breeding establishments for greater access to developing country markets. Many countries allow seed import for crops such as vegetables and certain cash crops, but policies have often restricted private sector plant breeding for major food crops. This is, though, beginning to change; a number of countries are now beginning to permit both

multinational seed companies and local enterprises to offer their varieties for sale. However, the establishment of local plant breeding capacity requires a considerable investment, and only countries that have a strong tradition of plant breeding and large markets are likely to offer immediate opportunities for domestic plant breeding enterprises. The high investment requirements also mean that commercial plant breeding will concentrate primarily on crop varieties for which there is strong and continual demand; the principal example is hybrid varieties whose seed must be purchased each season.

Of equal interest are the growing number of endeavours that attempt to develop community-level capacity for varietal selection and aim to promote the increased use and enhancement of local crop varieties and landraces. Some of these projects are motivated by the perception that local varietal improvement will be more likely to address the needs of resource-poor farmers than will the efforts of conventional plant breeding. There are also many efforts to explore more active collaboration between farmers and public agricultural scientists in participatory plant breeding.

Seed production

Until recently seed production too has been controlled by the public sector in most developing countries. In many cases large, parastatal seed companies have been established to produce seed of plant varieties developed by public research institutes. But the majority of public seed companies are not efficient and many are being closed, sold off, or restructured in an effort to make them more competitive.

Overall, it is very difficult to defend a public sector monopoly in seed production, and many countries have altered their policies to allow for more participation from private seed enterprises. Economies of scale are not as evident in seed production as in many other industries, and there are possibilities for a range of different seed operations to coexist. Small, local companies can serve particular niches, for instance. Such companies may not have their own breeding capacity, but can produce seed of varieties developed by the public sector. In many countries, multinational seed companies are also beginning to offer their own varieties for sale.

Local level seed production projects have also proliferated over the past decade, the majority being initiated by voluntary agencies (Cromwell *et al.*, 1993). Some of these have focused on increasing the availability of seed of public varieties by establishing local seed multiplication capacity. Others have attempted to develop sustainable small-scale seed production enterprises to address local needs.

Seed distribution

In many developing countries, seed distribution and

sale has been managed by parastatal seed companies, their agents (such as cooperatives or farmers' unions), or public input distribution enterprises. A great deal of seed has also been distributed through public extension systems and rural development programmes. This situation is, however, changing rapidly, as more responsibility for seed distribution is left to private merchants. There are also cases of cooperatives becoming directly involved in seed production and sale to their members and other farmers.

Changes in the nature of seed regulation

The precise nature of the changes in national seed systems varies from country to country. However, the general decline in support for public sector plant breeding, and particularly for public seed production and distribution, coupled with the rise of commercial and voluntary alternatives in many countries, imply the need for a careful examination of the adequacy of current seed regulatory frameworks.

As long as national seed systems are dominated by the public sector, seed regulation is fairly straightforward. Figure 1 summarises the seed regulatory responsibilities that until recently were common to most developing countries. In this scenario, plant breeding is the exclusive domain of the government research institutes, the priorities of which reflect national agricultural policies. The plant breeding procedures of these institutes are designed to move breeding materials through a well-ordered progression of trials; selection is based primarily on yield performance and approval criteria are established by the institutes themselves. The release of new varieties is in the hands of a committee of public sector scientists and other agricultural officials.

When a variety is released, seed production becomes the responsibility of a public seed enterprise. The public seed certification service is usually in charge of monitoring seed production and regulating seed quality during production and at the point of sale.

The last step in figure 1 represents the delivery of seed to farmers. The assumption has often been that farmers are progressing along a 'modernising' path that sees them using recommended production practices and participating in uniform markets; this in turn justifies plant breeders producing an increasingly homogeneous product. Plant breeding strategies therefore tend to be based on breeding for wide adaptability and selecting materials under favourable crop management conditions.

Although figure 1 necessarily simplifies the regulation of national seed systems dominated by public sector organisations, it fairly represents the relative lack of complexity that has characterised seed

regulation management until recently. A similarly simplified outline of current regulatory challenges is presented in figure 2. The increased complexity is evident.

Public sector plant breeders are under increasing pressure to define their targets and demonstrate impact. In addition, the public sector must think more carefully about its division of labour with both commercial plant breeding and community level efforts. These factors necessitate reconsideration of the management of public plant breeding. If the plant breeding process is to be reorganised, procedures for variety regulation must also be reconsidered. Variety release is no longer an internal question for public sector research; plant breeding that complements or competes with the public sector system requires equitable variety approval procedures. Growing recognition of the diversity of farmers' needs calls into question the validity of standard performance testing as a prerequisite for variety approval. Current testing procedures rely too heavily on narrow yield criteria and often eliminate varieties that would be useful for farmers.

In addition, seed regulatory systems must come to terms with the demands for plant variety protection (PVP). The recently concluded GATT negotiations require countries which join the World Trade Organisation (WTO) to provide some type of

intellectual property protection for crop varieties. This is an important issue which has commanded considerable space in the popular press. The following discussion of seed regulatory reform includes an examination of the debate, but also attempts to place it in proper context. This analysis is based on the belief that countries will not be able to develop a coherent response to the challenge of PVP until they address the more conventional seed regulatory issues that are the focus of this study. In addition, the reform of current seed regulations can have an immediate impact on farmers' access to an expanded range of crop varieties and seed, while PVP will initially affect only the most commercial elements of national seed systems. Thus, while acknowledging the importance of the PVP debate, our discussion urges attention to some of the more neglected, but crucially important, aspects of seed regulatory frameworks.

A further aspect of regulation is quality control within seed production, which itself is becoming even more complex as the number of production options increases. In most countries, government certification services are already stretched beyond their capacity. A solution must therefore be sought that reconciles declining public budgets with the growth and decentralisation of seed production. Opportunities for expanding the range of seed production and distribution channels must be supported by innovative

Figure 1. The past scenario: The regulation of public seed production

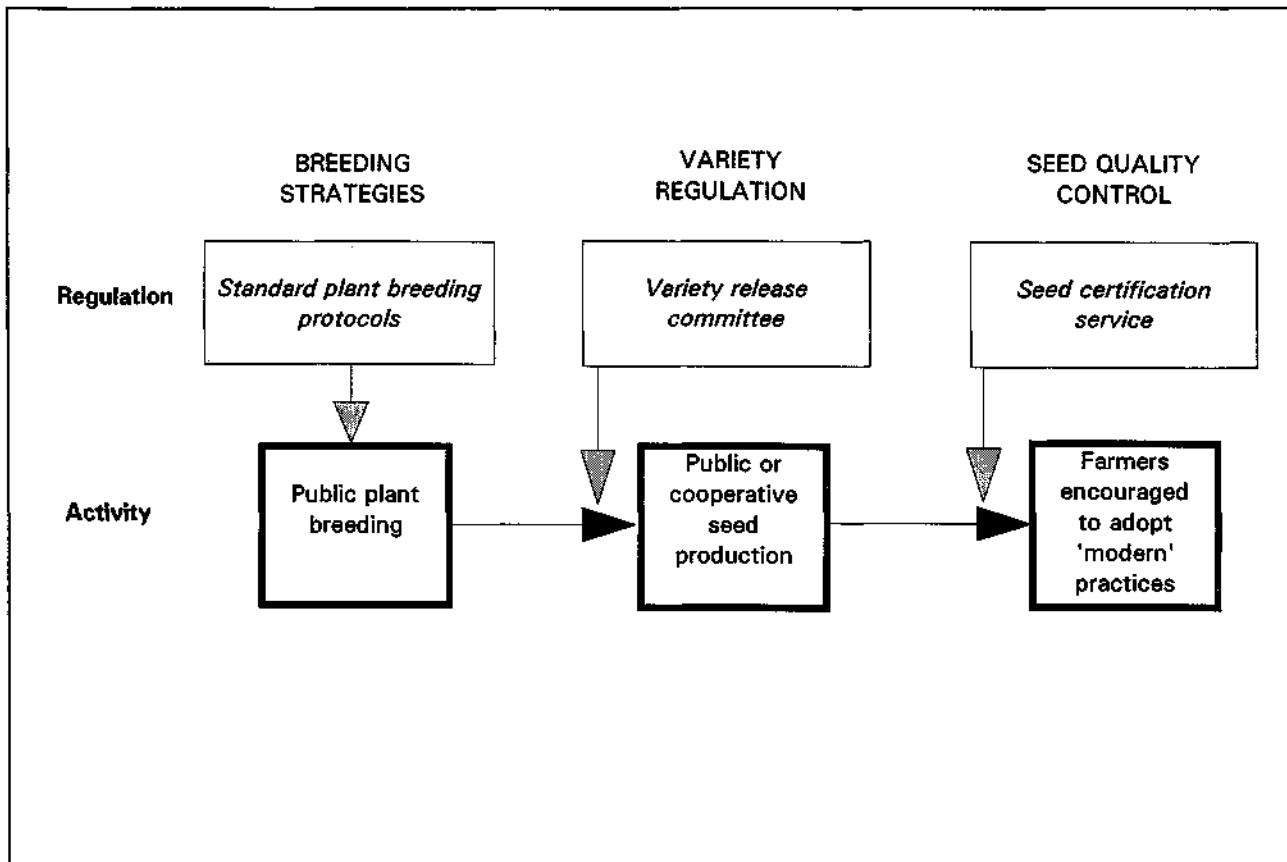
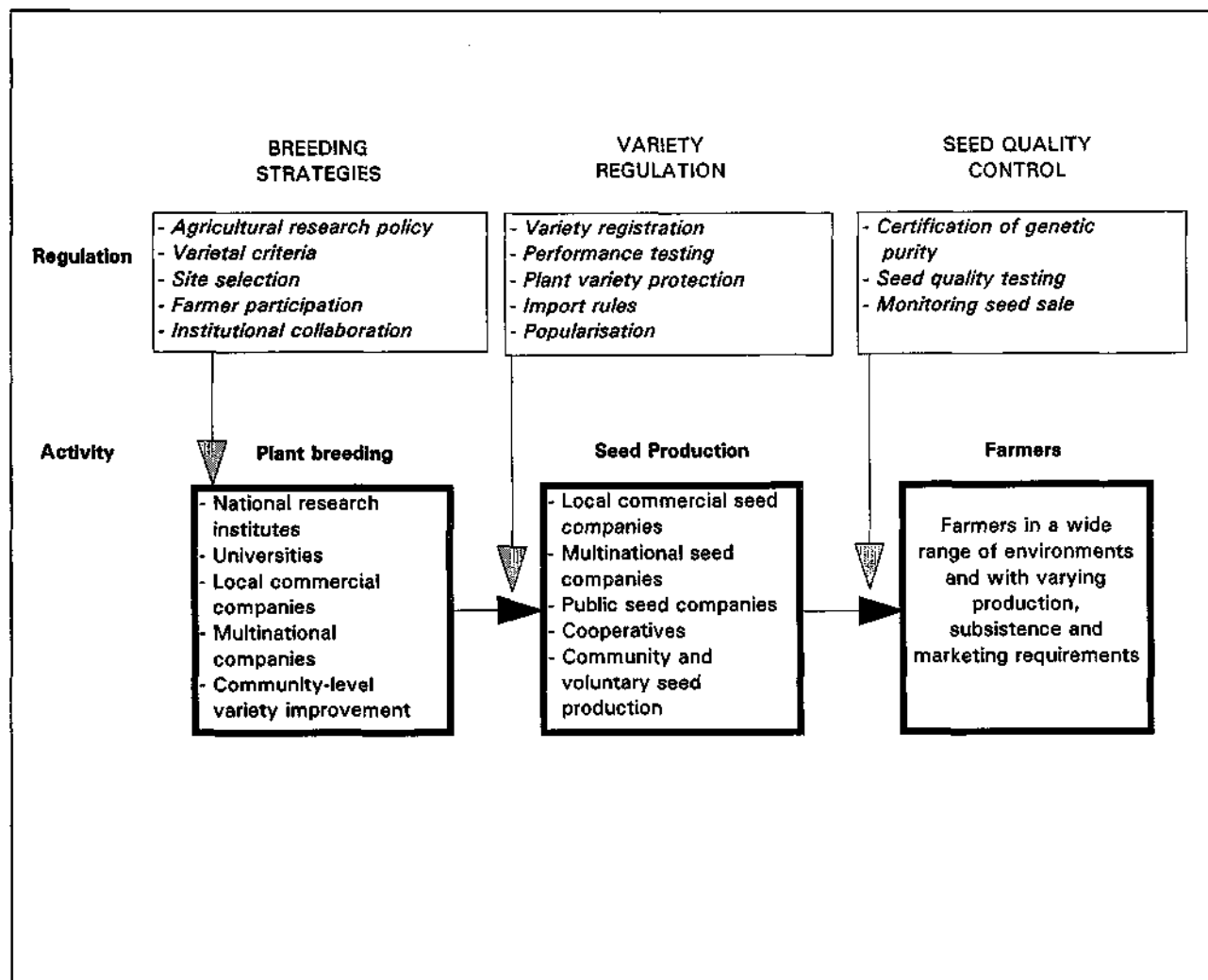


Figure 2. The current scenario: The regulation of national seed systems



mechanisms for seed quality control that ensure adequate standards without jeopardising prospects for diversification.

In summary, seed regulatory reform addresses the questions of how public sector plant breeding is to be organised, how new crop varieties are to be approved for use, and how seed quality is to be controlled. These are crucial issues for all national seed systems. Before looking at some of the options available for regulatory reform, we review the principal problems that affect the ability of current regulatory frameworks to address these challenges.

3 Problems with current seed regulatory frameworks

For ease of analysis, we have divided seed regulatory frameworks into three areas: (i) the organisation of public plant breeding; (ii) the management of crop variety regulation; and (iii) the management of seed quality control. This section will briefly introduce each of these areas and summarise the problems with current regulatory structures. Following a brief review

of the nature of regulation and regulatory reform (Section 4), we shall return to each of the areas in turn to examine concrete possibilities for regulatory reform (Section 5).

Public plant breeding

Public plant breeding policies require urgent attention. The resources available for investment in public agricultural research in most countries are stagnant or declining. This makes it critical that public research institutes improve their capacity to identify their targets and demonstrate impact. They must also define their role vis-a-vis commercial agricultural research, specifying comparative advantages and identifying complementarities. In addition, they must increase their capacity to collaborate with community level operations involved in variety selection and *in-situ* germplasm conservation.

The aspect of public plant breeding policy that most affects the conduct of seed regulation is the management of variety testing systems; this is the focus of the following discussion.

The organisation of variety testing

All plant breeding organisations feature a system of multilocational trials arranged in stages. These progress from the identification of promising early-generation materials, to the development of advanced-generation products that are tested under standard conditions, to the final identification of varieties that are proposed for official release. The organisation of this variety testing system is strongly influenced by the official requirements for variety release. Although the organisation of public plant breeding programmes is not strictly part of the seed regulatory system, the interactions between breeding strategies and variety regulation are so strong that the former must be included in any analysis of seed regulatory reform.

The organisation of variety testing varies by country. In some countries a single agricultural research institute is charged with coordinating variety testing for major crops. Where there are several plant breeding entities, there is often a coordinated variety testing system. In India, for instance, plant breeding is carried out by a network of research institutes under the Indian Council of Agricultural Research (ICAR) and by state agricultural universities. Variety testing for major crops is conducted by ICAR through a series of All-India Coordinated Crop Improvement Programmes (AICCIPs) that manage a nationwide testing scheme. State level variety testing is also done under the management of the state agricultural universities.

Problems with the management of public variety testing

Box 1 summarises the major problems - related to efficiency, the use of improper standards, inadequate participation, and lack of transparency - that have been identified with public variety testing systems. This section provides further explanations.

- *Frequency of variety replacement.* The frequency with which farmers replace older public varieties with newer ones is a measure of the success of plant breeding and varietal testing systems. When farmers continue to use older varieties, there are three possible explanations: (i) public plant breeding and variety testing are not producing superior, new varieties; (ii) the variety release regulations inhibit farmers' access to new varieties; or (iii) there is inadequate popularisation of new varieties by seed producers and extension services.

One method of quantifying the rate of varietal replacement is to calculate the average age of varieties currently in use, weighted by the area sown to each variety (Brennan and Byerlee, 1991). Virk *et al.* (1996) used Indian data on breeder seed indents (the quantities of breeder seed of each variety requested by all seed companies from the national research system) and state level data on certified seed production to calculate the average

Box 1. Problems with the management of variety testing

Efficiency

Low frequency of variety replacement. Analysis of variety use in many countries shows that the turnover rate of modern varieties is quite low, indicating problems with the variety testing system, variety release, or popularisation.

Uneven resource allocation to different trial stages. A large proportion of the varieties submitted for testing do not survive the early stages, but there is rarely an increase in plot size or number of testing sites to balance the decreased number of varieties in later stages.

Prolonged variety testing. Varieties can be kept in the various stages of the testing process for six years or longer.

Inappropriate site selection. Sites for variety testing are often chosen for convenience of access rather than representativeness of the major growing environments of the crop.

Inappropriate zoning. There is insufficient attention given to targeting variety testing for different environments.

Standards

Unrepresentative trial management. The levels of trial management (such as fertiliser application) are often much higher than average farmer levels. Unwarranted assumptions are made about the capacity of farmers to use higher levels of external inputs.

Trial analysis biased against poor environments. Trial sites with low or variable yields are likely to be eliminated from the overall analysis.

Lack of attention to farmer-relevant variety traits. Many varietal characteristics that are important to farmers, such as fodder yield, earliness, and marketability, are often overlooked in variety testing systems.

Participation

Lack of participation from related organisations. There is little opportunity for a wider range of agricultural research and extension organisations to participate in the design or interpretation of the trial system. Private commercial breeders usually have little voice, even when their varieties must be tested before official release.

Lack of farmer participation. There are few mechanisms through which farmers can participate in establishing priorities or expressing preferences in the standard variety testing system.

Transparency

Lack of coordination between national and regional testing systems. In countries with both national and regional testing systems there is often poor coordination between the two levels and inadequate exchange of information between regional authorities.

Lack of accountability and linkages. Variety testing tends to be tightly controlled by commodity programmes and there is insufficient accountability to other parts of the research and extension system.

age of varieties for a number of important crops (wheat, pearl millet, groundnut, sorghum, rice, chickpea, and maize). In the majority of cases the average age of varieties in use is more than 10 years. This is higher than would be expected if variety testing, release and popularisation were functioning efficiently.

- *Uneven resource allocation across trial stages.* In multi-stage variety trials, the most efficient results can be obtained by devoting equal resources to each stage of testing (Finney, 1958; Curnow, 1961). This strategy requires that a constant proportion of entries are promoted at each trial stage and that the declining number of survivors is balanced by increasing the intensity of assessment (ie. increasing the plot size and/or replications devoted to each remaining variety). A review of the organisation of variety testing for the project's case study countries revealed that this ideal is rarely achieved. In particular, it was found that there is often a very rapid decline in the number of lines being examined in early trial stages, and that this is generally not compensated by a proportionate increase in the number and size of trial sites in later stages.
 - *Prolonged variety testing.* It may take more than 10 years to develop varieties that are approved to enter the testing system. It is obviously, therefore, important that as much time as possible be saved during actual testing. In many countries, however, a variety may be tested for six years or more before it is proposed for release.
 - *Site selection.* Variety testing should be conducted in environments that represent the major conditions for a crop's cultivation. However, this is achieved less often than might be expected. Trial site selection is often based on administrative criteria, or is constrained by low budgets or lack of personnel. These limitations, combined with the fact that the total number of test sites is often inadequate, result in trial data which are of little relevance for agroecological targeting.
 - *Environments and zones.* There is also the concern that the strategy of breeding for wide adaptation does not adequately address the needs of farmers in more marginal environments. It is true that breeding for wide adaptation has been exceptionally successful in many cases, and is one of the foundations of the Green Revolution. However, the practice of selecting varieties on the basis of mean performance across locations results in varieties that yield more than average in low-yielding environments, but are not necessarily the *best* varieties for those environments. In such cases there is growing evidence that variety selection is more effective if it is carried out directly in the targeted environments (Simmonds, 1991; Ceccarelli *et al.*, 1994).
 - *Trial management.* Not only are trial sites often unrepresentative of important environments, but trial management may be very different from the management practices of the target farmers. This is a result of two factors. First, plant breeders prefer to select varieties under good (and uniform) management conditions, so trial sites usually feature excellent weed control, high levels of chemical fertiliser, and often the application of other chemical inputs. Second, many breeders make the assumption that farmers' crop management practices will become more intense, both in response to extension programmes and to the attraction of growing new varieties as part of a productive package of practices.
- These assumptions are often unwarranted. The result is that varieties are selected under management conditions that are completely unrepresentative of average farmer practice. Although exact comparisons between trial site and average farmer management may be hampered by a lack of information on typical farmer practice, one indication of the bias is provided by examining differences between trial mean yields and average yields in farmers' fields. In an analysis done on Indian data (Virk *et al.*, 1996), comparisons of trial yields with farm yields in the same districts showed significant differences. The difference between the mean yields of AICCIP pearl millet trials and those of farmers in the districts in which the trials were located was 257%; for sorghum the difference was 272%. Much of this difference can be attributed to the higher levels of fertiliser applied to the trial sites.
- *Trial analysis.* Another problem with conventional variety testing is the fact that methods of trial analysis contribute to additional bias against results from marginal environments. In many cases, trial sites with low or variable yield results are eliminated from the analysis. In addition, there is often excessive reliance on the use of the coefficient of error variation (CV) as a measure of trial efficiency. Trials that exceed a pre-set level are rejected as unsatisfactory, without any regard to the significance of differences among trial entries. Sites in marginal environments tend to produce high CVs, because yields are low, and thus data from these sites are likely to be excluded from the cross-site analysis.
 - *Assessing farmer-relevant traits.* In promoting a variety from one trial stage to the next, overwhelming attention is given to yield performance, while other traits of economic importance to farmers take second place. In most cases, varieties with significantly superior disease or pest resistance, earliness, or improved fodder yield or grain quality are not promoted or released unless they also have a higher yield. Often these traits are not even measured during the trials, and the assessment of traits, such as cooking quality, taste, market acceptability, and storability, may not be conducted until the variety has been released. This means that many new varieties simply do not meet farmers' requirements. Such varieties exhibit low adoption rates and represent a waste of plant breeding resources.

- *Participation from related organisations.* Most national variety testing programmes are managed by public plant breeding institutes, and the level of participation from other research and extension organisations is often very low. Extension and rural development agencies rarely participate in trial site selection or in the review of trial results. In cases where commercial plant breeders must submit their varieties to the testing process, they rarely have a voice in the management or interpretation of the trials.
- *Farmer participation.* There is a complete absence of farmer participation in the planning of variety testing in most countries, and farmer input and management is usually not an element of early trial stages. In some countries trials in farmers' fields are part of the latter stages of the variety testing process but the nature and extent of farmer involvement in these researcher-managed trials is not well defined. Most often, farmers are only included in on-farm trials at the pre-release or release stage, when it is considered useful to expose them to new varieties in order to promote adoption. This lack of farmer participation is one of the most serious deficiencies in the variety testing process and helps explain why many varieties are poorly targeted and remain unadopted.
- *Regional versus national testing systems.* In some larger countries, such as India or Pakistan, both national and regional level variety testing systems are in place. These supposedly help to cater to both the concerns of wide adaptation and the requirements of regional specificity, but there are often conflicts in the management of the system. In India, the central (national) variety release committee must be notified of any state-released varieties in order for these to qualify for certification. But state variety releases are dominated by materials bred by the local universities, and national and out-of-state releases are rarely, if ever, considered. This means that many excellent varieties are never tested beyond the boundaries of the state in which they were bred (Joshi and Witcombe, 1995). The economic implications of this failure to share data are exceptional. One analysis examined the case of an upland rice variety that was released and widely adopted in the Indian state of Orissa but was not considered by other state testing authorities, despite evidence of farmer demand. Failure to test and promote the variety in similar environments is estimated to be responsible for losses in potential production equivalent to almost £200 million over the estimated life of the variety (Balogun, 1996).
- *Accountability and linkages.* Accountability is not a prominent feature of public sector variety testing systems. Trial systems are established and maintained with little consideration for improving

their efficiency. For instance, even if trials conducted at a particular site have been consistently unsatisfactory over a number of years the site often continues to be included in the trial system. The inclusion of other disciplines, such as socio-economics and biometrics, is rarely considered, although this could stimulate positive changes in the varietal testing system.

Variety regulation

The organisation of variety regulation

Decisions that are made regarding the regulation of new crop varieties play an important role in determining the incentives for public and private plant breeders and hence the range and types of varieties that are available to farmers. There are three procedures that need to be distinguished when examining variety regulation: registration, performance testing, and release.

- *Variety registration* involves recording sufficient morphological and agronomic data about a variety so that it can be identified and distinguished from other varieties. Variety registration helps limit possible confusion in nomenclature and is also used for seed certification. In addition, extensive variety registration data form part of any system of PVP.
- *Performance testing* of new varieties is done to ensure that they meet certain standards and that they compare favourably with varieties that are already available. In many developing countries performance testing is the final stage of the variety testing sequence described in the previous section. The results of variety testing may simply be used to provide recommendations to farmers and to seed producers, but in many cases they form part of the variety release decision.
- *Variety release* is an official authorisation that allows seed of a particular variety to be sold or otherwise made available. The release decision is based on registration and/or performance testing. The management of variety regulation varies considerably, but in most developing countries public sector varieties, and often private varieties as well, must pass through an official release process that includes performance testing. Release decisions are usually made by a committee composed of agricultural officials, rather than any farmers or representatives of the private sector.

Problems with variety regulation

Box 2 presents a summary of the major problems with the management of variety regulation, once again divided into the categories of efficiency, standards, participation, and transparency.

- *Delays.* The variety registration and testing process

Box 2. Problems with the management of variety regulation

Efficiency

Delays. The testing process for variety approval is often excessively long. In addition, meetings of release committees may not be organised in a timely manner. Overcoming such delays could place new varieties in farmers' hands several years earlier.

Costs. An extensive performance testing system is expensive to maintain and plant breeding organisations (public or private) will have to bear the cost. Registration requirements, especially those related to the establishment of PVP, are also becoming more sophisticated and thus more costly.

Popularisation. Public sector variety release systems are not efficiently linked to extension and seed production. Extension agents and seed producers may have inadequate information about new varieties, and farmers often have little opportunity to learn about the varieties that have been released.

Standards

Standards for variety registration. The move towards more precise characterisation of varieties means that an increasing proportion of time will be spent on establishing varietal distinctness, rather than on selecting for useful properties. In addition, demands for greater varietal uniformity may threaten attempts to enhance the useful heterogeneity of varieties, especially for farmers in more marginal environments.

Standards for performance testing. The performance standards for variety release are biased toward broad adaptation and rarely acknowledge the characteristics and growing conditions important to resource-poor farmers. Rigidities in official performance testing also limit the release of relevant varieties by private breeders.

Sharing data. There is insufficient attention given to using data from other countries or regions to speed up the release of imported varieties.

Participation

Variety release authorities are subject to professional and political bias. In addition, they rarely allow for any meaningful representation of private sector plant breeders, NGOs or farmers.

Transparency

National policy on seed companies and imports. Protectionist policies often limit the participation of foreign institutions, and sometimes of domestic private plant breeders, in variety development.

Uneven application of regulations. Variety release procedures for minor crops are often poorly defined and the resulting uncertainty is a disincentive to variety development. The mandate and legal status of variety release authorities is sometimes in doubt.

is often the cause of considerable delay in variety release. Delays can be the result of both lengthy field testing requirements and infrequent meetings by release authorities. The costs of delaying farmers' access to productive and useful varieties may overwhelm any contributions that the variety release process makes to safeguarding farmers from inappropriate varieties.

- **Costs.** Registration and performance testing incur

significant costs, and it is not clear how these will be met in the future, especially when more privately developed varieties become available. Inadequate funding arrangements combined with comprehensive mandatory testing present serious disincentives to the development of independent plant breeding capacity.

- **Popularisation.** Variety release authorities usually consider their task completed when a variety has been approved. Information about new varieties is provided to extension services and public seed enterprises, but neither may have adequate incentives to promote the new variety or to organise seed production. Where commercial seed companies operate they often have difficulty learning about the existence of newly released varieties, especially in countries with large and complex public plant breeding systems, such as India. Extension agencies often wait until seed of a new variety is available before they promote it, while seed companies wait until there is evidence of demand before initiating seed production. The principal loser in this vicious cycle is the farmer who is denied access to new varieties because the release system does not include adequate information dissemination.

- **Standards for variety registration.** Registration standards vary but there are increasing pressures to require extensive morphological characterisation of new varieties. If varieties must be registered before their seed is sold, and if registration requires evidence of high uniformity, this may interfere with plant breeding strategies that focus on varietal mixtures or other heterogeneous materials that provide adaptation and resilience in variable growing conditions.

Much of the pressure for more sophisticated standards for varietal characterisation comes from the requirements of PVP, which demands exceptionally precise characterisation. The establishment of standards for variety registration must, though, be able to distinguish between the strict requirements of PVP systems for commercial purposes and the value of a more agile approval system that stimulates variety development and promotes genetic diversity. It will be a tragedy if PVP is allowed to dominate national seed regulation. Amongst other things this may threaten the basis for collaboration between public sector plant breeding and local level variety development.

- **Standards for performance testing.** The discussion of public variety testing emphasised that this is rarely conducted using the conditions or criteria which are of importance to many farmers. Variety release decisions based on performance testing suffer the same deficiencies. National level performance tests and insistence on wide adaptability make it difficult for location-specific

varieties to be approved. Joshi (1995), for instance, describes an early maturing rice variety in Nepal that proved popular with farmers who used it as a rotation crop with vegetables but whose low yield (related to its early maturity) made it ineligible for official release. The evolving and heterogeneous nature of farming conditions argues against the use of rigid or narrow standards for performance tests and suggests that a more open and participatory system for variety approval is needed.

- *Sharing data for variety release.* Industrialised countries that have established mandatory variety registration and performance testing systems have found it increasingly effective to share responsibilities between them for carrying out tests. In the European Union (EU), for example, there is a Common Catalogue that lists varieties approved in member countries which require no further testing to be sold throughout the EU. In addition, data required for release decisions may be provided by the plant breeders themselves, or by independent agencies. Such mechanisms for data sharing are not in evidence in developing countries, and varieties approved in a neighbouring country must usually go through the entire registration and testing process again if they are to be made available elsewhere. In countries with sub-national release systems, such as India, varieties released in one state must be submitted to other states' release procedures before they are approved. This discourages the movement of new varieties between states.
- *Composition of the variety release authority.* Variety release authorities are subject to the ill effects of professional biases and jealousies, interpersonal rivalries, and ideologically-motivated positions. In addition the diversity of national seed systems is not evident in variety release committees - most of whose members are drawn from the public sector - even where private-sector varieties must be officially released. Voluntary agencies or other community level groups are rarely represented, and farmer participation is often limited to a token 'progressive farmer' or assumed to be satisfied by the presence of an extension official. There are exceptions to these generalisations, but in almost all cases variety release authorities need to be broadened to become more representative of the diverse needs of the farming population and the interests of seed enterprises and independent plant breeders.
- *National policy on seed companies, imports and exports.* Variety regulation is often related to policies on seed enterprise development. Policies may protect public sector plant breeding or seed production organisations and may limit or restrict the development of local plant breeding capacity. The rationale that is often given is protection from

dependence on private or foreign sources of seed, but the restrictions often severely limit the choice of varieties that are available to farmers. Even when official pronouncements may seem to encourage diversification of the national seed system, subtle policy or regulatory mechanisms may be used to discourage competition with public sector variety breeding and seed production. Public sector seed may benefit from subsidies, for instance, or restrictions may be imposed on the operations of foreign seed companies.

- *Uneven application of regulations.* Variety regulation is often not as transparent as it should be. Although variety release procedures may be defined for major crops, that may not be the case for other more minor crops. This acts as a disincentive to invest in the breeding of new varieties. In addition, the legal status of variety release authorities is often questionable, leading to uncertainties about the basis and enforceability of their decisions.

Seed quality control

The organisation of seed quality control

Seed quality control has two separate elements. The first is the verification of genetic quality, which provides an assurance that the seed is of the specified variety and is of sufficient genetic purity. This procedure represents the narrow meaning of the term 'seed certification'. It is the responsibility of a certification agency. The second element of seed quality control relates to assessing physical characteristics, such as analytical purity and germination capacity. This is usually done by a seed testing laboratory. The results of the tests are then considered by the certification agency when making its decision whether to issue a certification label. Seed quality control may also include attention to storage and marketing conditions; certification agencies often take responsibility for inspecting retail outlets, sampling seed offered for sale, and licensing seed merchants.

Seed that is certified by public agencies meets a defined standard of genetic purity and usually meets several physical quality standards as well. A principal alternative to certified seed is 'truthfully labelled' seed. Such seed is not officially inspected, but the seed producer is responsible for certain aspects of its genetic and physical quality, which must be described on the label.

In most developing countries, seed produced by state enterprises is usually required to be certified, although in certain cases the public company may be allowed to market a second class of seed that has not been through the entire certification process. The rules for private seed certification vary. In some countries

(such as India) privately produced seed may be sold as truthfully labelled. In other countries all seed from the private sector must be certified. In developing countries, certification is almost universally in the hands of government certification agencies. In the EU both public and private agencies are involved in seed certification for field crops. In the USA, by contrast, seed certification is voluntary and is managed by private agencies.

Problems with the management of seed quality control

Box 3 summarises the major problems of seed quality control.

- **Delays.** If certification is to take place, seed production fields must be inspected at specific stages of the growing season. If the fields are widely dispersed this will imply an investment of considerable time and resources. Similarly, inspections done at harvest time or immediately post-harvest in the laboratory require a significant concentration of trained labour. Inability to mobilise these resources can lead to delays and serious losses as seed that is not inspected cannot be marketed.
- **Costs.** Multiple visits by certification agency staff to seed production plots and laboratory tests on large numbers of samples incur significant costs. The question of how to finance and support a certification service must therefore be addressed when considering realistic regulatory reform. In many developing countries seed certification is provided at little or no cost to the seed producer. However, government budgets are usually unable to support more than a minimal operation and they cannot cope with the prospect of expanded seed production from the private sector. Even where certification services are self-sustaining they are usually unable to finance needed improvements in equipment and staff training. The financing of seed certification is therefore a major challenge. If private seed enterprises must pay for mandatory government seed certification they will demand that the service provided is worth the investment.
- **Standards.** Standards for seed certification should be based on an assessment of the farming conditions under which the seed will be used and the technical capacities of seed production and inspection. If standards are set too high, as they are in some countries, they will discourage seed production and add unnecessarily to the cost of the seed. This in turn can result in large amounts of rejected and unsold seed. Standards that are set too low are equally problematic. A number of public seed companies (e.g. in Pakistan and Nepal) sell large amounts of seed that is not certified. If this seed is acceptable to farmers, it may be argued that

certification standards are too high. If, on the other hand, these arrangements lead to the provision of low quality seed, farmers will suffer and they may be discouraged from using this source of seed again.

- **Commercial participation.** Private seed companies are unlikely to be invited to participate in the definition of seed certification standards in most developing countries. There is also little evidence that public seed policy is encouraging the development of independent seed certification or seed testing capacity.
- **Interactions with local level seed production.** In countries throughout the world there are a growing number of local level seed production activities, often initiated by voluntary agencies. Their

Box 3. Problems with the management of seed quality control

Efficiency

Delays. Seed certification requires field inspections and tests at appropriate times. If agency staff cannot be efficiently mobilised, seed certification will be delayed and seed may reach the market late, or not at all.

Costs. Seed certification activities generate a very seasonal demand for technical staff. The costs of multiple field inspections, especially of dispersed sites, are considerable and the costs of laboratory testing are also rising.

Standards

Excessively strict management of certification standards is sometimes responsible for keeping appropriate seed from the market. On the other hand, public seed companies often sell seed that is of a class below the established certification norms, or is produced in response to government requests that suspend certification standards. These practices call into question the relevance of current standards.

Participation

Commercial seed sector. When seed certification is mandatory, commercial enterprises rarely have the opportunity to participate in defining the management practices or standards that are used. There are few countries in which private certification or seed testing is allowed.

Local level seed projects. There are few instances in which certification agencies are able to provide appropriate services or advice to local level seed production projects. Certification requirements at times discourage such projects.

Transparency

Rent-seeking and collusion. Mandatory certification schemes provide opportunities for rent-seeking, the exercise of political or economic influence, and possibilities for collusion among public sector entities.

Uneven management. Seed producers may find themselves subject to varying interpretations of certification rules. The breadth of certification agency authority may not be clearly defined.

Inadequate enforcement at point of sale. Insufficient resources are available for monitoring seed quality at point of sale, contributing to farmer uncertainty regarding the nature and purpose of seed certification.

experience with government seed certification agencies is mixed. In some cases the certification agency provides technical training and support and offers flexibility in terms of seed quality standards. More commonly, though, the certification agency has no interaction with local seed production projects, even though the latter would often welcome their advice and input. Uncertainties over potential certification agency response may discourage local level activity.

- *Rent-seeking and collusion.* When seed certification is mandatory, there are three principal opportunities for corruption. The first is the temptation for inspectors to demand payment or favours from seed producers or merchants for the approval of a seed lot. The second opportunity is for politically or economically powerful seed producers to influence the decision of inspectors to pass seed that is below standard. Finally, where a government regulatory agency is charged with inspecting seed production of a government company, the incentives for maintaining standards may be low.
- *Uneven application of the certification system.* Certification standards may allow room for individual interpretation, and it is not uncommon to hear that two inspectors have made different decisions (perhaps due to differences in training or experience). There is also the problem of defining the coverage of a certification agency. In some countries with an emerging private seed sector official certification agency jurisdiction may be poorly prescribed.
- *Quality control at the point of sale.* The majority of resources for seed certification and seed testing are invested in monitoring and supervising seed production and immediate post-harvest conditions. Relatively little attention is directed towards storage and marketing, even though these may be the source of many of the seed quality problems faced by farmers who use purchased seed. Monitoring seed at the point of sale requires frequent visits and sampling at widely dispersed locations and regulatory agency budgets can rarely afford to institute such a system.

Summary: The need for regulatory reform

Seed regulatory frameworks need to be reformed in order to better address the conditions of rapidly changing national seed systems. The preceding discussion has identified problems in four general areas:

- *Efficiency.* Most variety testing, variety regulation and seed certification is managed by government organisations that operate with low, and often declining, budgets. There are many delays in the regulatory process, and the current financial

structure of regulatory organisations will not be able to cope with future demand. In addition, there is little evidence of plant breeding or variety testing being targeted to farmers in less favoured environments, and once varieties are released they are not actively promoted or popularised.

- *Standards.* Variety testing does not take account of the conditions and priorities of many farmers. The standards of uniformity and performance that are prerequisites for variety release are often inappropriate for resource-poor farmers, and the standards for seed quality are not set in reference to the realities of typical farmer management conditions.
- *Participation.* There is little participation from other public agricultural agencies, such as extension, in the conduct of variety development or testing. Private (commercial and voluntary) enterprises that are involved in plant breeding and seed production have little voice in the management or direction of seed regulation. Farmers have almost no opportunity to participate in plant breeding, the testing and selection of varieties, or the definition of seed quality standards.
- *Transparency.* The management of the variety testing process is rarely open for review. The requirements for the development and release of new varieties are often not clear, which acts as a disincentive to plant breeding. Tight government control of seed certification leads to opportunities for rent seeking and there is uneven enforcement of seed quality standards, particularly at the point of sale.

4 Regulatory reform

The nature of regulation

Before considering the options for seed regulatory reform, to address the problems identified in section 3, it will be useful to review the characteristics of regulation. Despite the prevalence of complaints about regulatory systems, it is surprisingly difficult to find a precise definition for regulation. In his comprehensive review of regulation, Mitnick (1980) points out that the concept has no single accepted meaning and that the distinction between regulatory and non-regulatory government activities is often problematic. A clearer contrast would seem to be offered by the difference between those activities conducted through open markets and those that are subject to government control. However, on closer inspection, this begs the question of defining the nature of markets and we must acknowledge that most markets are themselves subject to rules, customs and laws that may overlap with our conception of regulation.

Of equal importance is the realisation that government is not the only source of regulatory

authority. There are many examples of what Ayres and Braithwaite (1992:3) refer to as 'private regulation - by industry associations, by firms, by peers and by individual consciences.' Thus our consideration of regulation and regulatory alternatives will have to include a much wider range of participants than just government agencies.

Regulation is established for several possible reasons, mostly related to market failure (instances where competitive markets are unable to be established or are not capable of providing goods at an economically optimum level). The aspects of market failure most relevant to seed regulation are information asymmetry, externalities, and the public goods character of seed production.

- *Information asymmetry.* Market transactions assume that buyer and seller have access to adequate information about the product. In the case of seed, however, the buyer may have difficulties assessing potential performance or quality. The final assessment may only be possible at harvest, so seed regulation may be needed to provide adequate information to farmers.
- *Externalities.* One farmer's choice of seed may cause significant damage to neighbours' production (eg. through the spread of plant disease) and thus certain controls may need to be established to guard against the use of inappropriate seed.
- *Public goods characteristics.* One feature of public goods is their non-excludability; once they are provided to one consumer it is difficult to limit further access. To the extent that seed qualifies as a public good, this limits the incentives for private seed provision. In these cases, seed provision becomes the responsibility of what is in effect a public monopoly. Regulations will be required to monitor and control its operation.

Although there are obvious justifications for some types of seed regulation, the discussion in Section 3 emphasises that current government regulatory structures are inefficient, not adequately targeted, do not allow for participation from farmers, commercial enterprises or voluntary agencies and are not sufficiently transparent to provide clear signals to potential participants in an expanding national seed system. We thus need to consider options for regulatory reform.

Regulatory reform

Although government regulation is often established because of market failure, problems arising from government regulation are themselves responsible for serious inefficiencies. We must thus look at both public and private regulatory options and, more importantly, understand how regulatory responsibilities can be shared amongst different institutions. Regulatory reform is best described not in

terms of an absolute choice between idealised models of 'state' or 'market' performance but, rather, as a complex process that seeks to encourage an effective conjunction of public and private responsibility in the development of national seed systems.

There are many possibilities for taking greater advantage of private regulatory alternatives in national seed systems. The most obvious opportunity is to place greater reliance on market mechanisms, allowing farmers a bigger say in what types of varieties are produced and what quality of seed is offered for sale. Seed companies themselves usually contribute to regulating seed quality in their quest to establish their reputations, secure repeat sales and offer guarantees to distinguish them from competitors. In addition, because the actions of a minority of unscrupulous firms can damage the reputation of the entire industry, seed company associations may establish their own regulatory mechanisms. Finally, independent regulatory bodies, such as private certification services, can be established.

These examples of private regulation are not, however, without their drawbacks. For example, farmers may have difficulty obtaining all the necessary information about variety performance and resource-poor farmers generally do not have the capacity to influence the decisions of private seed producers, as their levels of seed purchase tend to be low. Companies may also not be concerned about their reputations if rural communication systems are poor or under-developed. In addition, in order for industry or independent regulation to be effective, farmers need to be aware of the operation of these regulatory mechanisms and must know how to pursue complaints.

It should be obvious from the foregoing discussion that complete reliance on either government regulation or market mechanisms is likely to be inadequate. Fortunately, though, there are many opportunities for sharing regulatory responsibilities. The design of such options should benefit from the fact that regulation can be divided into three components: (i) setting standards; (ii) monitoring and supervision; (iii) and enforcement. Various institutions (government, private industry, consumers etc.) can take responsibility for different aspects of the regulatory process.

The discussion in Section 5 emphasises these possibilities for shared responsibility. It stresses three principles: participation, differentiation, and evolution. First, any regulatory option for national seed systems must pay particular attention to broader participation in the process. Seed regulation is currently dominated by the state, though national seed systems are characterised by a decline in state activity and an increase in commercial and community level initiatives. This change must be reflected in the management of seed regulation. Second, seed

regulatory reform must be directed towards greater accommodation of the heterogeneity of the farming population. Regulations established for commercial agriculture may be detrimental to subsistence farmers, for instance, and regulations that are appropriate for well-established commercial firms may be inadequate for community level seed activities. Finally, any examination of seed regulatory reform must acknowledge that national seed systems are growing and evolving. There is no such thing as a perfect regulatory solution; regulatory reform must provide sufficient flexibility to encourage the expansion and diversification of national seed systems.

5 Alternatives for seed regulation

This section outlines the alternatives for seed regulatory reform. As in Section 3, the discussion is divided into three areas: variety testing, variety regulation, and seed quality control.

Alternatives for managing variety testing

Public sector plant breeding institutes have a number of opportunities for improving the efficiency and targeting of their variety testing systems. Re-examination of the procedures that are employed in the testing process is required. In addition, organisational changes, including decentralisation and the establishment of better links with outside organisations, should be considered. The issue of farmer participation in variety selection must also be addressed. Finally, the incentives required to bring about such changes must be taken into consideration. Table 1 presents a summary of current conditions and alternatives to guide public sector variety testing towards goals consistent with a more equitable and diverse seed system.

Procedural changes

In order to target variety development to resource-poor farmers there is a need to increase the quantity and diversity of variety testing. Plant breeders should conduct a wider range of trials and utilise a greater number of test sites. Such suggestions may seem impractical given the realities of decreased funding for public agricultural research, but there are several opportunities for trade-offs. An increase in certain activities can be balanced by a decrease in others; more efficient zoning of trials will result in fewer irrelevant test sites, for instance. In addition, any increased investment should result in a much higher proportion of varieties actually reaching farmers' fields. But the increase in variety testing activity will also have to rely on broader participation from farmers and from community organisations.

The absolute level of variety testing is currently inadequate. In particular, the latter stages of variety

testing do not include sufficient locations to provide information about the performance of varieties in diverse environments. Instead of relying on a few test sites with complex, replicated trials, plant breeders should place more emphasis on using a greater number of sites, often with single replications. In addition, better definition of testing environments is required. This can be achieved through better zoning; the development of geographic information systems (GIS), for example, makes it possible to consider much more sophisticated zoning for variety testing.

A greater number of test sites and a more precise approach to zoning will contribute to an understanding of the limits of the strategy of breeding for wide adaptation. Under current variety testing protocols, breeders have little incentive to test genotypes that have highly specific environmental adaptation because they will rarely perform well across the majority of test sites in a single, broadly defined zone. Because these types of material are eliminated on the basis of their average performance, their specific contributions to more carefully targeted environments remain untested. A greater (but more carefully targeted) dispersion of trial sites will encourage the use of material more specifically adapted to the environments and conditions of the many resource-poor farmers currently neglected by conventional variety testing.

The management of variety testing sites also needs to reflect the actual conditions and management practices of target farmers. An increase in the diversity of trial sites should be accompanied by an increase in the diversity of trial management. This greater range of trial management practices also implies a broader evaluation of trial performance. If more trials are planted under representative farmer conditions, the range of observations will automatically increase; performance under different planting dates, intercrops or rotations will be noted, for instance. In addition, greater familiarity with farmer priorities will suggest further measures (such as fodder yield, cooking quality, or market acceptability) that need to be assessed.

In addition to broadening the coverage of trial sites, breeders also need to make better use of the data generated at each site. The practice of discarding results from low yielding sites and an over-reliance on the CV statistic should be rethought.

Most fundamentally, the diversification of the variety testing process should lead to a greater number of varieties being released; the justification for the investment necessary to reform variety testing procedures lies in the promise of a wider range of useful varieties.

The organisation of variety testing

The diversification of variety testing requires

Table 1. The evolution of variety testing in public plant breeding systems

Current Status	Alternatives	Goals
Variety testing procedures		
<ul style="list-style-type: none"> • Few zones; reliance on breeding for wide adaptation • Sites chosen on administrative criteria • Uniform level of trial management • Yield is major criterion for selection • Analysis of trials eliminates results of low yielding or variable sites • Few varieties proposed for release 	<ul style="list-style-type: none"> • Invest more in adequate zoning and site selection • Change trial management to better represent actual farmer conditions • Use a wider range of criteria for promoting varieties • Devote more emphasis to low yielding test sites • Propose more varieties for release, targeted to a wider range of conditions 	<ul style="list-style-type: none"> • An understanding is achieved of when breeding for specific niches is more effective than breeding for wide adaptation • A more complex set of criteria for variety testing is established • The focus is shifted from breeding for uniform management and market conditions to tailoring varieties for specific requirements • A much wider range of varieties, offering more choices to farmers, is available
Organisation of variety testing		
<ul style="list-style-type: none"> • Variety testing centrally administered • Low utilisation of materials and data from other breeding programmes 	<ul style="list-style-type: none"> • Decentralise research; develop better collaboration with extension, NGOs, farmer groups • Develop more interchange with other breeding programmes • Develop relations with seed production to help popularise varieties and understand client needs 	<ul style="list-style-type: none"> • Effective zoning and decentralisation places plant breeders in contact with target farmers • Public and private plant breeding programmes collaborate effectively, within and between countries • A wide range of seed production enterprises have access to public varieties
Farmers' role		
<ul style="list-style-type: none"> • Farmers are rarely consulted about breeding priorities • Farmers do not have a chance to test new varieties until the final stages of development 	<ul style="list-style-type: none"> • Place more emphasis on farmer-managed variety trials • Develop programmes with farmer input in early stages of variety selection • Develop farmer selection and breeding skills 	<ul style="list-style-type: none"> • Farmers are seen as clients <i>and</i> collaborators for public breeding programmes • Farmer skills and local materials are fully utilised in plant breeding
Incentives		
<ul style="list-style-type: none"> • Breeders are not directed towards addressing the needs of resource-poor farmers • Breeders are rewarded for variety release rather than variety utilisation 	<ul style="list-style-type: none"> • Change research policy to emphasise the needs of resource-poor farmers • Devote more resources to monitoring and analysing variety use 	<ul style="list-style-type: none"> • Resource-poor farmers are recognised as targets and partners for plant breeding programmes and success is measured by the degree to which their problems are solved.

decentralisation. The practice of managing plant breeding from a central institute that relies on relatively few experiment stations as testing sites is not adequate. Plant breeding institutes need to examine the correspondence between the current distribution of trial sites and the location of target farming populations, and then make appropriate adjustments. One solution is to assign more plant breeders to regional research sites and to provide facilities to support agricultural research away from the central research station. The administrative challenges involved in such a strategy are similar to those faced by adaptive on-farm research programmes. Experience with these has shown that greater decentralisation of

agricultural research is both managerially and financially feasible (Merrill-Sands *et al.*, 1991).

Another solution is to provide more support for the variety testing programmes of local organisations, such as agricultural universities. Any decentralisation strategy for variety testing must also include increased collaboration with other organisations, such as NGOs and extension services. In many cases these can be effective partners in the management of a variety testing programme, identifying farmers to host trials, helping to collect data and observations on variety performance, and organising farmer participation in the definition of plant breeding priorities.

Public plant breeders also need to establish much

better links with the parastatal, commercial and community level seed production enterprises that will be responsible for diffusing new varieties. There is no sense in promoting more targeted plant breeding and variety testing if the resulting products are not utilised.

Farmer participation

Farmer participation in agricultural research has been the subject of considerable debate and innovation in the last decade, and the term may be used in a wide range of contexts (Biggs, 1989). With respect to plant breeding and variety testing, there are a number of possibilities for increasing farmer participation. Greater use of on-farm variety trials under farmer management in the earlier stages of variety testing is a step in the right direction. But there are also methods for involving farmers more directly in variety testing. Breeders may give finished or near-finished varieties to farmers to test in their fields (Maurya *et al.*, 1988; Joshi and Witcombe, 1996) or farmers may observe materials at an experiment station and then make their own selections for further testing on their farms (Sperling *et al.*, 1993). There are also possibilities for involving farmers in work with segregating breeding material, although there are only a few examples of this to date (eg. Sthapit *et al.*, 1996). Farmers could also be trained to make crosses and do selections, with or without assistance from breeders.

Incentives

In order for decentralised plant breeding to function as intended, public plant breeders will need adequate incentives to change from their current operating procedures. Under the current system, public plant breeders receive recognition for the number of officially released varieties they produce. Professional promotion is, unfortunately, less often based on the extent of actual variety adoption. Under a more decentralised breeding scheme, in which more varieties are made available, often without official release, the reward system is potentially less clear-cut. To address this problem, leaders of breeding programmes should emphasise that the primary measure of success is farmers' utilisation of the programme's materials, whether these are acquired through farmer-to-farmer seed exchange, local seed production schemes, or certified seed production. National agricultural policy must also accord research priority to the needs of resource-poor farmers.

Alternatives for managing variety regulation

The reform of variety regulation is most effectively addressed by separate examination of its two principal components, variety registration and performance testing.

Reforming variety registration

Improvements in current variety registration practices will require attention to the management of registration standards and a more flexible approach to sources of data for registration. The funding and management of variety registration also require scrutiny.

- *Registration standards.* All participants in a variety registration system should contribute to defining the standards that are to be used. If commercial varieties are included in the registration system, then private sector plant breeders should have a voice in determining the parameters to be used for registration. The characteristics used for registering varieties should be few in number and as simple as possible to record. They should also be in accord with the purposes of the registration system.

If registration is established to allow farmers, extensionists and seed merchants to distinguish among varieties, the registration system can be relatively simple.

It is very important that countries do not confuse the requirements for managing PVP with the much less rigorous demands of a registration system for non-protected varieties. As PVP becomes established in developing countries, many breeders in the private and public sectors will choose to register their varieties, especially those that are not hybrids. But conventional and PVP registration may be handled with quite different standards, and by separate authorities.

The coverage and clarity of registration standards is also important. A rigid and comprehensive registration system could restrict the use of local varieties. Indeed, this is what happens in the EU today. Traditional vegetable or crop varieties cannot be registered or sold as seed under present regulations, despite decades of farmer experience with the varieties. Variety registration must not interfere with the use of local varieties or landraces for cultivation, or hamper decentralised variety improvement efforts. Similarly, although a national PVP system should provide sufficient protection to stimulate competition among commercial seed companies, it should not jeopardise the protection and enhancement of local crop genetic diversity.

- *Data for variety registration.* A more flexible approach to collecting data for variety registration is required. Simplified procedures that can utilise varietal registration data from other countries will be an important step towards harmonising national seed regulatory systems. Clear policies for harmonised variety registration will encourage both public and private plant breeders to explore wider markets for their products. It can also stimulate plant breeding in countries whose national markets alone do not offer sufficient demand. Moves should

also be made towards assigning greater responsibility to plant breeders themselves for providing the necessary data for registration.

- *Funding variety registration.* Any varietal registration system must be funded in a sustainable fashion. The charges for registration must be sufficient to cover the costs of the tests carried out, but they should not be so high as to limit registration and should not be used to raise revenue at the expense of plant breeders. If a simple registration system is shown to be efficient, and if it is effective in informing farmers of new varieties, private variety developers will be encouraged to participate.
- *Managing variety registration: voluntary or mandatory?* The question of whether variety registration should be voluntary or mandatory has been deliberately left until last, in the belief that the decisions implied in the previous sections are of greater importance. A well-managed mandatory registration system helps prevent confusion in the seed market. Indeed, it was the inexperience (and at times dishonesty) that characterised the early development of commercial seed operations in industrialised countries that led to the establishment of variety registration there. An additional argument for mandatory registration is that it may help control the diffusion of inappropriate varieties.

The danger of any mandatory system that controls all varieties entering the market (rather than simply having the power to ban specific varieties) is that it can be used to restrict the activities of certain types of enterprise. The usual example is the public regulatory system favouring public varieties, but if registration authority were assigned to a private seed producers' association, for instance, this too could limit further competition. An additional concern about mandatory registration is that, unless it is a very straightforward and inexpensive process, it will discourage new commercial enterprises and voluntary efforts.

- *The evolution of variety registration.* The preceding discussion has reviewed a series of factors that need to be considered in the reform of variety registration. Particular regulatory systems will emphasise different factors as they adjust themselves to national seed system development. There are, however, several general principles useful for guiding the evolution of variety registration (Table 2).

Many national regulatory systems are under increasing pressure to record a large number of crop characteristics for variety registration, in preparation for (or in imitation of) PVP. It will be preferable instead to think of two separate approaches. National policy-makers will establish the type of PVP legislation acceptable for their country, and a PVP authority and registration

system can then be defined. Independently, decisions need to be taken regarding the minimum amount of registration data that is useful and necessary for public and other varieties that will not fall under PVP. It is particularly important to ensure that registration requirements do not interfere with the use of diverse and 'non-uniform' local varieties and landraces.

Reforming performance testing

This section is concerned with the performance testing that is part of the variety release decision. In some cases it is difficult to draw a line between the testing done for variety selection in plant breeding (described in the first part of Section 5) and the performance testing that is part of variety release. If only public varieties are being considered, a variety release committee may simply scrutinise the data from the final stages of variety selection. But strictly speaking, performance testing involves independent field testing, often over several years, of materials submitted by both public and private breeders to an independent release authority. Such variety release procedures are in place in many industrialised countries that have mandatory variety release procedures, and these often serve as models for developing countries. It is important to examine the functions and limits of variety performance testing, especially because private plant breeding is becoming more important.

- *Standards for performance testing.* Much of the performance testing for variety release is based on rigid yield requirements from experiment station tests. These conditions often do not reflect the crop management practices or circumstances of most farmers. In addition, the criteria used for assessing performance do not necessarily reflect farmers' interests. Performance testing should therefore involve a more open-ended evaluation in which the suitability — rather than absolute superiority based on narrowly defined criteria — of the variety for a particular set of conditions stands as the basis for approval.

* *Monitoring performance testing.* A seed producers' or breeders' association can establish a scheme for performance testing for its members. If the scheme is voluntary, private breeders will have an incentive to participate in order to assess their materials against the potential competition, and to be able to provide farmers with a recognised standard for performance. One possibility is to include some type of 'pre-release' arrangement in the monitoring process, whereby a company is able to begin limited seed production and sale of a variety that is currently undergoing tests.

Besides placing more responsibility for variety assessment with plant breeders and seed companies, it is equally important that farmers have

Table 2. The evolution of variety registration

Current status	Alternatives	Goals
Registration standards		
<ul style="list-style-type: none"> • Many characteristics used for registration, sometimes in preparation for PVP • Standards for registration not widely understood by industry or farmers 	<ul style="list-style-type: none"> • Identify a minimum set of characteristics for efficient (voluntary or mandatory) registration of non-PVP varieties • Guarantee protection for use and exchange of local varieties and landraces • Establish policy for a PVP system for commercial varieties 	<ul style="list-style-type: none"> • Incentives established for development of non-PVP varieties • Increasing attention for maintaining and enhancing plant genetic diversity through local crop improvement • Promotion of commercial seed sector through an acceptable PVP scheme • Farmers have confidence that varieties are clearly identified
Data sources		
<ul style="list-style-type: none"> • All field tests and data for registration managed by public agency 	<ul style="list-style-type: none"> • Give breeders increasing responsibility for providing registration data • Use data from other countries (increasing harmonisation) • A PVP agency (public or private) establishes clear procedures for private companies participating in system 	<ul style="list-style-type: none"> • Efficient registration policy that relies on plant breeders for providing and managing data, with supervision from a public agency

a central role in the monitoring of performance testing. Farmer groups or associations can take the lead in establishing and organising local, voluntary testing sites in which public and private breeders can observe and demonstrate their materials.

This type of farmer-managed performance testing can be a stimulus for improving variety popularisation. If the variety assessment process is carried out in a public and participatory fashion, it will not only capitalise on farmers' observations, but will also be an excellent way of introducing farmers to new materials and developing the demand necessary to encourage investment from seed producers.

Financial support for performance testing is also an important issue. If performance testing is voluntary, there are a wide range of possible funding sources. Farmer organisations may be willing to sponsor local tests, for instance, and individual seed enterprises or seed producer associations can provide support for testing programmes. If the performance testing system is mandatory, the plant breeders who submit materials will have to support the cost of the testing. Any mandatory testing system will have to feature an efficient set of procedures that all breeders are willing to support; if it cannot, it must be prepared to accept partial blame for the stagnation of the national seed system.

- *Should performance testing be mandatory?* It is difficult to defend a mandatory variety performance testing system. Expanding current testing systems to accommodate the potential range of domestic and imported commercial varieties, as well as those developed by community efforts, is not feasible. A

bureaucratic, costly and unrepresentative performance testing system will discourage much public and private plant breeding. There are dangers on the other side, however, and the widespread sale of inappropriate varieties can cause problems. If farmers' disappointment with a variety's performance is translated into avoidance of all formal sector seed, or all new varieties, then the industry as a whole will suffer from the incompetence or dishonesty of a small proportion of its members.

Farmers should be protected from the false or exaggerated claims of seed companies but, just as important, they should be protected from an ineffective or biased testing system that denies them access to useful varieties. Voluntary testing procedures that attract the widespread participation of public and private breeders can be very effective when linked to an effective information system. Increasing reliance on enterprise reputations and market discipline will reward superior varieties. It must be remembered, however, that these options require 'a discriminating population of farmer-customers and efficient and competitive breeders' (Simmonds, 1979:222).

- *The evolution of performance testing.* Table 3 summarises the paths that can be considered for making variety performance testing more supportive of diversifying national seed systems. First, the representation on any variety testing authority must be broadened to reflect the diversity of the national seed sector. The standards used to judge variety performance must also be broadened.

Reform of performance testing also depends upon changes in the organisation of public plant

Table 3. The evolution of variety performance testing

Current Status	Alternatives	Goals
<p>Release authority</p> <ul style="list-style-type: none"> • The release committee is dominated by the public sector • Performance testing for all major crops 	<ul style="list-style-type: none"> • Broaden the representation of the release authority • Reduce the number of crops requiring mandatory testing • Allow limited pre-release production while tests are conducted 	<ul style="list-style-type: none"> • Increasing reliance on the reputations of breeders and seed producers for distinguishing varieties • Any release authority has participation from breeders, seed enterprises, and farmers
<p>Performance standards</p> <ul style="list-style-type: none"> • Rigid release criteria based mostly on yields in experiment station tests 	<ul style="list-style-type: none"> • Decentralise variety testing and development • Base standards for release on actual farming conditions • Use adaptation rather than yield ranking for release recommendations 	<ul style="list-style-type: none"> • Increasing attention paid to the diversification of varieties • Variety development responds to farmer priorities
<p>Data sources</p> <ul style="list-style-type: none"> • Standardised data from public variety testing system are used for release 	<ul style="list-style-type: none"> • Increase participatory variety testing with local groups • Use variety testing plots for popularisation of both public and private varieties 	<ul style="list-style-type: none"> • A wide range of criteria are used to make judgements about variety release • Data are increasingly the responsibility of plant breeders, through voluntary systems or through licensing
<p>Farmers' role</p> <ul style="list-style-type: none"> • Farmers do not participate in performance testing • Farmers receive recommendations from extension and publicity from seed companies 	<ul style="list-style-type: none"> • Promote stronger role for farmers in setting plant breeding standards • Support <i>in-situ</i> conservation and local variety enhancement • Encourage local farmer organisations to sponsor performance tests 	<ul style="list-style-type: none"> • Farmers' input to public breeding system increased • Farmers' capacity to articulate requirements to private sector increased

breeding. Increased capacity for decentralisation and increased farmer participation are required. If standard performance tests are maintained, public and private breeders need more of a voice in how they are conducted and evaluated.

If mandatory testing is retained it is likely to be for a restricted number of important crops. This can provide a type of competition with the voluntary testing systems in place for other crops, and all parties should have an interest in strengthening the voluntary systems and showing how they can replace more restrictive ones. The final goal of this evolution in the management of performance testing is to allow public and private plant breeding to address the diverse needs of farmers and to place increasing responsibility with breeders and seed producers for maintaining the reputation of their own products.

Finally, farmers' role in performance testing must be strengthened. Initiatives by farmer groups to sponsor and organise performance tests of new varieties are a step in the right direction as they will provide farmers with a forum for articulating their requirements to variety developers.

Alternatives for managing seed quality control

The following discussion outlines options for the reform of seed quality control regulation, beginning with a review of the standards that might be used.

Standards for seed quality control

Seed quality standards should be appropriate to the farming conditions and seed production capability of the country in question. The level at which the standards are set should be decided through open debate among seed producers and farmers and should reflect changes in market demand and production conditions. It is also reasonable to expect that the standards for local seed production projects might be different from those used in large commercial operations, even though a single authority might control both.

Although in many countries reform needs to focus on increasing the flexibility of control systems, there are also instances in which increased attention, or regulation, is necessary. First, as seed production expands and seed producers improve their own capabilities in quality control, it will be sensible to

direct regulatory efforts towards ensuring the quality of earlier generations of seed. Much of this seed is still the responsibility of public sector organisations and it is sometimes argued that many of the certification problems that arise in commercial seed lots can be traced to inadequate basic or foundation seed. A second area that requires increased attention is seed quality control at the point of sale. The resources devoted to point-of-sale inspection are not adequate. Other organisations, such as extension agencies or farmer groups, should be able to help maintain standards and report problems with marketed seed.

Monitoring seed quality control

There are four basic options for managing the monitoring of seed quality control: (i) to continue to rely heavily on a government certification service; (ii) to establish an independent certification service; (iii) to encourage shared responsibility between certification agencies and seed producers; and (iv) to establish a system of truthfully labelled seed. The characteristics of the four options are summarised in Table 4.

- *Government seed certification.* Most seed quality control in developing countries is the responsibility of public certification agencies, the problems of which were discussed in Section 3. Nevertheless, there are several reasons why government certification agencies may continue to operate. First, governments may insist that seed of important

crops continues to be inspected by the official certification agency. Second, seed from parastatal seed enterprises may still require government inspection. Third, where seed is produced by scattered grower cooperatives or outgrowers, or as part of small-scale projects, some official supervision may remain necessary. In all cases, however, significant changes in the management of the public certification system are likely to be required.

One such change is decentralisation. There is a mismatch between centralised regulatory agencies and increasingly dispersed seed production capacity. Decentralisation involves establishing regulatory authorities at a sub-national level and providing them considerable independence to develop their own standards and procedures. Decentralisation of seed quality control offers the possibility of closer contact with seed producers and users and more opportunities for targeting regulations.

A second change is to pay more attention to controlling rent-seeking and corruption so that farmers and seed producers have greater confidence in the certification agency. There are a number of ways in which to reduce corruption, including making improvements in staff recruitment, establishing rewards and punishments to discourage corruption, increasing internal monitoring, and changing staff attitudes (Klitgaard, 1988).

Table 4. Options for monitoring seed quality control

Option	Justifications	Concerns
<ul style="list-style-type: none"> • Conventional certification by a public sector regulatory agency 	<ul style="list-style-type: none"> • Government control for main food crops • Necessary when seed production monopoly exists (e.g. parastatal) • Provides technical assistance, particularly if seed growers are dispersed and/or inexperienced • Often required for seed export 	<ul style="list-style-type: none"> • Allows little flexibility in standards • High costs • Limited coverage and participation • Possibilities for corruption
<ul style="list-style-type: none"> • Certification by an independent certification agency 	<ul style="list-style-type: none"> • Allows seed producers and consumers the option of certification • Permits flexibility in standards 	<ul style="list-style-type: none"> • Depends on consumer understanding of certification • Requires sufficient demand to pay for private certification service
<ul style="list-style-type: none"> • Quality control tasks shared between regulatory agency, seed producers and merchants (through Quality Declared Seed, delegating authority, or licensing) 	<ul style="list-style-type: none"> • Encourages development of quality control capacity • Less expensive • Allows wide coverage • Permits flexibility in standards 	<ul style="list-style-type: none"> • Requires good capacity for spot checks • Requires clear enforcement strategies • Requires technical capacity for seed producers and merchants
<ul style="list-style-type: none"> • Truthful labelling: seed producers and merchants monitor seed quality with regulatory agency oversight 	<ul style="list-style-type: none"> • Seed producer responsible for seed quality • Allows standards to respond to market demand • Encourages diversification • Costs borne by seed producers 	<ul style="list-style-type: none"> • Needs strong, independent enforcement capacity • Assumes well-functioning market and competition • Should not be confused with lower standards • Still requires supervisory oversight

Finally, because many of the justifications for government seed certification are related to the control of parastatal seed production, parastatals need to become more efficient and more competitive. One way of achieving this is to begin to transfer more responsibility for seed quality control to the parastatal enterprise and to make it understand that its future depends on developing a reputation for delivering quality seed.

- *Independent certification.* An independent certification service is an alternative to public seed certification. Such a body may be part of a mandatory certification system, but most often use of its services will be voluntary; seed producers may choose to contract the services of an independent certification agency if they feel this will add value to their product. For example, most of the seed certification in the USA is done by state-level independent agencies that have been formed by farmer cooperatives or associations. This type of independent certification is most useful when farmers are aware of the meaning and value of certification.
- *Sharing responsibilities for seed quality control.* There are several examples of how government certification agencies can share responsibilities for monitoring quality control with seed producers.

The concept of Quality Declared Seed (QDS) was developed by the FAO to provide guidelines for establishing a seed regulatory system that could be operated with limited resources (FAO, 1993). Under this system, the regulatory agency randomly samples a small percentage of seed production plots each year, rather than attempting to inspect all of them. Sampling from a percentage of sales points is suggested as well. Such a system can begin to shift responsibility for quality control to seed producers and merchants. The system does, however, require a well-defined enforcement strategy.

Another step towards devolving quality control responsibility to seed producers and merchants is the delegation of some monitoring responsibilities to other agencies. This is especially helpful for the management of small-scale seed production activities, where some technical supervision is required but it is unlikely that a certification agency can provide full or adequate coverage. Extension agents, agricultural research staff, or technicians working for NGOs can take over some of these responsibilities, especially if they can count on training and technical backstopping from the certification agency.

Another possibility for transferring quality control responsibility to seed producers is through licensing. Seed company technicians may be licensed to carry out seed certification. Such an arrangement requires spot checks from the state

certification agency and a good enforcement mechanism that provides well-defined penalties for seed producers who fail to meet the standards.

- *Truthful labelling.* A very straightforward option for seed quality control is truthful labelling. The minimum standards (for purity, germination, etc.) for truthfully labelled seed may be determined by the state regulatory agency, or may be left to the discretion of the seed producer. Consumers bear an important responsibility for monitoring adherence to standards and reporting complaints, while regulatory agencies may play an oversight role and carry out spot checks. The enforcement of truthful labelling may be the responsibility of the courts or the regulatory agency. The principal distinguishing feature of this system is that the regulatory agency plays little role in the direct supervision of seed production. It is up to the seed producer to ensure that the seed meets the minimum standards described on the label.

Although truthful labelling offers a number of advantages, there are certain prerequisites for its successful operation. Most important, it requires the support of open markets and good information systems. It also requires a minimum level of farmer literacy. The system works best where consumers have choices and can shift to alternative suppliers. It must be emphasised that truthful labelling is not a 'second best' type of quality control, nor does it necessarily imply lower standards; it is rather a conscious choice by regulatory authorities about how to share responsibility for monitoring and supervision,

Enforcing seed quality control

Under current certification systems, the public regulatory agency usually has primary enforcement responsibility. The agency can withhold certification or, in serious cases, seize a company's seed or close its operation. Responsibilities for enforcing seed quality standards can also be shared, especially as more supervisory duties are passed to producers and merchants. If the system chosen is QDS or truthful labelling, for example, those seeking to implement it can perhaps enlist the cooperation of seed producer or merchant associations to discipline their members,

More effort also needs to be placed on developing farmers' capacities to use the markets and courts to enforce seed quality standards. When farmers have a wide range of choice as to seed sources they can use the market to punish those with unacceptable quality standards. Courts can also be useful for enforcing seed quality standards but they must be accessible to farmers.

- *Should seed certification be mandatory?* The preceding discussion has illustrated the fact that the choice between voluntary or mandatory seed

Table 5. The evolution of seed quality control

Current status	Alternatives	Goals
<p>Standards</p> <ul style="list-style-type: none"> • Single set of standards for seed genetic and physical quality • Standards are not necessarily appropriate for the needs of many farmers 	<ul style="list-style-type: none"> • Allow different standards for various types of producer • Establish minimum standards to guide truthful labelling • Place more emphasis on genetic quality control in early generations of seed production 	<ul style="list-style-type: none"> • Seed quality standards are set in response to farmer demand and producer capacity o Standards change as seed system evolves
<p>Monitoring</p> <ul style="list-style-type: none"> • All supervision of seed quality control done by official agency • Supervision means that all seed production must be inspected 	<ul style="list-style-type: none"> • Decentralise some public quality control activities • Delegate some responsibilities to other agencies and NGOs • Devolve more responsibility to seed producers and merchants through a QDS or licensing system complemented by spot checks and monitoring • Allow truthful labelling • Encourage independent certification capacity 	<ul style="list-style-type: none"> • Increase in quality control skills of seed producers • Majority of quality control activities carried out by seed producers, with oversight by public agency
<p>Enforcement</p> <ul style="list-style-type: none"> • Enforcement of seed quality standards is uneven • Little attention given to quality at point of sale 	<ul style="list-style-type: none"> • Establish clear enforcement strategy • Devote more resources to point-of-sale inspections; train or delegate others to do this • Encourage seed quality disputes to be addressed by consumer courts • Encourage greater seed industry participation in enforcement 	<ul style="list-style-type: none"> • Seed producers and farmers understand penalties for faulty seed • As much enforcement as possible takes place through commercial law and market mechanisms
<p>Farmer role</p> <ul style="list-style-type: none"> • Farmers have little awareness of seed quality options • Farmers have no clear recourse for complaints or concerns 	<ul style="list-style-type: none"> • Use extension and NGOs to acquaint farmers with issues and options of seed quality • Encourage growth of brand names and use of media to stimulate seed producer reputations • Promote farmer associations to monitor/demand seed quality 	<ul style="list-style-type: none"> • Farmers have access to multiple sources of information about seed quality • Farmers can clearly identify seed producers and merchants and know how to pursue complaints

certification systems must be made in the light of decisions about several other factors. Regulatory reform should first pay attention to establishing standards for seed quality control that are appropriate to the needs of farmers and that are within reach of a range of different seed enterprises. In addition, the development of seed producer and merchant capacity to take responsibility for an increasing proportion of the supervision of quality standards should be a priority under either a mandatory or a voluntary system. Finally, a more diverse set of actors needs to be involved in the enforcement of seed quality standards.

The choice among public certification, private

certification, shared responsibility, or truthful labelling is an important one and it should not be confused with the mandatory/voluntary decision. A system such as QDS could be established with either mandatory or voluntary participation, for instance, and truthful labelling can be accurately described as mandatory in many cases. Mandatory certification systems may be poorly managed and openly flaunted, while successful voluntary systems may be widely subscribed and respected. Thus the important choice is not whether all seed enterprises must submit to a mandatory certification system, but rather how to select a strategy that enlists the cooperation and comprehension of all actors in the seed system.

- *The evolution of seed quality control regulation.* Table 5 summarises the most important factors that deserve attention in reforming national seed quality control systems. They are divided into: the management of standards; monitoring and enforcement; and the farmers' role.

Seed quality control standards must be appropriate for the needs of all farmers and, as a consequence, must be more diverse than they are at present. On the other hand, there should be stricter controls on early generation seed provided to an expanding number of seed producers.

The responsibility for supervision of much commercial seed production should pass from the regulatory agency to other organisations. Seed producers will assume increasing obligations for quality control, and the regulatory agency will perform more backup and spot check duties. QDS, licensing of certification to seed producers or independent agencies, and the establishment of truthful labelling are all options for increasing the resources available for supervision of quality control and reducing public sector regulatory investment.

Enforcement of seed quality will have to depend increasingly on farmers' capacities to act through the market or through commercial law. Any move toward delegation of authority for monitoring or truthful labelling will, however, have to be accompanied by a well-conceived structure for enforcement by the regulatory agency and, more important, a system of spot checks that pays particular attention to point-of-sale monitoring.

Finally, it should be obvious that an adequate system of seed quality regulation depends crucially upon farmers' capacities to recognise and demand seed quality. An important part of seed regulatory reform is the development of these capacities, and the strengthening of the media and the markets to transmit information between producers and farmers.

Summary

This section has examined the alternatives for reforming public plant breeding, variety regulation and seed quality control. This range of activities and organisations is quite broad, but there are several common themes that emerge from the discussion.

- *Diversity.* Seed regulation must take account of the great diversity of farmer requirements. Breeding for a few widely-adapted varieties, releasing varieties based on narrow performance criteria, and producing seed that conforms to a single standard are all examples of inappropriate strategies that need to be addressed by regulatory reform.
- *Decentralisation.* A corollary of the move towards more diversity in seed systems is a requirement to decentralise seed regulatory authority to make it

more flexible. There is also a need to explore decentralised plant breeding programmes. Variety release decisions and seed quality control should more often be in the hands of local authorities.

- *Participation.* Seed regulation should not be the exclusive responsibility of a government agency but should feature more input from farmers and from private (voluntary and commercial) plant breeders and seed producers.
- *Sharing responsibility.* Responsive regulatory systems depend on shared responsibility. Private plant breeders should help determine how varieties are registered and released and seed producers should assume more responsibility for seed quality control.
- *Increasing reliance on market mechanisms.* Markets and competition should be used whenever possible to provide regulation. The reputations of both public and private plant breeders and seed producers should be directly linked to the quality of their products.
- *Balancing incentives.* Regulatory incentives for private seed sector development (such as PVP) are important, but must be tailored to particular national conditions, and should not interfere with the use and free exchange of public and farmer varieties.

6 Institutional implications

The previous section has described a number of options for the reform of national seed regulatory frameworks. Regulatory reform, like other types of policy change, is not accomplished by mere changes in laws, rules, or procedures. The options that have been described require specific changes in the mandates of various organisations and, of equal importance, involve significant shifts in the institutional backdrop of national seed systems. As a conclusion to this paper we summarise the major institutional implications of seed regulatory reform. These include a strengthening of farmers' capacities, additional support to the commercial sector, and significant shifts in public sector responsibilities.

Local level seed activities

Public plant breeding needs to do a better job of addressing the needs of resource-poor farmers. This will require greater attention being paid to farmer participation. Individual farmers and farmer groups must be provided with more opportunities to collaborate with plant breeders and other agricultural researchers; there are certainly many possibilities for further innovation in farmer participatory research (Ashby and Sperling, 1995; CGIAR Systemwide Initiative on PR/GA).

There are also more opportunities for promoting local level seed production. Many NGOs are placing

greater emphasis on the economic viability of their seed production activities, but equal attention should be given to institutional sustainability; in the future local level seed production will need to strengthen its links with sources of new germplasm, foundation seed, and technical advice. Many of these links will be formed with plant breeding institutes, extension agencies, or seed regulatory authorities. There are a growing number of examples of productive collaboration between public organisations and NGOs in seed production initiatives (Cromwell and Wiggins, 1993; Joshi, 1995).

Local level seed activities can also help develop greater farmer participation in seed regulatory activities. Farmer organisations can be encouraged to host voluntary variety performance tests, and NGOs can help educate farmers to be more demanding seed consumers, pursuing complaints about seed quality in the market or in the courts.

The commercial seed sector

Under the new scenario, commercial seed organisations will play an increasingly important role in national seed systems. These commercial organisations include everything from large domestic and multinational seed companies that have their own plant breeding capacity, to small local level activities that might have emerged from NGO initiatives. In fact, neither the public/private nor the commercial/voluntary dichotomies are very helpful for understanding seed system development.

Seed policy should encourage entrepreneurial activity and should direct attention to the needs of resource-poor farmers. But it is unlikely that conventional commercial seed activity will be willing to address many of the problems of farmers in more marginal environments who grow less commercially attractive crops or varieties. Thus innovative combinations of public, commercial and voluntary activities will be required to make national seed systems responsive to the needs of all farmers.

As commercial seed enterprises offer farmers an increasing range of choices, the market will come to play a more important role in seed regulation. But seed policy should also encourage seed enterprises to assume more regulatory responsibility themselves; the formation of seed producers' associations is one way to help regulate firms and promote the reputation and integrity of the industry.

Finally, the establishment of intellectual property protection — through PVP legislation - to provide adequate incentives for commercial plant breeding, should not distort the management of conventional seed regulation. The registration requirements of PVP should not be taken as general models for variety development, and extreme uniformity or exhaustive description must not be prerequisites for the release of

useful varieties. The use and free exchange of farmer and public varieties must be protected and enhanced.

The public sector

Seed regulatory reform will require a number of changes in public sector organisations. These changes include paying more attention to seed policy units, a reorientation of research and extension, streamlining parastatal enterprises, and a renovation of regulatory agencies.

Seed regulatory reform does not involve simply abolishing the majority of current regulations and hoping that commercial and local level seed activity will meet farmers' needs. Seed policy must provide clear guidelines for the management and expectations of the regulatory system. Stronger seed policy units are required to assume responsibility for: the definition of seed regulatory frameworks; the protection of genetic diversity; the provision of information to guide seed system development; the assurance of equitable access to the seed system; and the identification of training and technical assistance requirements and opportunities.

Seed regulatory reform also has implications for the direction of public agricultural research and extension. Public plant breeding institutes need a clearer definition of their division of responsibilities with commercial breeding, on the one hand, and a clearer mandate towards resource-poor farmers, on the other. The public extension service can contribute to regulatory reform by helping create awareness of new varieties, providing technical assistance to small-scale seed producers, and helping monitor seed quality at point of sale.

The future of many parastatal seed companies is in doubt. But there are a great number of situations in which seed demand will not be sufficient to attract commercial enterprise. In these cases, government seed production needs to become more efficient, perhaps through decentralisation or greater reliance on contract growers. Parastatal seed enterprises will have to establish new relationships with seed regulatory agencies. The parastatal should be treated like any other seed company, and it should be expected to develop internal quality control capacities similar to those of private seed companies.

Finally, public seed certification agencies and variety release authorities will require significant reorientation to accommodate regulatory reform. It can be expected that seed certification agencies will spend less time on the day-to-day monitoring of seed production, and will devote increasing attention to strengthening the regulatory capacities of seed producers themselves. The future of variety regulation is more problematic. Even within government plant breeding institutes, variety release committees need to seek better representation of farmers' interests. If

private sector varieties must pass through an official release authority, there must be broad participation from seed producers, merchants, and farmer groups.

Conclusions

The major responsibility for guiding seed regulatory reform rests with the state, but it is not simply a question of establishing new policies or changing laws. It is a superficial view that sees regulatory reform as essentially an attachment to slogans such as 'privatisation' or 'deregulation'. Regulatory reform takes place within an institutional environment that determines the direction and character of the change. Government policy can help make the institutional environment conducive to the diversification of the national seed system and supportive of broad-based participation in the management of seed regulation. This includes fostering efficient markets that encourage the entry of a diversity of seed enterprises and that provide an effective interchange of information between buyer and seller. It also means encouraging the growth of civil society that allows farmers to participate in the direction of public agricultural research, to form associations for agricultural development, and to have access to a responsive legal system.

The implementation of seed regulatory reform is a complex process, subject to domestic political pressures and intervention from international donors. One of the principal challenges is to reorient the mandate of the public regulatory bureaucracy without losing its skills and experience. Public seed regulation must shift from a restrictive, policing strategy towards an enabling philosophy that supports wider participation in the regulatory process.

References

- Ashby, J.A. and Sperling, L. (1995) 'Institutionalising participatory, client-driven research and technology development in agriculture.' *Development and Change* 26: 753-770.
- Ayres, I. and Braithwaite, J. (1992) *Responsive regulation: Transcending the deregulation debate*. New York: Oxford University Press.
- Balogun, P. (1996) 'An empirical evaluation of financial losses due to failures within national seed regulatory frameworks.' Unpublished paper.
- Biggs, S. (1989) 'Resource-poor farmer participation in research: a synthesis of experiences in nine national agricultural research systems.' *OFCOR Comparative Study Paper* No. 3. The Hague: ISNAR.
- 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.
- Ceccarelli, S., Erskine, W., Hamblin, J. and Grando, S. (1994) 'Genotype by environment interaction and international breeding programmes.' *Experimental Agriculture* 30: 177-187.
- Cromwell, E. and Wiggins, S. with Wentzel, S. (1993) *Sowing beyond the State*. London: Overseas Development Institute.
- Curnow, I. (1961) 'Optimal programmes for varietal selection.' *Journal Royal Statistical Society* 23: 282-318.
- Finney, D.J. (1958) 'Plant selection for yield improvement.' *Euphytica* 7: 83-106.
- Food and Agricultural Organisation of the United Nations (1993) 'Quality declared seed.' *FAO Plant Production and Protection Paper 117*. Rome.
- ICAR (Indian Council of Agricultural Research) (forthcoming) *New Seeds for Indian Farmers: Challenges and Opportunities for Change in the Regulatory Framework*. New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.
- Joshi, A. and Witcombe, J.R. (1995) 'Farmer participatory research for the selection of rainfed rice cultivars.' In: Proceedings of the 1995 International Rice Research Conference. Fragile lives in fragile ecosystems, IRRI, Los Baños, Philippines.
- Joshi, A. and Witcombe, J.R. (1996) 'Farmer participatory crop improvement II: Participatory varietal selection, a case study in India.' *Experimental Agriculture* (in press).
- Joshi, K.D. (1995) 'Participatory and other alternative approaches to seed production and distribution in Nepal.' ODI/CAZS. Pokhara, Nepal: Lumle Agricultural Research Centre.
- Klitgaard, R. (1988) *Controlling corruption*. Berkeley: University of California Press.
- 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.
- Rajbhandary, K.L. (1994) 'The regulatory frameworks for seed production, purity and sale in Nepal.' ODI/CAZS. Pokhara, Nepal: Lumle Agricultural Research Centre.
- 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.
- 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.
- Sthapit, B.R. (1995) 'Variety testing, selection and release system for rice and wheat crops in Nepal.' ODI/CAZS. Pokhara, Nepal: Lumle Agricultural Research Centre.
- Sthapit, B.R., Joshi, K.D. and Witcombe, J.R. (1996) 'Farmer participatory crop improvement III: Participatory plant breeding, a case study for rice in Nepal' *Experimental Agriculture* (in press).
- Tripp, R. (1995) 'Seed regulatory frameworks and resource-poor farmers: a literature review.' *Agricultural Administration (Research and Extension) Network Paper* No.51. London: Overseas Development Institute.
- Tripp, R. (ed.) (forthcoming) *New seed and old laws. Regulatory reform and the diversification of national seed systems.* London: Intermediate Technology Publications.
- Virk, D.S., Packwood, A.J. and Witcombe, J.R. (1996) 'Varietal testing and popularisation and research linkages.' *CAZS Discussion Paper* No. 2. Bangor: Centre for Arid Zone Studies, University of Wales.

The authors' contact details are as follows:

Robert Tripp

Overseas Development Institute
Portland House, Stag Place, London SW1E 5DP, UK
Tel: +44 (0)171-393-1600 Fax: +44 (0)171-393-1699
Email: r.tripp@odi.org.uk

Niels Louwaars and W. Joost van der Burg

Centre for Plant Breeding and Reproduction Research
(CPRO-DLO), PO Box 16, 6700 AA Wageningen
The Netherlands
Tel: +31 (317) 477003 Fax: +31 (317) 418094
Email: n.p.louwaars@cpro.dlo.nl
w.j.vandenburg@cpro.dlo.nl

J.R. Witcombe and D.S. Virk

Centre for Arid Zone Studies (CAZS), University of Wales
Thoday Building, Bangor, Gwynedd LL57 2UW, UK
Tel: +44 (0)1248-382116 Fax: +44 (0)1248-371533
Email: j.r.witcombe@bangor.ac.uk

AgREN

Network Papers cost £3.00 sterling each (add postage & packing – 50p Europe or £1 elsewhere for each paper).

Please contact the Network Secretary at:

Overseas Development Institute, Portland House, Stag Place, London SW1E 5DP, UK

Tel: +44 (0)171 393 1600 Fax: +44 (0)171 393 1699

Email: agren@odi.org.uk



Information about ODI and its publications can be found on our World-Wide-Web pages on the Internet at:

<http://www.oneworld.org/odi/>