Seeds of Confusion

The impact of policies on seed systems

Promotor: **Prof. dr ir R. Rabbinge**
Universiteitshoogleraar Wageningen Universiteit

Co-promotor: **Dr L. Visser**
Directeur Centrum voor Genetische Bronnen Nederland, Wageningen

Samenstelling Promotiecommissie:
Dr G. Hawtin, Global Crop Diversity Trust, Portesham, U.K.
Prof. dr ir E. Jacobsen, Wageningen Universiteit
Prof. dr J.L. Jiggins, Wageningen Universiteit
Prof. dr G.C.A. Junne, Universiteit van Amsterdam

Seeds of Confusion

The impact of policies on seed systems

Niels Louwaars

Proefschrift
ter verkrijging van de graad doctor
op gezag van de rector magnificus
van Wageningen Universiteit
Prof. dr M.J. Kropff
in het openbaar te verdedigen
op maandag 12 november 2007
des namiddags te 16.00 uur in de Aula

Niels Louwaars, 2007

Seeds of Confusion; The impact of policies on seed systems.

PhD dissertation, Wageningen, The Netherlands – with references – with summaries in English and Dutch

ISBN 978-90-8504-793-3

Summary

Seed is basic to crop production. Next to its importance in production, food security and rural development, seed is a key element in many debates about technology development and transfer, biodiversity, globalisation and equity. The sustainable availability of good quality seed is thus an important development issue. This study deals with the impact different types of regulation have on how farmers access seed. I have analysed current regulatory frameworks in terms of their impact on different seed systems, provided explanations for their often unintended effects and apparent inconsistencies, and proposed some solutions to the problems that have arisen. This thesis builds on earlier work on seed systems, seed laws, intellectual property and genetic resource policies that I published in various media over the past twenty years.

- The analytical framework

Conventional approaches towards seed system development are based on a linear perspective in which policies should promote the development of seed systems through a number of fixed stages that proceed from the traditional towards the commercial. Seed policies in developing countries have long been based on this approach. I continue to question the validity of this approach. I consider it to be insufficiently grounded in reality and therefore an inadequate guide to those involved in formulating seed related policies. My main argument is that the development of a commercial seed provision system is neither realistic nor desirable for most crops. Secondly, when policies take the most advanced crops as a reference for investments and regulation major problems arise because of the differential speed of seed system development between crops and target groups. This analysis leads to the conclusion that the linear approach is counterproductive in terms of balanced sustainable growth and development and should be abandoned.

In this thesis I present an alternative framework for seed system development, which is based on the recognition of *two* fundamentally distinct seed systems, each with their own advantages and limitations: the farmers' seed system and the formal seed system. This framework also includes a range of possible ways of interaction. Farmers' seed systems are by far the most important suppliers of seed, and are particularly important for resource-poor farmers. Formal seed systems, on the other hand, provide tested seed to farmers through an organised and often regulated chain that includes genebanks, breeders, seed producers and seed marketing and distribution organisations. In practice, these different systems operate side by side to serve the needs of different types of farmers for different types of crops. Interaction between these two systems provide important ways of combining formal and local knowledge and plant materials and can lead to the creation of site specific solutions to limitations in production and produce markets. The parallel development of farmers' and formal seed systems plus their interactions create - at the national level - a diversified seed system. Developing policies that support such diversified seed systems creates challenges for regulators. This thesis sets out to analyse and solve this problem.

This publication is licensed under a Creative Commons Attribution 3.0 License.
See: http://creativecommons.org/about/license/

- Seed laws

Variety and seed regulatory frameworks and seed control institutions have been developed in most countries primarily to regulate the formal seed sector. However, the provisions of relevant laws and implementing regulations usually also apply to farmers' seed systems that are built on different principles and mechanisms. An analysis of forty national seed laws indicates considerable similarity as far as organisation and focus are concerned.

Variety control systems tend to limit the number of varieties available on the market. The regulations, their interpretation by responsible committees, associated costs and implementation methods favour varieties with a wide adaptation, especially to relatively benign cropping conditions. The system is not suited to identifying varieties appropriate for smallholders farming in ecologically diverse conditions. Breeders in the private sector cater for an agricultural sector with purchasing power while those in the public sector generally focus on release requirements rather than on the needs of different groups of farmers. Variety control systems thus support neither breeding for smallholders in ecologically diverse conditions, nor the integration of seed systems at the level of crop improvement.

Seed certification and quality control regulations tend to turn farmers' seed production and particularly the exchange and sale of farm-saved seed into illegal activities and put severe restrictions on initiatives that support farmers' seed systems. The level of farmer participation in official bodies set up under these seed laws is low. This may be one of the reasons why release procedures give little attention to the special requirements of farmers' seed systems.

Important openings in seed laws can be created that allow for diversified seed systems to develop and be recognised. Such openings would include explicit limitations on the scope of seed laws to the formal seed sector by adapting the definitions of 'seed' and 'market', for example. The full development of diversified seed systems depends on a shift of focus within those institutions responsible for implementing seed laws. Emphasis should be placed on supporting the production and use of good quality seed in both the formal and farmers' seed systems rather than on policing the formal seed system.

- Biodiversity policies

Genetic resources are the building blocks of crop improvement. They have developed as a result of millennia of natural processes and of conscious and unintentional human selection. Concerns about the reduction of global crop genetic diversity have led to the specific values of genetic resources being closely defined. These definitions form an important basis for policies and measures introduced to regulate new rights over these resources. Largely based on the Convention on Biological Diversity (CBD), these regulations deal with the conservation and use of genetic resources, access to these resources and the sharing of benefits arising from their use. The CBD does not focus on agriculture alone. It covers all areas of biodiversity. I have, therefore, tested the proposition that the CBD fails to support, or even obstructs proper seed system development. In this context I have assessed the potential of the International Treaty on Plant Genetic Resources for Food and Agriculture (IT PGRFA) to correct this type of failure.

The international policy framework and three distinct regional approaches to implementation strategies inspired by the CBD are analysed with regard to access to genetic resources. National regimes for access to genetic resources based on the CBD can negatively impact on seed systems. In particular they can lead to a reduction in the genetic resources available for different forms of plant breeding and exchange among communities. Since developing countries currently obtain larger numbers of genetic resources from genebanks than industrialised countries, it can be concluded that farmers in developing country are particularly negatively effected by the increasing number of access restrictions being implemented worldwide. The Multilateral System of the IT PGRFA is expected to facilitate access and benefit sharing for many important food crops and pasture species. Although it is too early to assess the actual effects of this treaty it is likely that it will alleviate some of these effects.

- **Intellectual Property Rights**

Intellectual Property Rights (IPRs) are a recent phenomenon in the seed sectors of developing countries. Like seed laws, these new regulatory systems impact on various seed systems. The potential impact of different types of IPRs is analysed from a historical perspective and - drawing on a large number of stakeholder interviews - an attempt is made to determine whether the introduction of such legal systems can be used to promote diversified seed systems. The options available to developing countries that want to design policies, regulatory frameworks and implementation systems that do not have undesired effects are then analysed.

IPRs support ongoing trends towards the commercialisation of the breeding and seed sectors. This trend disregards or even threatens the interests of resource-poor farmers, especially in cases where public research institutions are encouraged to create their own revenue through the use of IPRs. Strong IPR-like utility patents and plant breeder's rights consistent with the 1991 Act of Convention for the Protection of New Varieties significantly restrict opportunities for farmers' seed systems and small local seed companies to use the best available varieties, because in these systems exchange and sale of protected variety seed among farmers requires the consent of the right holder.

The analysis provides guidance for the development of IPRs in developing countries at the policy, legal, and institutional levels that minimise such negative effects. Balanced exemptions for farmers and breeders in breeder's rights and patent systems as well as a differentiation of the strengths of these rights across crops and farmer groups can be effective. Also, initiatives within the current IPR systems can support access to technology for the poor. Countries that intend to develop their IPRs in breeding in support of diversified seed systems will have to withstand current harmonization pressures from trade negotiations that would unnecessarily limit the flexibility offered by the World Trade Organisation.

- Discussion: disconnection and incoherence

The development of policy and regulatory frameworks affecting seed systems shows a disconnection between parallel policy processes on the one hand and between policies and everyday agriculture on the other. Current seed laws and IPRs cater for the needs of a relatively small segment of the total seed supply sector. Moreover, tensions exist between international agreements in the trade, environment and agricultural sectors. I discuss the conflicts between these policies and regulations that lead to disorientation, uncertainty, and commotion – in short 'confusion' - and I suggest a series of explanations and solutions.

Disconnections are identified among different stakeholders within a dossier, between dossiers (agriculture, trade, environment) and between different levels (local, national, international). These disconnections explain most of the inconsistencies in the observed policy outcomes. Parallel negotiations combined with insufficient direction over the relevant departments within a national government are important reasons for inconsistencies among dossiers, especially when complex power relations between departments and countries are strongly influenced by the involvement of particular stakeholders in individual dossiers. Disconnection between local, national and international levels within a dossier may be due to insufficient knowledge about agricultural practice, the prevalence of ‘higher’ policy goals, or to an attempt to modernize agriculture through legislation.

The analysis shows that given the complex influences and power relations among individuals and organizations, inconsistencies in policy making processes are inevitable. This is particularly the case in those policy areas that affect seeds where widely different objectives and value systems are represented. Legislation based on disconnected and inconsistent policies lead to problems with implementation, to confusion, and - in the field of genetic resources and seeds - to juridification and ‘hyperownership’ when proponents of national, communal or individual rights systems are caught in an increasingly dense thicket of rights.

The obvious solution lies in creating institutional mechanisms that increase communication among government departments and different levels of government, increasing opportunities for better policy congruence. At the legal level, options include avoiding generic wording in legislation that would have unintended effects beyond the primary focus, as often shown for seed laws and IPRs and to allow for flexibility and change as soon as the situation requires it. Alternatives can also be found in mechanisms that increase the public space without changing the rules. These include targeted public investments, open source strategies, standardised text for humanitarian use licenses for both IP and genetic resource rights, and patent pools. The initiative to use such tools can come from either government or from private or civil society stakeholders.

Seed is an essential element in crop production, representing a valuable resource that is important in sustaining the supply of food, feed, flowers, fuel and many functional compounds for industry. Seed is also essential for rural development and poverty reduction. It is, therefore, important to continually search for solutions to the inconsistencies that threaten the availability, access and quality of the seed farmers need. All these solutions can only develop when current inconsistencies are clearly formulated. This study contributes to that goal. It also analyses options available and, in some cases, it proposed regulatory change that could improve coherency, encourage more diversified seed systems and lead to policies that are increasingly consistent with development goals. Contrary to the main trends it criticises, such as linear approaches to seed system development and globally harmonised IPRs, this study offers no blueprint solution. Rather, it seeks to contribute to an improved analysis that will make targeted interventions possible at various policy levels and provide productive solutions to the problems that farmers actually face.

Samenvatting

Zaaizaad staat aan de basis van alle akker- en tuinbouw. Naast het belang voor de productie van gewassen, voedselzekerheid en rurale ontwikkeling, speelt zaaizaad ook een belangrijke rol in debatten over kennisbeleid, biodiversiteit, globalisering en duurzaamheid. De toegang tot goed zaaizaad is een belangrijke factor in ontwikkelingsbeleid. Deze studie behandelt de invloed van verschillende beleidsbeslissingen en daaruit voortvloeiende wetgeving op de toegang voor boeren van goed zaaizaad. Ik heb de invloed van bestaande wettelijke configuraties op verschillende zaaizaadsystemen geanalyseerd, ik bied verklaringen voor de ontstane incoherentie en onbedoelde neveneffecten en stel een aantal oplossingen voor problemen die daarvan het gevolg zijn. Dit proefschrift bouwt voort op eerder werk over zaaizaadsystemen, zaaizaadwetgeving, intellectueel eigendom en beleid op genetische bronnen, dat ik in verschillende vormen heb gepubliceerd.

- Het analytisch kader
Conventionele visies op de ontwikkeling van zaaizaadsystemen zijn gebaseerd op een lineair ontwikkelingsmodel waarin beleid er vooral op gericht is om de zaaizaadvoorziening via een aantal vaste stadia te moderniseren tot een volledig commerciële sector. Ik stel dat dit model onvoldoende gestoeld is op de realiteit in ontwikkelingslanden en daarom niet nuttig is om het zaaizaadbeleid op te baseren. De noodzakelijke verschillen in snelheid waarin de zaaizaadsystemen het lineaire pad kunnen doorlopen met betrekking to gewassen en doelgroepen, creëren problemen bij het gebruik van het model in beleidsontwikkeling, vooral wanneer de situatie van de meest commerciële gewassen als ijkpunt voor regelgeving en investeringen gebruikt worden. Deze analyse leidt tot de conclusie dat het lineaire ontwikkelingsmodel onvoldoende of zelfs contraproductief is in ontwikkelingslanden.

In dit proefschrift presenteer ik een alternatief model voor de ontwikkeling van zaaizaadsystemen, dat gebaseerd is op de aanvaarding van het bestaan van twee fundamenteel verschillende zaaizaadsystemen met elk hun eigen voordelen en beperkingen, het boeren- en het formele systeem. Dit model laat ruimte voor een aantal vormen van interactie tussen beide systemen. Boerenzaaizaadsystemen bestaan uit productie en selectie door boeren inclusief lokale uitwisseling. Deze zijn verreweg de belangrijkste producent van zaaizaad en zijn van bijzonder belang voor arme boeren. De formele systemen verschaffen getest zaad middels een georganiseerde en vaak gereguleerde keten van genenbanken en veredelingsonderzoek via praktische veredeling en zaaizaadproductie tot distributie en verkoop.

Deze verschillende systemen bestaan naast elkaar en voorzien gezamenlijk de verschillende soorten boeren met zaaizaad. Interacties tussen deze twee systemen geven interessante mogelijkheden om lokale en wetenschappelijk gegenereerde kennis en materialen te combineren, wat specifieke oplossingen kan bieden voor de beperkingen van beide systemen. De parallelle ontwikkeling van boeren- en formele zaaizaadsystemen en het stimuleren van de interacties leidt op nationaal niveau voor een gediversifieerd zaaizaadsysteem. Dit proefschrift biedt enkele oplossingen voor de complicaties aan aan de wetgever om een dergelijke diversificatie te ondersteunen

- Zaaizaadwetgeving
Wettelijke kaders voor plantenrassen en zaaizaad en de keuringsdiensten die op basis daarvan ontwikkeld bedienen bijna uitsluitend de formele zaaizaadsector. De formuleringen in de wetten zijn echter meestal dusdanig, dat de regels ook gelden voor boerenzaaizaadsystemen, die op heel andere principes en normen gebaseerd zijn. Een

analyse van veertig nationale zaaizaadwetgevingen geeft aan dat deze zeer gelijkluidend zijn wat betreft de algemene visie en organisatie.

Rassentoelatingssystemen beperken meestal het aantal rassen dat beschikbaar is voor boeren. De regels, hun interpretatie door verantwoordelijke instanties, de kosten en uitvoeringsmethodes bevoordelen rassen met een brede aanpassing en vooral aanpassing aan goede groeicondities. Het systeem is niet toegerust om betere rassen te identificeren voor arme boeren in ecologisch risicovolle omgevingen. Veredelaars in de private sector richten zich op boeren met voldoende koopkracht, en die in de publieke sector richten zich vooral op de toelating. Regels voor rassentoelating leiden dus niet tot veredeling voor arme boeren in ecologisch risicovolle gebieden, en ondersteunen de integratie van formele en boerenzaaizaadsystemen op het gebied van de veredeling ook niet.

Regels voor de zaadkeuring maken boeren-productie en vooral lokale uitwisseling en verkoop van zaad illegaal, en leggen als zodanig zware beperkingen op initiatieven om de boerenzaadsysteem te ondersteunen. Daarnaast is de deelname van boeren in formele instituties onder de zaaizaadwet vaak beperkt, wat verder bijdraagt aan de slechte aanpassing van de rassentoelatingsprocedures op boerenzaaizaadsystemen.

Belangrijke openingen in de zaaizaadwetten om ruimte te geven aan gediversifieerde zaaizaadsystemen zijn eenvoudig te maken. Een betere definitie van de termen ‘zaaizaad’ en ‘markt’ kan bij voorbeeld tot gevolg hebben dat de regels expliciet beperkt blijven tot het formele systeem. Daarnaast kan een verandering in de taakstelling van de keuringsdiensten ertoe bijdragen dat locale initiatieven ondersteund kunnen worden door de kennis van die diensten in plaats van dat deze zich alleen richten op hun politiefunctie.

- Biodiversiteitbeleid
Genetische bronnen zijn de bouwstenen voor de plantenveredeling. Deze zijn ontwikkeld door eeuwenlange natuurlijke processen gecombineerd met bewuste en onbewuste selectie door boeren. Bezorgdheid over de mondiale reductie van genetische diversiteit heeft geleid tot de formulering van een aantal waarden van genetische bronnen die de basis vormen voor beleid en regelgeving. Deze zijn grotendeels gebaseerd op de Conventie inzake Biodiversiteit (CBD) en handelen over de bescherming en gebruik van genetische bronnen en met de toegang tot materiaal en het delen van de baten die uit dat gebruik voortvloeien. De CBD richt zich op alle biodiversiteit en is niet beperkt to de landbouw. Mijn stelling is daarom dat de regels in veel landen die voortvloeien uit de CBD de zaaizaadsystemen niet ondersteunen en mogelijk zelfs tegenwerken. Ook zie ik de mogelijkheden van het Internationaal Verdrag inzake Plantgenetische Bronnen voor Voedsel en Landbouw (IT PGRFA) om mogelijke negatieve effecten recht te zetten.

Het internationale beleidskader en drie regionale implementatiestrategieën op basis van de CBD zijn geanalyseerd met betrekking tot toegang tot genetische bronnen. Zulke regels kunnen inderdaad negatieve gevolgen hebben op zaaizaadsystemen vooral door hun beperkende werking op de beschikbaarheid van genetische bronnen voor verschillende vormen van plantenveredeling van genetische bronnen en op de uitwisseling van materiaal tussen boerengemeenschappen. Omdat ontwikkelingslanden momenteel grotere aantallen monsters ontvangen van genenbanken dat geïndustrialiseerde landen, concludeer ik dat ontwikkelingslanden netto zullen verliezen bij mondiale beperking van de toegang. Het Multilaterale Systeem van de IT PGRFA zal naar verwachting zowel de toegang tot materiaal van veel belangrijke voedsel en voedergewassen als het delen van de baten vergemakkelijken en dus waarschijnlijk de problemen van de CBD implementatie verminderen, maar het is te vroeg om werkelijke effecten te meten.

- **Intellectueel Eigendom**

Intellectueel Eigendom (IE) is een recent verschijnsel in de zaaizaadsector in ontwikkelingslanden. Deze nieuwe wettelijke rechten zijn net als de reguliere zaaizaadwetgeving, gericht op de formele sector, met uitstraling naar de boerensystemen. Gebaseerd op een historische analyse, gecombineerd met de resultaten van een groot aantal vraaggesprekken met betrokkenen in vijf ontwikkelingslanden, is de potentie in kaart gebracht van verschillende vormen van IE om gediversifieerde zaaizaadsystemen te ondersteunen. Verschillende mogelijkheden zijn op basis van deze analyse ontworpen om hun beleid, wetgeving, en uitvoeringssystemen zo in te richten dat ongewenste effecten worden beperkt.

IE ondersteunt de huidige trends van commercialisering van delen van de veredeling en zaaizaadsector. Deze trend laat de belangen van arme boeren buiten beschouwing of beschadigt deze, vooral wanneer publieke onderzoeksinstellingen deze rechten gaan gebruiken voor eigen gewin. Sterke IE-systemen, zoals het industriële octrooi en het kwekersrecht volgens de laatste versie van het UPOV verdrag, bepalen dat elke uitwisseling of verkoop van zaad van een beschermd ras de toestemming van de rechthebbende behoeft. Dit beperken daarom in belangrijke mate de mogelijkheden van boeren om hun zaaizaadsystemen te blijven gebruiken, en ook het gebruik van opkomende lokale zaadbedrijven om de beste rassen te vermeerderen.

Deze analyse levert een bijdrage aan de vorming van ontwikkelingsgerichte opties voor de inrichting van IE op beleids-, wettelijke en institutionele niveaus die negatieve invloeden beperken. Goed ontworpen uitzonderingen op het recht voor boeren en veredelaars in zowel het kwekersrecht als het octrooisysteem en ook differentiatie van de reikwijdte van het recht op planten kunnen soelaas bieden. Daarnaast kan een strenger rechtssysteem de toegang tot technologie beperken voor gebruik in het kader van armoedebestrijding. Landen die een divers zaaizaadsysteem nastreven, zouden daarom de druk van handelsonderhandelingen om IE systemen internationaal te harmoniseren moeten weerstaan en alle ruimte gebruiken die de Wereldhandelsorganisatie in deze biedt.

- Discussie: ontkoppeling en gebrek aan coherentie

De ontwikkeling van beleid en wetgeving die zaaizaadsystemen beperken laten een ontkoppeling zien tussen aan de ene kant parallelle (internationale) beleidsprocessen en aan de andere kant een afstand tussen beleid en praktijk. De internationale verdragen over handel, milieu en landbouw zijn zoniet op juridisch dan toch zeker op beleidsniveau in strijd met elkaar. Daarnaast zijn de huidige zaaizaad- en IE wetgeving gericht op het ondersteunen van een zeer beperkt deel van de zaaizaadvoorziening. Dit proefschrift beschrijft en analyseert de conflicten tussen deze beleidsvelden en –uitkomsten, die de basis is van een grote verwarring, en levert een aantal verklaringen en oplossingen.

Ontkoppelingen komen voor tussen verschillende groepen van betrokkenen binnen elk dossier, tussen dossiers (handel, milieu en landbouw) en tussen verschillende niveaus: lokaal, nationaal en internationaal. Gebrek aan contact en begrip verklaren een groot deel van de inconsistenties in de onderzochte beleidsuitkomsten. Parallelle onderhandelingen, in combinatie met onvoldoende regie over de betrokken nationale departementen, zijn een belangrijk startpunt voor incoherentie tussen dossiers, vooral wanneer bepaalde betrokkenen in een dossier de machtsverhoudingen tussen departementen en landen extra complex maken. Ontkoppeling tussen lokaal, nationaal en internationaal niveau kan gebaseerd zijn op onvoldoende kennis van beleidsmakers van de boerenrealiteit en het idee dat regelgeving op zichzelf de modernisering van de landbouw tot stand kan brengen.

De analyse laat zien dat met complexe invloed- en machtrelaties tussen individuen en instituties inconsistenties in beleidsprocessen, die hun stempel op zaaizaadsystemen drukken, onontkoombaar zijn. Wetgeving die gebaseerd is op ontkoppeld en inconsistent beleid leidt tot uitvoeringsproblemen, tot verwarring, en op het gebied van genetische bronnen tot juridificering en 'hypereigendom' wanneer voorvechters van nationale, gemeenschaps- en private rechten gevangen zijn in een spiraal van elkaar versterkende rechten.

De oplossing ligt overduidelijk in institutionele mechanismen om beleidscongruentie te vergroten middels verbeterde regie en communicatie tussen overheidsdepartementen, en tussen niveaus. Op wettelijk niveau ligt een oplossing in het voorkomen van te generieke bewoordingen, die onbedoelde effecten tot gevolg zouden hebben, zoals geïllustreerd door zaaizaadwetgeving en IE, en in het inbouwen van flexibiliteit voor aanpassing van de regels wanneer nodig. Alternatieven kunnen ook gevonden worden in mechanismen, die de publieke ruimte vergroten zonder de regels zelf te veranderen. Voorbeelden hiervan zijn gerichte publieke investeringen in onderzoek, 'open source' strategieën, gestandaardiseerde teksten voor licenties voor humanitair gebruik van zowel IE als genetische bronnen, en 'patent pools'. Het initiatief om zulke mechanismen te ontwerpen en gebruiken kan zowel van de overheid zelf komen als vanuit de maatschappij.

Zaaizaad is een essentieel onderdeel van de akker- en tuinbouw en vertegenwoordigt een waardevolle bron van duurzame productie van voedsel, veevoer, sierplanten, energie en een scala aan industriële grondstoffen. Zaaizaad is ook een essentieel voor rurale ontwikkeling en armoedebestrijding, het vertegenwoordigt een onderdeel van biodiversiteit en het heeft een belangrijke handelswaarde. Het is daarom belangrijk om continu alert te zijn op beleidsinconsistenties die de beschikbaarheid, toegang, en kwaliteit van zaaizaad in de weg kunnen staan. Oplossingen kunnen alleen gevonden worden wanneer die inconsistenties helder geanalyseerd en geformuleerd zijn. Dit proefschrift draagt bij aan die doelstelling en draagt daarnaast keuzes en oplossingen aan voor verbeterde coherentie met betrekking tot de effecten van beleid op gediversifieerde zaaizaadsystemen en verhoogde consistentie met ontwikkelingsdoelen. In tegenstelling tot de algemene trends, zoals de lineaire ontwikkelingsvisie op zaaizaadsystemen en de harmonisatie van IE, levert deze studie geen blauwdruk - oplossingen. Het draagt echter bij tot een betere analyse en richt zich op gerichte interventies op verschillende beleidsniveaus, en productieve oplossingen voor echte problemen van boeren.

Acknowledgements

This thesis is the result of the irresistible encouragement Rudy Rabbinge and Bert Visser initiated several years ago who suggested I combine various experiences and research results into one volume. Unlike my earlier publications which aimed at reaching other stakeholders involved in seed systems, my objective would be scientific analysis. Their encouragement and support throughout the years has been indispensable in enabling me to complete this task.

While preparing this thesis I have had the luck and privledge to head a project – commissioned by the World Bank - researching the impact of intellectual property rights on the seed sectors of developing countries. Experiences within the project helped sharpen my views and provided me with much of the evidence I use in Chapter 5. I am grateful to Kees van der Meer who alerted me to this project and to Derek Byerlee and later Eija Pehu and Riikka Rajalahti who were responsible for it and of course to all members of the team: Derek Eaton, Victoria Henson-Apollonio, Fred Muhukku, Ruifa Hu, Maria Mendoza, Suresh Pal, Rob Tripp, and Joseph Wekundah. A second coincidence was my secondment to the Commission on Genetic Resources for Food and Agriculture in Rome. This provided me with additional insights in genetic resources issues and the operation of an international agreement and its secretariat. This experience is reflected mainly in Chapters 4 and 6. Marcel Vernooij and José Esquinas-Alcázar were instrumental in this secondment; the discussions with Clive Stannard, Dan Leskien, Martin Smith, Álvaro Toledo, Shakeel Bhatti and a large number of country representatives during international negotiations taught me a great deal. Similarly, the visions of Bob Ziegler and Coosje Hoogendoorn put me in a position to discuss institutional policies on intellectual property and genetic resources in the framework of the Generation Challenge Programme, enriching my views on the reality of international research management in relation to these policies and regulations. Working with Victoria Henson-Apollonio, Zeze Sampaio, Shawn Sullivan and others was very special. These coincidences have made the past few years very rich and I can only hope that some of that richness is reflected in this document.

Other people have been very important in putting me on the track of seed systems in developing countries. First, S.H. Charles, F. Kamugira and E. Gareeba Gaso, who showed me the opportunities and the weaknesses of formal seed systems in developing country contexts, and Louise Sperling and Charles Wortmann who showed me alternatives; Siebren Hoekstra and Marius Wessels supporting me in developing these ideas further. Conny Almekinders, Rob Tripp and Walter de Boef fed me in the process while Huib Ghijsen, Ton van Gastel and many others acted as sparring partners. Kees Hellingman, Hartmut Gast, Carl-Gustav Thornström and Ivar Virgin, providing me with platforms in international training programmes that enabled me to extend my views and test them with a large number of professional seeds men and women from all over the world.

The following people have been particularly important during the final stages of this exercise: Trond Selnes, van Tatenhove and Theo van de Sande for getting me started and helping me out on political science issues, Chris Kik, Derek Eaton, Maja Slingerland and Marilyn Minderhoud for giving me useful comments on draft texts, and Guy Akkermans for the cover picture.

Finally, my parents have been important among many other things for developing the norms that form an important basis for this study, and José, Sjoerd, Bas and Janneke have stimulated me over and over again to ‘get down and finish it’.

I have learnt that research has to be participatory one way or the other in order to be useful in development and to benefit the poor. Also, an exercise like this is the result of a large number of personal contacts with professionals, farmers and the loved ones. I am deeply indebted to all.

Abbreviations used

AATF	African Agricultural Technology Foundation
ARIPO	African Regional Intellectual Property Organisation
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
BIOS	Biological Information for Open Society
CBD	Convention on Biological Diversity
CEO	Chief Executive Officer
CGIAR	Consultative Group on International Agricultural Research
CIAT	International Centre for Tropical Agriculture
CSO	Civil Society Organisation
DNA	Deoxyribonucleic acid
DUS	Distinctiveness, Uniformity and Stability
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FTA	Free Trade Agreement
GO	Governmental Organization
GPA	Global Plan of Action
GRAIN	Genetic Resources Action International
GRPC	Genetic Resources Policy Committee (Of CGIAR)
GURT	Genetic Use Restriction Technology
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IGC	Intergovernmental Committee on Genetic Resources, Traditional Knowledge and Folklore
IP	Intellectual Property
IPR	Intellectual Property Right
ISAAA	International Service for the Acquisition of Agro-biotech Applications
ISTA	International Seed Testing Association
IT PGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
KARI	Kenyan Agricultural Research Institute
MLS	Multilateral System (of IT PGRFA)
MTA	Material Transfer Agreement
NARI	National Agricultural Research Institute
NGB	Nordic Genebank
NGO	Non-Governmental Organization
OAPI	African Intellectual Property Organisation
OECD	Organisation for Economic Cooperation and Development
PBR	Plant Breeder's Rights
PCT	Patent Convention Treaty
PGRFA	Plant Genetic Resources for Food and Agriculture
PIIPA	Public Interest Intellectual Property Advisors
PIPRA	Public Intellectual Property Resource for Agriculture
PVP	Plant Variety Protection (= PBR under UPOV)
SADC	Southern African Development Community
SIDP	Seed Industry Development Programme
SINGER	System-wide Information Network for Genetic Resources (of CGIAR)
TRIPS	(agreement on) Trade Related Aspects of Intellectual Property Rights
UN	United Nations Organization
UPOV	Union for the Protection of New Varieties of Plants
USA	United States of America
USAID	United States Agency for International Development
VCU	Value for Cultivation and Use
WIPO	World Intellectual Property Organization
WTO	World Trade Organization

Table of contents

1. Introduction: seeds, values and policies

1.1 Introduction

Seed performs various functions in agriculture and as such plays a strategic role in a range of debates, in particular those concerned with rural development and food security, biodiversity, business development, knowledge and technology, and culture. The term ‘seed’ has several meanings, but it is used here only in the biological sense and restricted to crop plants and is used here to include any type of planting material that is intended for use in producing a new plant, i.e. either generative or vegetative, such as roots, tubers, bulbs, cuttings, rhizomes and apomictic seed. The use of the word ‘intended’ implies that human intervention in handling seed is explicitly considered. Only when biodiversity issues are being considered also are other types of seeds are included, i.e. seeds of wild relatives of crop plants.

Much is known about seed in the realm of natural sciences: morphology (Kozlowski, 1972), physiology (Murray, 1984 a,b), pathology, (Neergaard, 1977), genetics (Dickson, 1980; Koornneef & Veen, 1980), and about the technical handling of seed in agriculture (Justice & Bass, 1979). More recently a fair bit of literature has arisen in the social sciences about seeds to illustrate mechanisms of local knowledge transfer (Thrupp, 1989), cultural identity and gender (Opole, 1993), farmer experimentation (de Boef *et al.*, 1993), the role of seed in reconstruction after civil unrest (Richards, 1998) and choices in over-all agricultural policy (Röling, 2000).

There is a need to bridge the different sciences, not so much as part of a search for a holistic view or ‘cosmovision’ on seeds and their contribution to human wellbeing, but rather to contribute to building a good foundation for policy making that can steer the flow and use of seed. Such policy making is influenced by various international agreements that do not necessarily focus primarily on seed systems themselves. Often they are concerned with other issues like biodiversity, trade and culture, and these may have a marked impact on seed systems when implemented through national law. This research stems from a concern that such influences may affect access to good seed by farmers and smallholders in particular.

The importance of seed for farmers and different development goals, combined with the various regulatory frameworks that affect seed supply give rise to a number of questions. These form the basis of this study.

1.2 The roles of seed

1.2.1 Seed for food and agriculture

Seed is a crucial input in any form of crop production and one of the most precious resources in farming. The genetic makeup of the seed determines to a large extent the yield potential and yield stability of the crop and also the use qualities of the product. The germination percentage and seedling vigour determine the primary plant population in the field, one of the main factors for reaching this yield potential. The seed health status can be a key element in determining the development and severity of a disease epidemic. The choice and handling of the seed thus determine the chances for success of the crop to a significant extent. In this context, for every farmer the two key issues as far as seed is concerned are availability and quality.

- Availability and access

Seed has to be available for every crop production cycle. It has to be there at the right time, in the right quantities, with the right qualities and at the right price so farmers can access the seed they need (Gregg & van Gastel, 1997). Seed is - in principle - readily available in crops where the seed is the same plant part as the consumed product. This is the case in cereals, pulses, and some vegetatively propagated crops such as potato. Botanical seed can also be a 'by-product' with little value other than the fact that it can be used as seed or planting material. This is the case with root crops, fibre crops and vegetables such as cassava, sweet potato, jute, cotton and tomato. This 'by-product' is either readily available, for example, cassava or cotton or the production of seed is a separate operation which is the case with leafy vegetables. Biennials like onion, sugar beet, radish and cabbages, and many leafy vegetables are harvested before flowering, and several fruit vegetables such as cucurbits and okra, have to be harvested for consumption well before the seed matures. In these crops seed production becomes a more specialised operation. Some plants have to be left in the field to mature or special seed production plots have to be laid out.

Even where consumption grain can be used as seed, availability can be a problem. Severe drought, for example, can wipe out a crop's production and thus challenge next season's seed availability. Communities that regularly face such conditions commonly develop coping strategies such as the long-term storage of carry-over seed. Also civil strife is known to disrupt seed supply (Richards *et al.*, 1997). Even temporary displacement of farming communities can leave a whole region without seed to plant when normal conditions return (Sperling, 2001a; Sperling *et al.*, 2004).

Availability can also be challenged when farmers depend on purchased seed. This can happen when a seed provider is unable to supply seed at the right time, when logistics are poorly organised or when the least profitable (remote) markets are supplied last or not at all (Kugbei *et al.*, 2001). Even when seed is available, price could hinder poor farmers accessing good seed. Dependence on purchased seed is greatest when acceptable alternatives are not available, for example, when on-farm seed production is difficult to realize due to disease or germination problems, or becomes impossible if the varietal characterics are to be maintained (hybrids).

- Quality

Four basic seed quality aspects can be distinguished (Almekinders & Louwaars, 1999)

- physiological quality (germination, vigour)
- sanitary quality (seed-borne disease status)
- analytical quality (amount of good seed in a particular lot)
- genetic quality (varietal adaptation, varietal purity)

The first basic requirement of seed is that it has to germinate at the right time. Secondly, the seedling has to be strong enough to withstand the environmental conditions that it faces when emerging (seedling vigour). The use of seed of low physiological quality is likely to result in poor crop development and depressed yield potential, especially in non-tillering crops like legumes and many vegetables. Physiological seed quality depends to a large extent on the health and nutrition status of the mother plant, and on storage conditions and length of storage from the moment of physiological maturity (Justice & Bass, 1979).

The incidence of seed-borne diseases determines the sanitary seed quality. A number of plant-diseases can be carried in or on the seed creating a source of infection and a threat for the new crop. This can affect the severity of an epidemic of a plant disease that may be common in a particular area. Moreover, when seeds are transported over longer distances, they may introduce new and potentially much more damaging epidemics (Mathur & Jorgensen, 1988).

For clients of the commercial seed trade, analytical seed quality is often more important than it is in farmer-produced seed. The amounts of trash, weed seed, and broken seed in a seed lot constitute a net loss for the buyer when purchasing seed per unit weight. Like disease, the presence of weed seeds can either add to the seed bank in the soil loaded with the same weed species, or add new and potentially very harmful species to a farming system. There are few cases where analytical seed quality is a limiting factor in farmers' seed systems. Janssen *et al*. (1992) report that the inability to preserve seed from insect attack is a main reason why Colombian bean farmers buy their seed.

To a large extent genetic seed quality including varietal identity and purity determines the success of a crop. Since it determines aspects like yield potential, yield stability and product quality, the seed has to be adapted to prevailing ecological conditions and produce a crop that meets the consumption and market preferences. These may differ considerably from location to location and between farmer groups of different backgrounds, cultures and levels of wealth.

1.2.2 Seeds of change

Discussions about agriculture and agricultural change inevitably lead to the subject of seed (Tripp, 2001). Since seed is the carrier of the genetic makeup of the plant, it is a key tool for technology transfer. Seed - and in a wider sense agro-biodiversity - together with soil and water management are central to the sustainability of traditional farming systems. Seed is one of the key tools capable of changing complete farming systems. This can be seen, for example, by the effect a new crops such as maize has had on farming in north-western Europe after adaptation to a shorter growing seasons or in situations where changes have been made to existing crops, such as, for example, vegetables that can thrive in soil-less greenhouse horticultural conditions.

The genetic basis also contributes to increased yield stability through tolerance to abiotic stresses or resistances to pests and diseases, or to increased product value through qualities that are either important for a good price in the market, such as the grain colour of legumes, or that have direct nutritional benefits for home processing and consumption (Graham *et al*., 2001). As a result, seed is a key tool for technology transfer and technology driven development strategies and is widely considered a focal point in agricultural progress (McMullen, 1987).

The ability of seed to change agricultural production systems became particularly clear during the Green Revolution (Borlaug, 1968; Brown, 1970). The introduction of short straw wheat and rice varieties that increased yields by increasing the harvest index was a breakthrough of enormous importance in parts of Asia and Latin America. The short growth habit made it possible to reduce plant spacing, the time needed for the crop to reach maturity and most importantly it made possible the effective application of chemical fertilisers because of the greatly reduced susceptibility to lodging. The Green Revolution had important institutional effects, as the value of international agricultural research was readily acknowledged by stakeholders, including donors. National agricultural research organisations in developing countries that had concentrated on export crops in the colonial period increasingly focus on food crops and rural extension services were either developed or strengthened in order to transfer the technologies to farmers. In this way technologies were effectively transferred initially through seeds from international centres being passed to farmers through national public institutions. As a result several countries were able to reduce their dependence on imported food grain (Hesser, 2006).

Yet, the changes were not all positive. There was a difference in adoption rates between better-off and poorer farmers, which led - in many cases - to the latter losing their land before they could benefit from the new opportunities (Lipton & Longhurst, 1985, 1989). In various locations, excessive use of pesticides and irrigation water, and insufficient attention to soil fertility led to a large-scale soil degradation and water pollution. A reduction in crop genetic diversity in the field and in the diversity of foods in the diet of the poor lead to hectic debates about the role of "modern varieties" (MVs) or "high yielding varieties" (HYVs) in development.

1.2.3 Seeds of harmony

Seed is such a vital element of farming that seeds and characteristics of the plants that grows from them are inextricably linked with the culture of the people that developed, selected, maintain and use them. The concept of 'cosmovision' developed in Latin America, which placed agriculture in a holistic world perspective, conceptualizing it as a continuous interaction between the indigenous culture, the environment and technologies (Reijntjes *et al.*, 1992). In this vision, people are seen as part of that world and not as outside managers and users of the environment. They need to protect the harmonious coexistence of the spiritual and material world also in the agricultural methods they use. Living organisms such as seeds play an important bridging role (Ishizawa, 2004).

This vision puts emphasis on the linkage between the seed and people's culture and leads to claims that this linkage needs to be protected from outside pressures and that the seed should be protected from replacement by other varieties if culture is to be maintained. It also leads to demands to protect the seeds from exploitation by others without the consent of the community to which it belongs and it rejects property claims because it is believed that the special character of the seed is given by spiritual powers (Gonzales, 1996).

1.2.4 Seeds of concern

Interest in the genetic value of seeds has created worries about the availability of sufficient genetic diversity for future use. This has lead to initiatives to conserve genetic resources in genebanks, on-farm and *in situ* (Maxted *et al.*, 1997). Genetic resource policies are part of the over-all biodiversity policy arena, covering biodiversity at the landscape, ecosystem, species and genetic levels. Ecosystems are important for genetic resource conservation since the wild relatives of our crops are repositories of crop genetic diversity. Current developments in reproductive and more recently molecular sciences allow the transfer of potentially valuable genes from a much wider array of species to crops than was hitherto possible.

Conserving agro-ecosystems is important for managing the genetic resources of crop species in the wild. In addition, on-farm conservation strategies allow for the conservation and further development of crop genetic diversity through a combination of farmer-led and natural selection.

Finally, genebanks are important for the conservation of genetic resources, and for making these available through their evaluation, documentation and seed management systems (Engels & Visser, 2003). Genetic diversity does not, however, evolve any further in genebanks. Given their different strengths and limitations, these three strategies should be considered complementary rather than exclusive (Hawkes *et al.*, 2000).

The management and use of genetic resources with the aim to broaden the genetic base of crops (Cooper *et al.*, 2001) contributes to 'cashing in' on the option value of genetic resources (Smale, 2006). For this thesis, it is important to note that the diversity of seeds in farming systems are important in the context of global biodiversity policies.

Worries also extend to trends emerging in the commercial seed industry as Mooney observed in the late 1970s (Mooney ,1979). Since then, the industry has gone through several phases of concentration and is now strongly integrated into the pharmaceutical and chemical industries in so-called life-science companies that have interests in the application of genomic (proprietary) knowledge in different fields, including plant breeding (Pistorius & van Wijk, 1999; Dutfield, 2003). The concern is that this will result in corporate power to control seed markets and genetic resources particularly but not exclusively through genetically modified seeds (Murray, 2003). Seeds have, therefore, also become an issue in the various debates on equity, including in the context of the north-south divide the definition of the right to seed-related farmers' knowledge.

1.2.5 Seeds of profit

The value of seed for crop production and the investment needed to overcome seed production limitations is reflected in the commercial value of the seed itself. The self-replicating nature of seed characterises it strongly as a public good. Seed as a tangible asset may not be non-rivalrous but the information embedded in its genetics could be used by one without reducing its utilization by others. However, seed is also a high value commodity. High quality seed may be bartered in local exchange systems against consumption grain at rates of one to two. The value of seed in commercial systems can exceed a factor 50 compared to food grain for some crops (Almekinders & Louwaars, 1999). Such prices reflect the actual value of high quality seed for farmers, and may be much higher that the production costs of the seed itself, leaving opportunities to extract significant funds for research investments and shareholder rent.

The commercial potential of seed provision is an important driver of current thoughts about seed system development in developing countries. Seed provision has long been regarded as primarily serving rural development and food security, and seed supply was thus considered primarily a public task where the benefits of the spread of quality seed would accrue to farmers and countries as a whole through increased agricultural output and food security. Current policies in many countries, however, concentrate on supporting private investment in seed production and supply. This means that public seed production and distribution services are being dismantled or privatised. The emergence of local seed enterprises has been stimulated through tax benefits and intellectual property rights regimes, which also supported the emergence of multinational seed companies on the seed markets of developing countries.

1.3 International and national policies

The importance of seed in agriculture has made seed an issue in national and international policies. Its multiple roles, moreover, makes it vulnerable to policies that may not be directed at seed itself or even at agriculture. It is, therefore, necessary to assess a number of such policies and their implementation in exploring how developing countries can maximise the role of seeds in rural development. These include international policies that focus on agriculture, development, sustainability and trade.

In an increasingly globalised world, issues are debated at the international level. Often this leads to jointly agreed objectives, such as the Millennium Development Goals or rules laid down in conventions and treaties. In the environmental sector in particular, many such treaties have been concluded over the last 25 years in response to the growing recognition that many environmental issues are trans-boundary and go beyond short-term national interest.

The Millennium Development Goals (MDGs) currently play a strong normative role in the development arena and form a good example of jointly agreed objectives that have not been worked out in binding treaty. The MDGs illustrate that – in agricultural development strategies - poverty alleviation now has priority over production-oriented goals. Agriculture is seen as a tool that can be used to achieve a number of goals. This shift is a reflection of the widely held view that the world produces enough food to feed its population and that food insecurity is mainly the result of poverty. However, recent evidence indicates a process of gradually shrinking global food stocks a phenomena exacerbated by policies to stimulate the production of biofuels (Farrell *et al.*, 2006; Runge & Senauer, 2007) and the consequences of climate change (Barrett & Maxwell, 2005). Global, regional and national food insecurity has - in an absolute sense - returned to regional and international agendas (InterAcademy Council, 2004), and agriculture itself is receiving increasing political attention in the development arena (Sachs, 2005; DFID, 2005; World Bank, 2007; IAASTD, in press).

Agriculture itself is subject to a number of international agreements such as the International Plant Protection Convention (1951), and conventions with an explicit reference to agriculture, such as. the Rotterdam Convention on hazardous waste (1998), or less explicitly in the UN Convention to Combat Desertification (1994), the Convention on Biological Diversity (1992) and the Agreements to establish the WTO (1994), for example. One recent agreement that specifically deals with seed is the International Treaty on Plant Genetic Resources for Food and Agriculture (2001).

Sustainable development has dominated the development policy arena as a cross-cutting theme ever since the preparations for the 1992 United Nations Conference on the Environment and Development in Rio de Janeiro and the 2002 World Conference on Sustainable Development in Johannesburg. Even though the concepts are derived from the environment agenda, it is clear that the social and economic implications will impact on other policy fields, including agriculture. For example, the Convention on Biological Diversity has a significant influence on the management of agricultural and horticultural seeds.

Finally, these agreements have to fit into a dominant global strategy in the trade sector, which concentrates on promoting global markets. This trend has been strengthened by the reconstruction of the General Agreement on Tariffs and Trade into the World Trade Organisation (WTO), the many and wide ranging bilateral and regional developments that aim to facilitate international trade and national initiatives that focus on reducing public spending and promoting private enterprise. A good illustration is the Agreement on Trade Related Aspects of Intellectual Property Rights, one of three basic agreements that form the foundation of the WTO which has had a significant impact on agricultural and horticultural seeds.

Many major policies have their roots in international debates. Others reach international fora at an early stage and during formal discussions country representatives or stakeholders from civil society organisations or private sector associations identify the challenges of a changing world, and formulate a joint response. Most of these global responses are implemented through government interventions based on national regulations, and some through private initiatives based on the “People, Planet, Profit” concept in business strategies. Most international policies and institutions do not focus exclusively on agriculture, but they do have a marked effect on crop production and more particularly on seed. These global trends can, therefore, be translated into different views about the development of agricultural production.

1.4 This study

Seeds are at the basis of all crop production. In addition to the importance of seed in production, food security and rural development, seed is key to many debates about technology development and transfer, biodiversity, globalisation and equity. The sustainable availability of good quality seed is thus an important development issue. Seed quality and supply have attracted considerable interest from a variety of perspectives including botany, agronomy, genetics, technology, anthropology, sociology, commerce and law. Most studies, however, limit themselves to very particular aspects of seeds, their physiology, genetics or their connection to social linkages within and among communities.

This study concentrates on the question of how national and international policies and regulatory frameworks impact on the diverse seed systems that serve different types of farmers. This question arises from current developments in the international policy arena combined with concerns that I have that these policies may have effects on farmers' access to this essential agricultural input. The study's main aim is to design a conceptual framework and screen for seed systems that makes it possible to analyse the impact of policies. It then investigates the origin, content and impact of current regulatory frameworks, provides explanations for their often unintended effects and apparent inconsistencies, and proposes options for solving the problems that arise. The main objective is to contribute to the development of policies and regulations affecting seed systems that are more consistent with development objectives.

The analytical framework was developed to capture the different seed systems currently in operation. For this purpose, the dominant linear approach to seed system development (Douglas, 1980), which concentrates on the development of a sustainable, commercial seed provision through fixed stages from a traditional farmers' seed system, is questioned (Chapter 2). Solutions are sought in the parallel development of farmers' and formal seed systems and their interactions that together create, at the national level, a diversified seed system. These solutions are derived from combining literature surveys with my own observations during 23 years of work in and for seed systems in many countries. This has resulted in the screen (Figure 2.3) that is used throughout this book to identify the impacts of different national (Chapter 3) and international (Chapters 4 and 5) policies on various components of the seed systems and their interactions.

In the context of national food security and agricultural development, countries have developed seed policies to guide the use of particular types of seed, and regulations to steer the seed production processes. These regulations aim to facilitate transparency in the market and to create a certain level of consumer (farmer) - protection through procedures and standards for variety release, seed certification and seed quality control. Given the origin of the seed regulatory framework and variety and seed control organsations in the formal seed sector, and the importance of the farmers' seed sector in most countries, Chapter 3 elaborates on the proposition that seed laws do not support farmers' seed systems and often present disincentives to their further development. The analysis focuses on the concepts and components of laws that potentially affect farmers' seed systems. Secondly, given the growing interest in the integration of formal and local knowledge and materials, and the need to support a diverse seed system including private, public and farmers' initiatives as described in Chapter 2, the question arises whether such seed laws can support this type of activity and contribute to the development of diversified seed systems. An analysis of the key elements of such laws and particularly impediments created by seed certification and variety release regulations leads to the identification of opportunities to correct these obstacles.

The major questions investigated are: i) what is the impact of variety release procedures on the types of varieties that are bred and that become available to farmers?; ii) what is the impact of certification and seed quality control procedures on initiatives to support farmers' seed systems?, and iii) can formulations be found in different operational seed laws that minimize or avoid any negative impact on farmers' seed systems? These questions are investigated using 40 seed laws in combination with the screen presented in Chapter 2. The final goal of this analysis is to propose options for developing seed regulations that support diversified seed systems. In order to do this the key elements of laws that create disincentives and obstacles to supporting such diversification are analysed.

Chapters 4 and 5 examine developments at the international level that impact on seed systems. In particular attention is given to the shift in rights over seeds that accrue to various stakeholders through different international agreements. These include private ownership (intellectual property rights), collective rights over seeds and genetic resources (for example, farmers' rights) and national sovereignty over genetic resources.

The fact that the erosion of biological diversity is now more widely recognised has fuelled debate on the value of genetic resources. This debate has been key to the development of the Convention on Biological Diversity (CBD), which introduced the concept of national sovereignty over genetic resources. Agricultural genetic resources form just a small part of the much wider field of biodiversity covered by the CBD. The proposition that national frameworks based on this convention do not support the further development of seed systems or even present disincentives is discussed in Chapter 4. Relevant questions investigated are i) What are the key elements in determining whether agricultural genetic resources can be considered special in the context of CBD objectives?; ii) What is the likely impact of restrictive regulations on access to genetic resources in different types of seed systems?; iii) Does the CBD necessarily lead to restrictive access regimes? Furthermore, since the IT PGRFA has been designed specifically on the basis of the unique character of agricultural genetic resources largely developed in farming systems and the handling of seeds by farmers, an attempt is made to analyse whether the IT PGRFA is more likely to support the diverse seed systems relied upon by farmers. The analysis is based on three distinct regional policies relating to the access to genetic resources and the sharing of benefits derived from their use.

Chapter 5 investigates what the impact might be of implementing different types of intellectual property rights on formal and local seed systems and on initiatives to integration components of these two main systems. It intends to answer questions such as: Are current IPRs beneficial to the development of diversified seed systems?; Which managerial challenges would face public research institutions and what options are open to them?; Can IPR systems be designed in such a way that they support or at least do not to obstruct initiatives to link and integrate formal and local seed systems? The parallel with the analysis of conventional seed laws (Chapter 3) is that intellectual property rights have been designed to support formal seed systems and commercial ones in particular. Any impact on other seed systems may be conscious but should - in most cases - be considered to be a 'side-effect'. The main difference is that the main impetus to develop IPR systems in developing countries comes from abroad. The fact that these systems are very recent in most developing countries presents a methodological challenge. It is extremely difficult to quantitatively assess their impacts. My analysis is based on literature, and particularly on a recent study based on interviews with a wide range of stakeholders in five countries.

A different methodology is used in each of the three analytical chapters. This is because the status and development of the various policy fields differs depending on the countries involved. Seed laws have been in operation in many countries for some decades and, in many cases, they have gone through various revisions. This makes it possible to carry out a detailed analysis of the laws themselves. In many developing countries, Intellectual Property Rights laws have not been operational as far as seed systems are concerned. However, the fact that they have stimulated widespread discussion justifies putting great value on the way stakeholders perceive their future impact. The debate on biodiversity policies has been confined more to the policy levels, which is the reason why we analyse this subject at the level of regional policies. All these policy fields are in the process of development. It is therefore not practical to attempt any quantitative analysis. The fact that they are moving targets, however, greatly increases the potential value of such analysis as an advisory tool for future decision making.

This thesis identifies key elements in existing regulatory frameworks that may obstruct major development goals, and that create inconsistent international policies that produce confusion at national and local levels. Chapter 6 discusses the complex of the international agreements and national regulatory frameworks that have been identified in the previous chapters as having an effect on seed systems. It focuses on the extent to which these instruments are consistent with development goals and the degree of consistency between the instruments themselves. The key questions here are: i) How consistent are the different policy fields investigated in the previous chapters in their impacts on seed systems?; ii) What are the likely origins of the different types of inconsistency observed?, and iii) What ways forward can be suggested.

The confusion arising from this complex of international agreements is apparent in the definition of the word itself: it ***disorients*** national policy makers when they have to comply with requirements of international agreements; it produces ***uncertainty*** among stakeholders in the seed sectors based on a ***misunderstanding*** of the sometimes contradicting rules, and it produces ***disorder*** and ***commotion*** when policies appear to have negative effects.

2. The roles of seeds and seed systems

Abstract

Seed is an important vehicle for improving agricultural output, and major development goals such as food security, sustainable rural development and poverty reduction as well as the effective management of agro-biodiversity can only be achieved if the right types of seed are used. The sustainable availability of good quality seed for farmers is thus an important development issue. Conventional approaches to seed system development are based on a linear approach in which policies should be directed at developing seed systems by guiding them through a number of fixed stages from traditional to commercial. Seed policies in developing countries have long concentrated on this approach which aims at transforming farmers' seed systems into commercial, formal seed systems. This chapter questions the validity of this approach and aims to develop an alternative framework for analysing seed systems and for designing new ways to develop seed policies.

This chapter analyses different seed systems and in particular assesses the conventional approach to seed system development. It is based on an assessment of available literature and the authors own experience in a wide range of countries over the past 23 years. Two distinct seed systems have been identified: the farmers' and the formal seed system. Each has its own advantages and limitations. Farmers' seed systems are particularly - but by no means exclusively - important for resource-poor farmers growing their crops in ecologically diverse conditions, because of the importance of specifically adapted varieties and/or for reasons of seed price. These farmers' seed systems are by far the most important suppliers of seed for most crops in developing countries. Formal seed systems, on the other hand, provide tested seed to farmers in an organised manner known as the seed chain.

The linear system applies to a very small number of crop seeds. It is, therefore, neither useful for describing reality nor for guiding various seed related policies. The main arguments discussed are i) The development towards a commercial seed market is not realistic for some major and for most minor crops, and ii) The differential speed of development among crops and target groups creates major problems when policies and regulations focus only on the most advanced crops. This assessment leads to the conclusion that an approach that only takes into account the linear system cannot be justified.

It is proposed that recognition should be given to the fact that different seed systems need to operate side by side. They serve the needs of different types of farmers and different types of crops. Integration of the two major systems at the level of both knowledge systems and plant materials through different links of the seed chain can be very productive. Participatory methods in variety selection, breeding and genetic resource management, adaptive seed technologies and the promotion of small-scale seed enterprises create multiple opportunities for upgrading the quality and sustained availability of locally produced seed. These methods can complement efforts by the formal seed sector to supply profitable seed products such as hybrids of field crops and vegetables to commercial farmers, and occasionally to small-scale farmers as well. This approach emphasises the need to support a more diversified seed system, consisting of public and private formal seed supply, farmers' seed supply and a wide range of intermediate models all operating side by side.

This type of diversified approach creates challenges for both scientists and regulators, but the linear model is shown to over-simplify reality leading to ineffective or even counterproductive regulations and investments.

2.1 Introduction

- A crucial input for crop production
Seeds are a basic requirement for crop production and one of the most precious resources in farming. The choice and handling of the seed determines to a large extent the success of the crop. For every farmer the two key issues as far as seeds are concerned are availability and quality (Almekinders & Louwaars, 1999).

The importance of seed in crop production and food security and its ability to play an important role in technology transfer and improving farming systems has led to government interest in the organization of seed supply. In industrialised countries this has led to public investment in research and quality control institutions that help guide sector seed production. From the late 1950's development policies in developing countries placed the entire formal seed system from genetic resource management and breeding to seed distribution under public control.

After initial investments in breeding and seed in the 1960s and 70s, many developing country governments, often with donor support, developed seed policies and regulations to guide the further evolution of the seed sector. These policies were highly influenced by a seed system development paradigm published by Douglas in 1980. He laid down a linear approach that identified four stages. It was thought that the main challenge facing governments was to develop an environment that would facilitate the transformation of the current system into what would eventually be a modern, sustainable, commercial seed system. The approach required associated interventions such as targeted investments in infrastructure, support through tax benefits and the granting of intellectual property rights to emerging local seed enterprises and the foreign seed companies involved in developing country seed markets. Box 2.1 describes these four stages.

Douglas describes in detail the range of technical, institutional, legal and human resource requirements for moving a national seed system up one step at a time in a coordinated way. Governments would just have to take the right legal, institutional and economic measures to support such steps. The ultimate goal is a commercial seed system that assisted by government only where strictly necessary. Seed quality control and breeding are considered the last operational functions that the government could choose to phase out. Pray and Ramaswami (1991) support this approach and Jaffé and Srivastava (1994) translate it into actual options for actions in government or donor-assisted programmes.

- The challenge
This chapter analyses whether the linear approach to seed system development presented by Douglas sufficiently describes reality and whether it can be used as the basis for developing policies and national regulatory frameworks.

Box 2.1 Seed programme development stages according to Douglas (1980)

Stage 1 Agricultural research and development are ineffective, limited, or just getting under way. Most varieties of basic food crops are traditional, as are production practices. Nearly all farmers save their own seed, but a plant breeding department may be distributing small quantities of improved varieties of some crops.

Stage 2 Agricultural research and development are under way. Improved varieties of basic food crops are being developed and are beginning to replace traditional varieties. Use of production inputs, such as fertilizer is limited but improving. The limited quantities of seed available are a constraint upon improvements in crop production.

Stage 3 Agricultural research and development are well established and productive. High-yielding varieties of basic food crops are rapidly replacing traditional varieties in the most productive areas of the country. Production inputs are widely used, although usually not at the most efficient levels. Many components of a seed program exist, and the supply of seed ranges from fair to adequate. Seed quality may be poor, distribution remains relatively inefficient, and farmers use much less seed than is available for distribution. Some private seed enterprises are being formed.

Stage 4 The agricultural sector is well advanced. The national seed policy is re-examined, special attention is given to developing and strengthening commercial seed production and marketing, a seed law is in force, and links are established with related and supporting institutions and groups.

The proposition is that Douglas' linear approach to seed system development is misleading when it comes to analysing the complex development of seed systems in developing countries. It does not provide national policy makers with the information and advice they need to design public initiatives capable of guiding and supporting seed system development.

The integration of farmers' and formal seed systems as proposed by Louwaars (1994) is developed as an alternative approach. This framework can be considered an extension of experiences in participatory breeding and variety selection to all components of the seed system. The graphic representation of the concept which was developed in subsequent years with colleagues at the Centre for Genetic Resources in Wageningen is developed in this chapter as a screen that will be used in subsequent chapters to analyse the policies and regulatory frameworks affecting the seed sector.

In order to analyse Douglas' paradigm, this chapter describes and characterises farmers' and formal seed systems, their relative importance and their advantages and disadvantages as far as meeting farmers' needs are concerned (2.2). Based on this characterisation, the linear approach will be discussed (2.3) and an alternative way of looking at seed system development is presented (2.4).

2.2 Seed systems

2.2.1 Farmers' and formal seed systems

Seed supply systems are analysed by identifying two major types:

- Farmers' seed supply systems, covering methods of local seed selection, production and diffusion (see Figure 2.1). Cromwell (1996) describes these systems as 'traditional', 'informal' seed systems; Louwaars & van Marrewijk (1996) as 'local', since they operate mainly at farmer and community levels both in terms of production and exchange mechanisms. Almekinders & Louwaars (1999) introduced them as 'farmers' seed systems', being the most neutral term and one that made clear that the ones operating this system are the farmers themselves.
- Formal seed supply systems, covering seed production and supply mechanisms operated by public or private sector specialists in different aspects of seed supply and ruled by well defined methodologies, controlled (stages of) multiplication, and in most cases regulated by national legislation and international standardisation of methodologies (see Figure 2.2). Such systems are introduced, organised, operated in most cases at (inter) national level, and generally involve cash transactions and large uniform quantities. This corresponds with the terms 'conventional seed sector' (Camargo *et al*., 1993) and the 'organised seed sector' (Reusché & Chopra, 1993).

- Farmers' seed systems

Farmers' seed supply systems are based on the recurrent production and selection of seeds alongside or as part of crop production. Historically, the use of seed marks the transition from human food collection to agriculture and the transition from early nomadic to the first sedentary civilisations (Harlan, 1992). Characteristics of plants that are not optimal for the prevailing methods of crop production are selected against and other characteristics, such as larger grains, non-shattering of seed and erect plant architecture are selected for. In this process, plants have changed considerably and new types have developed, some even having biological crossing barriers with their ancestors and thus developing into new crop species, for example. maize, triticale, and triploid bananas (Simmonds, 1979: 8-9).

These processes continue to generate new diversity (Quiros *et al*., 1992). Many farmers today continue to select good plants, panicles or grains from their crop in order to obtain a source of the seed for their next plantings. The resulting diversity is based on the diversity of ecosystems in which the selected takes place, the diversity of farmers and their selection methods and the diversity of selection objectives that they use (for example,. grain and straw yield, cooking and consumption qualities, storage characteristics, etc.). Some farmers take an interest in seeds and develop into local seed specialists, whereas others may be better at optimising land preparation and soil fertility or some other skill (Louwaars & van Marrewijk, 1996). Uncertainties about seed saving due to natural disasters or other sources of seed insecurity, plus the fact that the crops of the local seed specialists may germinate better due to additional care and may gradually improve genetically are the major reasons for traditional seed exchange or trade at the local level. The value of seed is recognised in local (barter) trade, but handfuls of seed are commonly shared among farmers and communities because there are many farmers who are always looking for new types of seeds as 'things to try' (Jiggins & de Zeeuw, 1992). Next to seed selection as part of crop production and the selection of seed for each crop planting, there is a sharing, a diffusion of seed among farmers and farming communities (Figure 2.1).

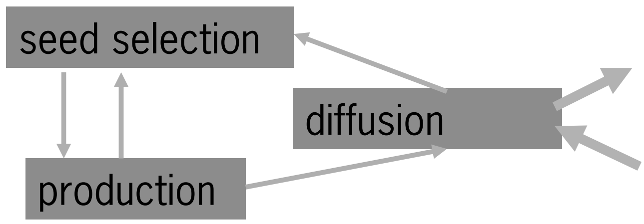

Fig. 2.1 the farmers' seed system, consisting of crop/seed production, seed selection and diffusion (with the occasional in- and outflux of seeds). Seed, selected from own production or from other sources provide the basis for a new production season (this study).

Even though the genetic quality of the seed is recognised and valued in farming communities, there are no reports of such values being monopolised (Salazar *et al*., 2005). The farmers' seed system can be depicted as a rather closed system of production and selection that is open for occasional out and influx of materials through diffusion (Fig. 2.1). Seed materials and the knowledge associated with them are closely linked and embedded in the community and are often closely associated with the community's identity (Perales *et al*., 2005).

- Formal seed systems

Commercial seed systems emerged in industrialised countries in the second half of the 19th century and rapidly developed further after the re-invention of Mendel's laws on heredity in the early 20th century. The development of a commercial breeding and seed sector in the USA was especially enhanced by the discovery of the phenomenon of heterosis and the subsequent introduction of hybrid varieties of maize (Kloppenburg, 1988). This trend separated crop improvement and seed production from other regular farm operations, creating different specialised actors, including breeders, seed producers and seed conditioners. In industrialised countries this development was associated in the early 20th century with an increased use of farm inputs like chemical fertilisers and mechanisation followed by chemical crop protection.

Such formal systems have been refined over time and specialised procedures and institutions have evolved, namely:

- breeding research and practical crop improvement (breeding),
- continuous variety maintenance procedures,
- regulation of a generation system in seed production from breeder's to certified seed; certification systems are then harmonised internationally through the OECD seed schemes (OECD, 2005a), and
- tested seed quality systems for which all procedures and techniques have been harmonised internationally (ISTA, 2005).

Different countries developed different levels of formal (state) regulation and control for the different links in the chain (Kloppenburg, 1988). The formal seed system aims at securing a trusted supply of seed to farmers who can thus access the results of plant breeding and obtain seed of a relatively constant and trusted quality.

The formal seed system is considered a chain (van Gastel *et al.*, 2002). This chain represents a one-directional flow of seeds from genebanks and breeders' working collections ('genetic resources' in Figure 2.2) to breeding programmes, and further through seed production and marketing and distribution programmes to farmers' fields where they are used as an external input. Next to genetic resources, breeders also use a range of technologies which may originate outside the field of breeding, such as modern statistical and genomic tools, which are made applicable in practical breeding by 'breeding research'. There is a small feedback mechanism in this material chain since new varieties finally also end up in genebanks as inputs for further use in crop improvement (Fig. 2.2).

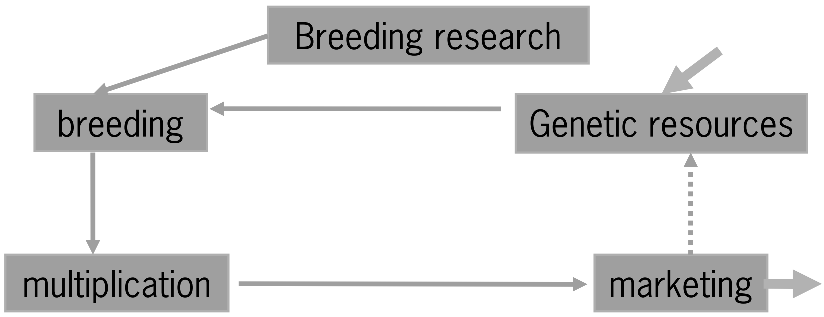

Fig 2.2 the formal seed chain, starting with genetic resources and knowledge derived from breeding research, and moving through plant breeding, seed multiplication and marketing stages to finally reach end users outside the system. The arrows represent the flow of seed (and associated knowledge) through the chain. The dotted arrow represents the inclusion of finished varieties in the genetic resources collections (this thesis).

The formal seed sector is mainly organised in one direction. It forms a pyramid with small quantities of breeder's materials at the top and large quantities of commercial seed in the marketing channels. As far as genetic diversity is concerned it is a funnel with a wide variation in the genebanks at the top and a very small number of varieties that actually reach the farmer. This chain is a closed system of materials except for the very small quantities of seed from local varieties or wild relatives that may be taken up in the genebank collection (and turning the chain in a loop). At the marketing end of the chain seed leaves the system when it is used by farmers, and in some cases is reused and distributed further in the farmers' seed system. The main feedback mechanisms consists of information flows that make sure that breeders develop varieties that the customers need and that the seed production planners can use to make sure that sufficient seed of the required qualities is available on the market.

Formal seed systems have developed very effectively for most crops in industrialised countries. The introduction of hybrid varieties in maize in the USA triggered a fully commercial seed sector for that crop from the 1920s onwards, whereas for other crops (notably cereals and pulses) components of the system such as plant breeding still depend heavily on public investments (Kloppenburg, 1988). In other countries, such as

The Netherlands, the public sector has withdrawn completely from breeding except for some perennial fruit crops. The government does, however, invest heavily in upstream breeding research, particularly in genomics and its application in breeding. The large-scale scientific plant breeding of food crops for developing countries to increase national and global food security started in the 1950s. This was followed in the 1960s and 1970s by significant investments aimed at establishing formal seed production systems (Feistritzer, 1975). The main emphasis of these seed initiatives was to spread the "high-yielding varieties" of the Green Revolution as quickly as possible with a development and food security focus. Seed production was thus considered primarily a public task (Feistritzer, 1984). Between 1958 and 1987 the United States Agency for International Development (USAID) supported the development of the seed sector in 57 countries. The FAO Seed Improvement and Development Programme (SIDP: 1972-1984) covered 60 countries, whereas the International Bank for Reconstruction and Development (World Bank) funded 13 national seed programmes and at least one hundred other seed related projects in the decade following 1975 (Venkatesan, 1994; Wiggins & Cromwell, 1995; Cromwell, 1996). These programmes were geared to developing the capacity to multiply quality seed of modern varieties and distributing it to farmers in order to modernise agriculture and contribute to national and global food security. Seed was considered a tool for technology transfer. The programme included the establishment of contract growing schemes within the public sector, the erection of large-scale seed processing facilities and basic seed quality control infrastructure and the development of the human resources needed to implement these plans. Large numbers of seed technologists were trained in these programmes, notably at Mississippi State University in the USA where significant expertise in supporting developing countries in seed technology had been developed (Vaughn *et al*., 1968). Distribution was commonly organised through the public agricultural extension services (Feistritzer, 1984).

From 1985 onwards, many of these seed production programmes included aspects of commercialisation, i.e. privatisation of public sector entities and promoting private investments in the seed sector. The privatisation trend in seed system development became part of a more general shift from conventional formal seed supply to a modern seed industry framed to look like the successful commercial seed industry in industrialised countries. The shift requires the primary focus on seed production to gradually change to seed demand (Heisey & Brennan, 1991; Maredia *et al*, 1999).

Seed policies that followed the general economic policies of structural adjustment led to the transformation of public seed units into viable seed enterprises. This proved much more difficult than expected (FAO, 1999; 2000a,b; 2001a,b) largely because of the shift in 'driver' needed for such a transition. In development-oriented seed chains it is the breeding component that drives the chain: seed production and marketing are necessary to take new varieties to as many farmers as possible. In commercial seed systems it is primarily the marketing component that takes the lead. Even though the basic components are the same (breeding, seed production, marketing), developmental and commercial formal seed systems are fundamentally different. Insufficient appreciation of this difference is an important reason for the fact that many attempts to commercialise the public seed production infrastructure failed (Louwaars, 1990).

- Linkages between farmers' and formal seed systems

Conventionally, the formal and farmers' seed systems remain separate except for two major points where they meet (Fig. 2.3):

i) Genetic resource conservation activities extract the diversity from the farmers' seed systems, where locally selected landraces evolve, and

ii) Seed marketing brings new varieties into the farmers' seed system where they can be multiplied as new varieties or mixed and hybridized with local materials.

In most countries, this separation is clearly visible and seed policies concentrate on developing an efficient formal seed system.

In conventional seed system development strategies, this separation is confirmed. Farmers' seed systems are considered traditional and backward systems providing un-tested and thus poor quality seed and not warranting major support or investments. The formal system is regarded as a modern organisational form and one that is essential if agricultural development is to take place.

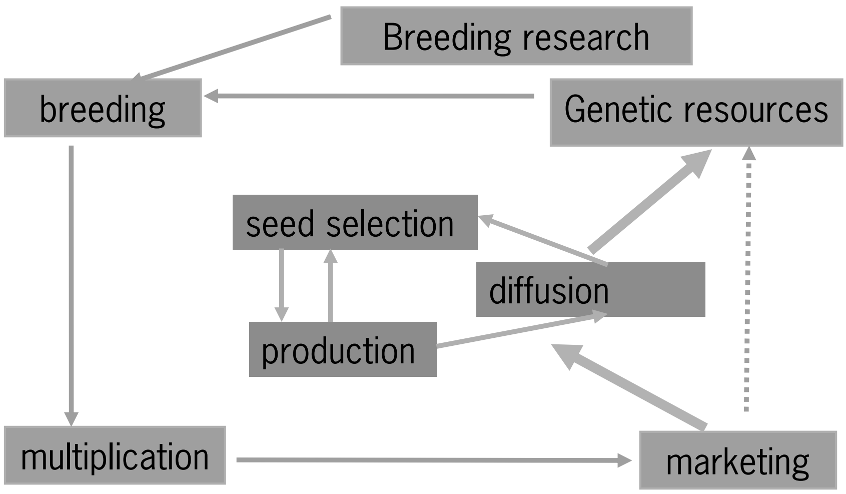

Fig 2.3 Links between the largely separated formal (outer circle) and farmers' (inner circle) seed systems - see Figures 2.1. and 2.2 (presentation adapted from Almekinders & de Boef, 2000)

2.2.2 Relative importance of formal and local systems

- Seed use

Despite the efforts put into developing formal seed supply in developing countries over the past 50 years, at the global level farmer-produced seed remains by far the most important source of planting materials. Some national seed policies, for example, in Russia, aim at replacing farmers seed by formally produced seed every season, others such as India concentrate on reaching a 'seed replacement rate of 2 – 4, meaning that all farmers are expected to use new uniform varieties and that they purchase seed every 2nd to 4th season (Heisey & Brennan, 1991).

The importance of farmer-produced seed varies between crops, farms, regions and continents. It is by far the most important source for small-scale farmers in low-input agriculture in developing countries. Farmers' seed is the only source of planting material in situations where no formal sector breeding or seed supply exists for such food crops as indigenous vegetables and root crops like yam and sweet potato.

Turner (1994) estimated the use of formally produced seed of field crops in India, one of the countries with the highest foreign and local investments in seed industry development since the early 1960s. For rice the coverage by formal seed (certified and truthfully labelled) approached 10%. For all other major crops including wheat, groundnut and chickpea, the formal system accounted for less than 5% of the total seed use. Only for sunflower – a minor crop in India - was the percentage over 50% (Fig. 2.4). The situation in other developing countries is either similar or even more dependent on farmers' seed systems.

Crop	*Total seed requirement*
Sunflower	*1,640*
Pearl millet	*4,180*
Rape/mustard	*2,880*
Castor	*1,010*
Jute/mesta	*1,020*
Sorghum	*17,400*
Cotton	*14,800*
Maize	*11,900*
Rice	*127,800*
Safflower	*980*
Black gram	*6,800*
Soybean	*14,820*
Bean	*6,840*
Sesame	*1,300*
Peas	*3,300*
Wheat	*239,800*
Pigeon pea	*7,240*
Groundnut	*124,500*
Lentil	*4,640*
Chick pea	*55,580*
Linseed	*2,880*

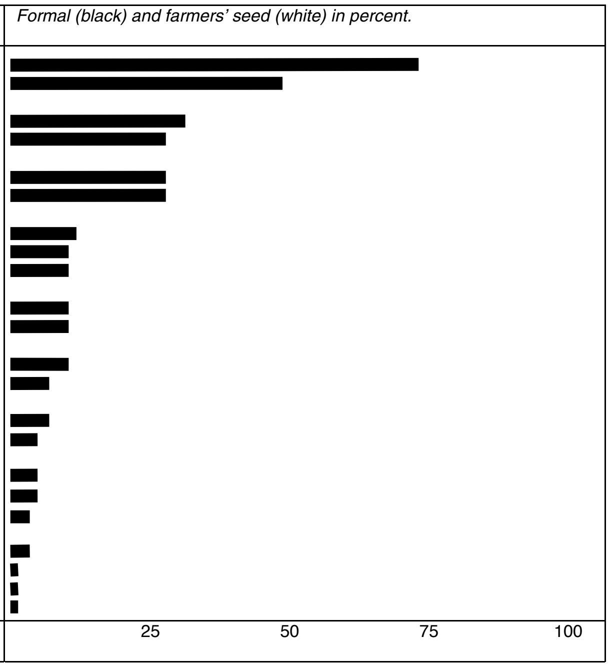

Figure 2.4 Availability of certified and truthfully labelled seed in India as percentage of total seed requirements (tonnes): 1992 – 1993. Source: Turner, 1994.

Data collected in the 1980s within Europe indicate that in Denmark and The Netherlands, approximately 90% of seed was purchased. This percentage was only 10% in southern European countries like Italy and Greece (COSEMCO, cited in Gaasbeek *et al.*, 1996). European seed producers currently estimate the use of farm-saved seed in major cereal markets in Europe at 50% (http://www.advanta-europe.com/show?id=85250&langid=96 last checked 07 May 2007). The importance of farmers' seed systems in Europe often comes as a surprise to many seed specialists and agricultural policy makers in developing countries.

- The use of modern varieties
The failure of the public seed production initiatives to meet high expectation as far as seed replacement rates in many countries are concerned does not mean that the formal sector does not have a very significant impact on farming. Table 2.1 illustrates the spread of scientifically bred varieties in different regions, in many cases despite a limited share of the formal system in the seed market. This is largely because of efficient farmer-to–farmer seed exchange mechanisms and – as in Europe – it is a mistake to think that all farmer-produced seed is likely to be of local varieties.

Table 2.1 Percent area planted to modern varieties of rice, wheat, and maize in developing countries

	Rice (1983)	Wheat (1990)	Maize (1990)
Sub Saharan Africa	15	52	43
West Asia/North Africa	11	42	53
Asia (excl. China)	48	88	45
China	95	70	90
Latin America	28	82	46
All developing countries	59	70	57

Source: Byerlee, 1996

2.2.3 Analysis: advantages and challenges of the two systems

- Farmers' seed systems
Farmers' seed systems are particularly important when
i) Seed of acceptable quality can be produced and obtained relatively easily,
ii) Formal seed systems are absent, inefficient or expensive, or
iii) Preferred varieties with specific adaptation to local conditions cannot be obtained from the formal sector.

Farmer seed systems are particularly important where seed is actually the edible or marketable product, generally readily available and the level of local knowledge in relation to seed quality is high. Since seed selection and handling in most cultures is the responsibility of women, this local knowledge is commonly concentrated in the female sections of society (Howard, 2003a,b).

Formal seed systems have been developed mainly for major food crops and high value crops (see 2.2.2). For many crops, especially those that are important for home consumption and the local market, farmers have to rely on their own seed in the absence of alternatives. This is commonly the case for many pulses, most root and tuber crops and indigenous vegetables. The relation between the importance of the farmers' seed sector and the varietal aspects has received attention. Local varieties may have remarkable adaptations to local farming conditions. Fore example, de Rouw (1991) describes very tall varieties of upland rice in forest areas of Ivory Coast that are very competitive with weeds and that fit very well in the labour-constrained farming system.

Formal seed producers cannot carry too many varieties of each crop efficiently. Farmers in ecological niches, in ecologically diverse areas and producing for very specific uses, are least likely to benefit from varieties from the formal sector. At the same time, these farmers maintain a large genetic diversity within (and between) crops, which makes them interesting co-operators in programmes that aim at the on-farm management of plant genetic resources.

Key problems in farmers' seed systems are availability and quality; more specifically related to

- seed security
- the anti-cyclic nature of seed availability
- crop-specific limitations due to quality constraints
- limited adaptation of local germplasm to changes in demand
- local ignorance

Where seed is commonly readily available, farmers may be poorly prepared for shortages. Problems with seed security can be acute, for example, because of drought or civil unrest, or chronic, basically due to poverty and the inability to put seed aside from the harvest (FAO, 1998). Farmers who fully depend on their own and their neighbours' crops for seed are vulnerable and seed has become an important relief product in recent years (Sperling, 2001a; Sperling *et al.*, 2004). The dependence on relief supplies of seed during and after civil unrest or natural disasters can also lead to a loss of genetic resources (Huamán & Schmiedliche, 1991; Richards *et al.*, 1997).

A more fundamental problem in local seed supply is that the seed supply of major crops is anti-cyclic when compared to crop production. After a productive season, there is plenty of seed available, and demand for seed among neighbours or relatives and on local seed markets is low, because most farmers have been able to combine saving seed with their consumption needs. After a poor season, however, seed availability is low and demand is likely to be high. When contacts with communities in areas that have experienced a better cropping season are limited, over-all seed shortages can occur and farmers may have to rely on poor quality planting materials, such as food grain obtained in the market whose varietal characteristics and seed quality are unknown (David *et al.*, 2002).

Some seeds are easier to produce than others even when the seed is the same part of the plant as the consumed product. Germination capacity and vigour can be lost during storage, seed transmitted diseases may build up in a seed stock and varieties can 'degenerate' because of insufficient selection. Such quality constrained farmers' seed production is in general less pronounced in the centres of origin or domestication of crops than areas where the crop was introduced later (Almekinders & Louwaars, 1999). Similarly, some seeds are easier to breed than others. Farmers tend to have a more intimate knowledge of their major crops, and selection is likely to be more precise and intense in these types of crops than in others. Also, the availability of more modern varieties of such crops may trigger a wider use of variation and a stronger interest in local breeding, in several cases leading to 'modern farmers' varieties' that can be fairly uniform and well adapted to advanced mono-crop production, However, they are distinctly different to varieties from the formal sector (Salazar *et al.*, 2005).

As long as farmers' selection depends on natural ways of creating diversity (mutations and occasional introgression from wild populations and introduced varieties), improvement and adaptation of the crop to changing farming conditions is normally quite slow. Adaptation may be necessary, for example, to deal with a gradual decrease in soil fertility (Stoorvogel & Smaling, 1998), the introduction of new (strains) of diseases (Strange, 2005), or to meet the needs of farming systems that are in the process of change because of population pressures, the introduction of new technologies or radical changes in markets (Dyer, 2006). Some of these changes are major and cannot easily be met by existing genetic diversity. Movement of potentially good materials to cope with such developments can be very efficient among farmers, as is illustrated by the rapid spread of new materials outside the official system, such as the rice varieties Pokhreli Masino in Nepal (Green, 1987), Mahsuri in India (Maurya, 1989), and Bordagol in the Philippines (Salazar, 1992). However, ecological (mountain ranges) or social (tribal) barriers can reduce the introduction of new materials into farming systems (Green, 1987).

Finally, despite the extensive local knowledge base of communities that depend on their own varieties and seeds, there remains a certain level of local ignorance as well. In seed related issues this commonly translates into assigning the appearance of severe disease epidemics to rain (own observation in Sri Lanka and Uganda), whereas they are actually based on seed transmitted fungi or bacteria. In such cases opportunities to considerably improve crop production through seed selection and treatment may be missed. Other examples of shortages in local knowledge are reported by Louwaars & van Marrewijk (1996) who observed the extraction of seed from tomato and snap bean crops at the end of the cropping season when diseases have accumulated in the plants rather than leaving healthy fruits to mature early in the season. Another example is illustrated by George (1985) who reported 'the temptation to sell the good quality melons in the local market and to save seeds of the off-types or otherwise unmarketable fruits', thus risking selection for unwanted characteristics. Louette *et al*. (1997), moreover, report beliefs in Mexico that offspring of maize plants have intermediate characters because roots of neighbouring plants touch and 'marry'. This creates an understanding of cross fertilization, but on the wrong evidence.

- Formal seed systems

Formal seed supply can tap scientific insights in breeding, seed technology and marketing. Potentially it can produce markedly better seed for crop production, but it depends to a large extent on the effectiveness of the feedback mechanisms that inform breeders what to develop and seed producers how much to produce for which markets. Limitations of the formal seed systems are illustrated at the level of the individual components and in terms of the connections between the components.

Formal seed chains are as strong as their weakest link. Systems where the breeding component is weak have 'nothing to sell' that farmers do not already have and tend to lose impact. Many farmers purchase seed primarily to access new varieties. Uganda, for example, faced this problem in the late 1980s when civil unrest had disrupted public breeding for over a decade, leaving the formal system without a marketable product (own observation, 1987). Similarly, the chain will break when seed production is poorly organised and seed quality is low or when the delivery system fails, and the seed does not reach the farmers in the right quality and quantity at the right time and price (Gregg & van

Gastel, 1997). The interdependence of the different components is a challenge for the organisation of a formal seed chain.

Breeding: Since breeders in the formal system in principle have access to the genetic resources of the whole world, they can produce any type of variety, given time and resources. They may find it impossible to satisfy some farmers' needs, especially those located in ecologically or culturally diverse areas. Louwaars & van Marrewijk (1996, p 68) identify three main phenomena that are responsible for poor adaptation of scientifically bred varieties in smallholder farmer conditions: focus on wide adaptation, lack of knowledge of farmers' conditions and preferences, and a certain breeder's arrogance that blocks contact between breeders and farmers or extension workers.

There is a cost to trying to develop adapted varieties for every ecological niche. In practice, breeders both in the public and in the commercial sectors are required to breed for wide adaptation instead of developing different varieties for each niche. In the public domain this is considered necessary in order to maximise the impact on national food production; in the private sector it is done to maximise seed sales and royalty incomes. This explains the success of plant breeding for either large 'recommendation domains' (Hildebrand, 1984), i.e. areas with rather homogeneous environments such as for wheat in the Punjab, or conditions that are made homogeneous through the application of fertilisers and pesticides in intensive crop production systems, for example. in horticulture or through irrigation systems, in particular in rice. In addition, limited feedback mechanisms and limited importance that (mainly publicly employed) breeders give to such feedback are often responsible for the development of poorly adapted varieties.

There are advantages to applying modern techniques in *seed production* as well and scale advantages in producing high quality products. However, here too the desire to aim at specific adaptation causes problems: producing, processing and stocking many different varieties of the same crop increases costs and reduce chances in the market. Commercial seed producers, therefore, cannot cater for all ecological niches with different, specifically adapted varieties. They have to choose for varieties of important crops that can be sold in many markets. In the words of Echeverría (1990): "private (maize seed) companies are working for the best endowed areas where the large-scale farmers tend to be located. Multinational companies have greater interest in the more uniform areas where a variety . . . can be marketed widely".

More fundamental to the analysis of sustainable formal seed systems are questions that relate to the *marketability of seeds* based on the biological differences between 'seed products' and the level of market orientation of crop production itself (Almekinders & Louwaars, 1999, chapter 9). Farmers are most likely to purchase seeds when they can provide more advantages than farm-saved seed. This means that a commercial seed market with sufficient mark-up levels can develop only if specific benefits can be obtained from purchased seed (new varieties) or when farmers face sufficiently severe problems when saving or accessing farm-produced seed. These problems are then offset against the price difference between purchased and farmers' seed:

- *Quality-related factors:* seed quality includes physiological, analytical, sanitary, and genetic aspects. Some crops – such as soybean in Indonesia (Amstel *et al*., 1996) are renowned for longevity problems in humid-tropical conditions, thus providing opportunities for commercial seed provision. Seed transmitted diseases like grain smut in sorghum can also increase the demand for seed if the supplier can guarantee freedom from this disease, for example, through a chemical seed dressing. Also pest problems during local storage create an incentive to purchase seed (Janssen *et al*., 1992). Genetic problems create an incentive to purchase seed when farmers are unable to maintain the genetic uniformity or identity of the variety something that is particularly difficult with cross-fertilising crops and which is obvious in hybrids.

- The *seed price* is often an obstacle to farmers using seed from the formal sector, especially when cash transactions are required and the previous crop had been sold several months earlier. Proponents of the formal seed sector counter this concern with the slogan "good seed does not cost, it pays", a slogan which is used by various seed producers, certification agencies and projects. However, the investment in seed differs from crops to crop and this influences the capacity to buy seed. A major component is the *multiplication factor,* the amount of seed relative to the average yield. This factor is crucial for farmers in determining whether purchasing seed will pay off (Maredia *et al.*, 1999). For crops with a low multiplication factor, such as groundnuts in East Africa (100 kg sown, 600 kg harvested per hectare), the investment in seed is enormous. Very few farmers would want to pay more than twice the (confectionery) groundnut price for seed, because this would raise the investment in seed to over 33% of the crop value, thus leaving little room for investments in land preparation, crop protection and harvesting. Conversely, when the multiplication factor is high, a small improvement in the yield through the use of better seed is enough to warrant a seed price of even four times the grain price. The investment in the case of sorghum, for example, which yields 1 MT/ha when planting 6 kg per ha, would be close to 2.5%.
- *Biological factors:* Commercial seed production becomes very interesting when farmers are unable to produce seed themselves. This is the case with many vegetables, where farmers either do not have the opportunity to produce seeds, for example in the case of biennal crops like cabbage in tropical conditions, or to re-produce the variety such as in hybrid maize, pearl millet or bitter gourd (George, 1985).
- *Other economic factors:* As a general rule, opportunities in seed business increase when a major share of the crops is sold on the market. Developing a seed market for (mainly) subsistence crops is extremely difficult. Even when a net benefit can be illustrated, cash investments in locally consumed crops are not made readily. This limits market opportunities for crops like finger millet and beans in East Africa.

Commercial formal seed sector

The commercial formal seed sector is thus least effective for the self-fertilising crops with a low multiplication factor that are used in diverse environments (large genotype x environment interactions), and where the crop is primarily used for home consumption (Almekinders & Louwaars, 1999: 135-146). Since these characteristics are very common for almost all field crops grown by resource-poor farmers, it is concluded that policies to support the formal seed sector are not likely to favour resource-poor farmers.

The above analysis further indicates that seed enterprises have to consider two types of competitors: their fellow seed companies and the farmers themselves. When commercial seed suppliers find an answer to the challenges of on-farm seed production to meet quality and availability requirements, they are likely to be able to increase their margins and pay more attention to grading, packaging, marketing, and even breeding while securing an interesting rate of returns. A commercial sector is indeed emerging in several countries for those crops that offer prospects of viable enterprise development. In many countries there is now a commercial sector for modern varieties of maize and other hybrid cereals as well as oil crops, vegetables and some important cash crops like cotton.

Public formal seed sector

Most public seed enterprises have been built to produce seed of the main food crops like cereals and pulses. These are usually self-fertilising crops with a low multiplication factor where commercial seed producers face important competition from farm-produced seed.

In such situations chances of successful privatisation are slim and continuous public investments are needed to maintain the formal seed sector.

Many public sector initiatives do not prove to be very successful when measured against the standards of institutional sustainability. Many public seed enterprises have lost their importance in the market (for example, Uganda), have faced bankruptcy (Tanziania), been sold (Malawi) or split up (Ethiopia). The more successful these public seed systems were in producing large quantities of seed, the more severe their cash-flow problems became, partly because of low profit margins and partly due to government restrictions on financial and human resource management. Moreover, many public seed enterprises suffer from over-staffing (Bangladesh). Secondly, large amounts of money are locked up in seed stored between the time of purchase (from contract growers) and sale. Large amounts of cash during the other part of the year are liable to reductions in value in countries plagued by inflation, particularly when funds cannot be invested in other business initiatives because of strict government accounting rules. Many national seed programmes have become donor-dependent as a result of the above trends. Inefficiencies that are inherent to government-run production units were largely held responsible for the poor coverage and the lack of financial sustainability of these units.

2.3 Discussion: critique of the linear approach

Based on the observations and evidence presented in Section 2.2, the linear approach to seed sector development elaborated by Douglas (1980) described in Box 2.1 is analysed.

The first three stages of Douglas' approach describe the history behind the development of components of the formal seed chain in the public sector. It illustrates the public agenda of increasing agricultural output for food security, export and rural development. Stage 1 is the phase where research stations distribute some seed to selected farmers; in Stage 2 agricultural inputs are more widely used and adapted varieties are available, but in small quantities; and in Stage 3 an inefficient public seed production sector has developed which encounters adoption problems. The driver in each of these stages is agricultural research and breeding. There are major shortcomings to this approach.

The approach bypasses the capacities of farmers to deal with seeds. It is built around the idea that scientific knowledge can solve the problems of farming by breeding 'improved varieties' and providing 'high quality seed'. Farmers are positioned as recipients of this technology who just need to be convinced to adopt the new seeds. It excludes support to improving other types of seed supply even when farmers may be quite capable of producing seed of acceptable physiological quality and securely available as quantitatively illustrated in Section 2.2.2.

A second criticism concerns the assumption in the linear model that seed systems would or should develop along the same lines for all crops and for all seed users. The projects that were derived from this seed system development paradigm concentrated on just a few major food crops only, notably rice, wheat and maize and some pulses depending on the country. Even though this may be justified in terms of increasing national food security as measured in calorific value (Flores-Palacios, 1997), this choice carries the inherent assumption that the needs of all farmers are similar for these crops, and that farmers do not need support for other crop seeds (millets, root crops, vegetables). The approach is based on national food supply needs rather than farmers' priorities. Bypassing the farmers' seed systems means that initiatives were not based on a thorough analysis of the limitations that farmers experience with respect to their seed supply. Therefore, they were not geared to solving actual problems, but followed a modernistic development blueprint that replaced rather than built upon existing seed supply systems.

Additional limitations emerge in the transition from Step 3 to 4, i.e. the movement towards a commercial private seed supply. Commercialisation of an infrastructure that was built on development rather than commercial objectives has proved to be very difficult to implement (Bay, 1999). This is partly due to forces that oppose the transformation of any type of public operation, and because of specific seed related factors. Commercialisation and subsequent privatisation of productive institutions in the public sector requires amongst other things additional (commercial) skills, flexible financial management and the creation of healthy competition in the market. Moreover, since seed production is often the only productive enterprise in Ministries of Agriculture, officials may lose a potentially interesting source of rent. As far as the commercialisation of the seed sector is concerned it is clear that different seed products provide very different opportunities for commercialisation. Commercial seed production – whether in public or private ownership – has only proved feasible for a very few crops, notably maize, oil seeds, in some cases vegetables - especially those for which hybrid varieties can be commercialised. These – with the exception of maize in large parts of Africa and Latin America and possibly hybrid rice in a growing number of Asian countries are often not the crops that are most important for national food security.

This means that for the majority of crops the ultimate goal of the approach cannot be achieved. This can be seen from developments, for example, in the USA, where public investments are still needed for breeding research and for the practical breeding of self-fertilising crops like cereals and pulses. The result of this approach is that public investment in the seed sector in developing countries has fallen dramatically during the past decade as a result of efforts to forestall unfair competition with the emerging private sector. Whilst the private sector may be able to take over the provision of commercial seed crops it hardly ever produces crops like finger millet and pigeon peas. If the goal cannot be attained in industrialised countries, it becomes even more necessary to carefully analyse the proposed steps for achieving it in developing countries.

Finally, given that each specific crop will have a different pace of development throughout the approach, as Douglas himself observed, it must be questioned whether the approach provides sufficient tools including investment support and seed laws necessary for designing policy measures that impact on all crop seeds.

The blueprint seed system development model that aims to create efficient commercial seed provision may be successful for a limited number of crops, for certain types of (commercial) farmers, and in countries with a good infrastructure that are able and willing to provide the right institutional environment and encouragements for the private sector. The conclusion in this section is that this model is not a suitable base for a comprehensive national seed strategy and cannot provide an adequate basis for the development of the regulatory and institutional frameworks needed in the seed sector.

2.4 Alternative strategies

2.4.1 Integration of formal and farmers' seed systems

Seed supply for some crops and farming systems may be organised sustainably by balancing public and private tasks in a formal seed system. This balance is continually monitored in most OECD countries where the public sector currently invests mainly in upstream research, leaving most of the actual crop improvement to the private sector. It was shown in Section 2.2.3 that for certain crops and classes of poor and remote farmers an economically viable formal seed sector cannot be developed.

One way of dealing with the diversity of situations in any given country is to diversify seed systems by creating specific policies and supporting regulations and services for:

1. the commercial seed sector to serve large sections of the commercial farming community, securing seed quality and availability in a competitive market - possibly with both domestic and multinational companies,
2. the public seed sector to deal with strategic tasks not being taken up by the commercial sector such as pre-competitive breeding research; breeding and (foundation) seed production of open pollinated crop seeds of high importance to food security but of low commercial value; seed quality control and seed promotion services.
3. NGO and GO initiatives that support local capacities to upgrade or maintain farmers' seed saving and diffusion systems, with as primary objectives the support of sustainable crop production, food security, and the management of on-farm agro-biodiversity.

These components of diversified seed systems should be regarded as equally important. Diversified seed systems should integrate the needs of the formal and farmers' seed systems at the policy level. Such integration should also take place at the operational level. Based on this concept, combining local knowledge and materials with formal knowledge and materials can create optimally adapted technologies with benefits for both farmers and institutions (Fig 2.5). The concept of integrated seed systems was introduced in 1994 (Louwaars, 1994 a,b). This concept stimulates scientists and technologists to find new ways of co-operating with farmers and vice versa in the different functions of the seed sector and builds upon early experiences in participatory variety selection and on-farm management of genetic resources. The value of Figure 2.5 for this study is that it contains all the major components of seed systems. It can, therefore, be considered an instrument and screen for analysing the interrelationships among these components and particularly how they change in response of external effects, such as (inter) national policies.

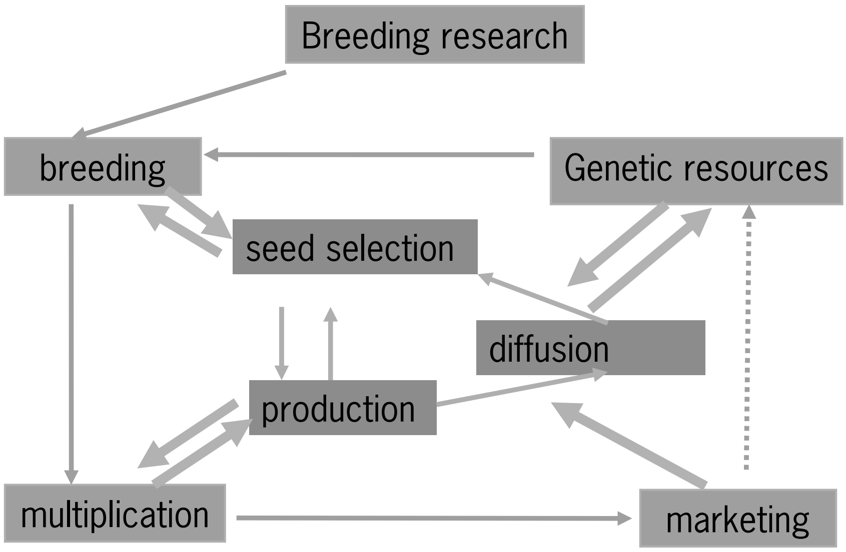

Fig 2.5 The diversified seed system, consisting of farmers' (Fig.2.1) and formal (Fig 2.2) seed systems with multiple opportunities to integrate knowledge and materials from the components of both (bold arrows, see 2.4.2) . (this study)

2.4.2 Interaction at different points

Integration of knowledge and materials from the formal and farmers' systems can be stimulated within different components of these systems.

- Genetic resources
The conventional link is the extraction of genetic resources from the farmers' seed systems for the purpose of conservation and broader use. Genebanks and breeder's collections of genetic resources commonly contain a wide array of farmers' varieties and landraces.

Linking local knowledge with formal knowledge greatly facilitates conventional (*ex situ*) operations for the conservation of genetic resources. Local knowledge adds to the efficient collection and characterisation of materials. Using formal knowledge to assist the local system has led to a range of on-farm strategies for the management of genetic diversity in crops (Engels & Visser, 2000). Genebanks have not only obtained materials from the local system, they have also played a central role in the re-introduction of appropriate genetic diversity of crops after disasters. The 'seed of hope' programme that followed the civil unrest in Rwanda in 1994 was an excellent example of the reciprocal role of genebanks (Buruchara *et al*., 2002). Initiatives for the on-farm management of genetic resources can also support farmers' seed systems in their objective to stimulate the use of local varieties and landraces by farmers (Visser, 2002). A recent addition to this strategy is to include the effective development of markets for diversity based products in such initiatives, either in the country itself (Louwaars & Visser, 2006) or in export markets (Hermann *et al.*, 2006).

- Plant breeding
The linkage of local and formal knowledge in plant breeding has resulted in novel strategies for breeding both for benign and more diverse ecological conditions. Participatory Variety Selection has greatly increased the understanding of farmers' preferences by scientific plant breeders (Sperling 1992). It has also created an initial recognition of the ability of local communities to select materials for their own conditions. The concept of participatory plant breeding has introduced farmers' knowledge into many more aspects of plant breeding: setting objectives, creating variation, selection and finishing of a new variety (Hardon & de Boef, 1993; Witcombe & Joshi, 1996; McGuire *et al.*, 2003; Vernooy, 2003; Smolders, 2006; Smolders & Caballeda, 2006). The complexity and variation of marginal environmental conditions that creates great difficulties for breeding programmes to overcome genotype x environment interaction can - in some cases - be tackled effectively by breeding for diversity in participatory settings (Cooper *et al.*, 1999).

Almekinders and Elings (2001) provide a good overview of different experiences and practices and an analysis of a variety of methods and impacts of a number of ongoing initiatives (Almekinders & Hardon, 2007). These show that, from a scientific point of view, participatory plant breeding connects scientific plant breeding with social sciences and that there are initiatives started by social scientists (Sperling *et al.*, 2001; Baenziger & Cooper, 2001) and by 'hard core' plant breeders (Ceccarelli *et al.*, 2001; van Eeuwijk *et al.*, 2001) alike and that there are many instances where these specialists have found each other in an effective cooperation. Farmer-participation is also likely to lead to an increased use of local genetic resources in breeding programmes that would otherwise be largely dependent on materials from international programmes. This could potentially lead to an increase in genetic diversity.

- Seed multiplication
Farmers' seed systems can be substantially improved through the introduction of scientific knowledge developed within formal seed systems. This includes knowledge about agronomic practices and ways in which farmers can improve the way they handle and store seed (Walker & Tripp, 1997). Knowledge of seed transmitted diseases which is rather poor in many local communities is also a critical element here. (Diekmann, 1993).

Secondly, improving seed storage conditions can significantly improve the sustainability of supply. The identification of diseases is the key to avoiding them (Mathur & Joergensen, 1988). Furthermore, understanding local methods of handling seed, such as storage in the chimney (Kone, 1993), the use of leaves with insecticidal properties (Kone, 1993, Gwinner *et al.*, 1991) ash or vegetable oils (van Rheenen *et al.*, 1983) when storing seed, or even local methods of seed priming can contribute to formal knowledge.

- Marketing
Finally, farmers' seed systems can benefit from a linkage with the marketing aspects of formal systems (Reusché & Chopra, 1993: 77-98). One strategy is to decentralise and diversify seed supply by the promotion of local seed producers and merchants. Farmers who are known in their community for the quality of their seed may be assisted to develop into small-scale seedsmen, thus filling the gaps that the larger formal seed units leave in remote areas or in the market for particular seeds (Kugbei & Bishaw, 2002). Some basic knowledge of accounting and planning is essential to the success of such strategies (Kugbei *et al.*, 1998).

2.4.3 Challenges for integration at policy levels

- Policies
The changes in seed sector development from the linear approach of Douglas (1980) to the notion of integrated (Louwaars, 1994) and diversified seed systems (Tripp & Louwaars, 1998) creates a range of challenges for various stakeholders. National seed policies that observe the need for diversified seed systems design particular roles for the public, private and civil sectors. They need to create appropriate support for the various actors involved each of whom may have contradicting needs and objectives. This may create challenges for the regulatory framework surrounding the seed sectors and the institutional implementation of policies supportive of diversification. The linear approach has the beauty of simplicity but the complex reality normally does not fit the theory.

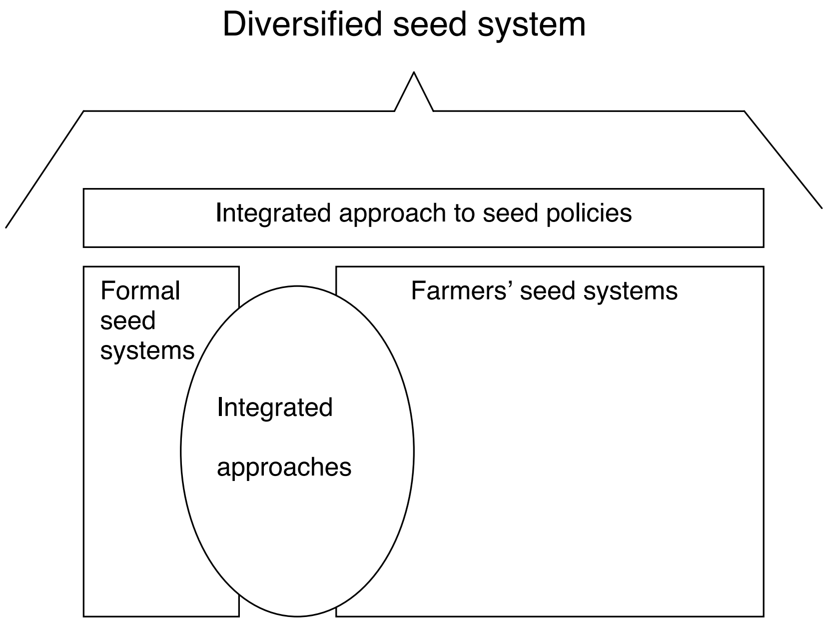

Figure 2.6 Illustration of a diversified seed system consisting of farmers' and formal seed systems and integration of farmers' and formal knowledge in the interaction. This system requires an integrated policy approach that recognises and supports the different components (this study)

- Regulatory frameworks
Governments are faced with the notion that regulatory frameworks have to serve the different needs of various types of breeders, seed producers and farmers.

i) The emerging private sector may need protection to develop financial stimuli, and a certain level of freedom to operate; and the government may want to check on the products of the private sector for consumer (farmer) protection;

ii) The public seed sector has to adapt to changing conditions and objectives, making room for the private sector, and its role in poverty reduction and food security may include leaving the conventional top-down approaches to breeding and seed supply in favour of participatory methods;
iii) The valuable aspects of the farmers' seed systems have to be nurtured and supported, and government and civil society organisations are to be guided to do so.

The promotion of formal seed production in many countries has lead to the introduction of a regulatory framework that was to guide the developments in this part of the seed sector (see Chapter 3). These laws do not take into account the role of farmers' seed systems, and in many cases they criminalise farmers who sell or barter locally produced (non-certified) seed of non-released varieties. Integrating the local and formal seed systems cannot be stimulated without the support of appropriate regulations.

While policy makers may be struggling with guiding and regulating their diversified seed sectors, international developments have created additional challenges for national governments and other actors. The introduction of intellectual property rights (see Chapter 5) and national sovereignty over natural resources (see Chapter 4) into the field of agriculture, and the subsequent discussions in various forums on the concept of 'farmers' rights' have raised new questions for national policy makers about how these issues should be dealt with at national and local levels.

- Institutional change
At the institutional level, the creation of linkages between formal and farmers' seed systems requires fundamental changes, especially in the way that formal institutions and actors operate. Technical scientists such as geneticists, breeders and seed technologists have to co-operate closely with social scientists and new working procedures need to be designed. The standard evaluation processes of researchers may have to be abandoned. For example, the range of genetic resources conserved in diverse farming systems has to be assessed differently from the way in which resources stored in a genebank are assessed. The number of varieties that are formally released is commonly used as a yardstick for the success of formal breeding and in reviewing the performance of breeders, but it cannot be used to measure advances in participatory plant breeding because - in most cases - new varieties developed in such programmes are not officially released. In addition, the issue of ownership of inventions may lead to discussions among the partners, especially when participatory research uses both formal and local knowledge.

2.5 Conclusions

Two major seed supply systems have been identified, farmers' and formal seed systems, both with their own specific advantages and limitations. The analysis of the currently widespread linear approach to seed system development that follows a linear pathway from traditional (farmers') seed systems through different stages to the preferred system consisting of a fully commercial seed supply, leads to the conclusion that this approach does not sufficiently correspond with the complexity of seed supply and (re)use and that it does not lead to meaningful strategies for the evolution of policies for seed system development. Instead, diversified seed systems are proposed with different tasks for private seed enterprises, public sector institutions and civil society in order to develop optimal linkages between local and formal knowledge and local and formal genetic resources.

The integration of formal and farmers' seed systems in the different functions of these systems is likely to lead to a more accurate assessment of needs, to more location specific solutions to challenges, and to new opportunities for seed supply to contribute to sustainable improvement of crop production. It can be concluded that diversified seed systems rather than the blueprint linear model should be supported for all crop seeds in all situations. Such seed policies require important regulatory and institutional changes.

The screen (Figure 2.5) of seed systems and their integration developed in this chapter will be used in the following sections when analysing the impact of seed regulatory frameworks, biodiversity regulations and intellectual property rights on the elements and their interactions, depicted in the screen.

3. The impact of conventional seed regulations on seed systems[1]

Abstract

Variety and seed regulatory frameworks and seed control institutions have been developed in most countries primarily to regulate the formal seed sector. The provisions of these laws and their implementing regulations usually also apply to farmers' seed systems that are built on different values and mechanisms.

Questions concerning the role of regulations in farmers' seed systems are relevant in view of the importance of these (see 2.2.2). When such regulations appear to obstruct farmers' seed systems or the integration of formal and local knowledge and materials in diversified seed systems, alternative approaches need to be found.

An analysis of forty national seed laws indicates that they are very similar with regard to their organisation and focus. Yet, important differences are identified with respect to the definitions and key articles that affect the scope of the laws and their potential impact on different types of seed systems.

Variety controls tend to limit the number of varieties available in the market. The regulations, their interpretation by responsible committees, associated costs and implementation methods favour varieties with a wide adaptation, especially to relatively benign cropping conditions. The system is commonly unable to identify better varieties for smallholders who farm in ecologically diverse conditions. Varieties selected in participatory breeding programmes tend not to be eligible for official release due to a lack of uniformity or limited width of adaptation. The reward system for breeders is commonly based on the number of varieties released and not on their widespread use. As a result, breeders tend to focus on the release requirements, rather than on the needs of farmers. Based on this evidence it is concluded that variety controls neither support breeding for smallholders in ecologically diverse conditions, nor the integration of seed systems at the level of crop improvement.

Seed certification and quality control regulations tend to render farmers' seed production and particularly the exchange and sale of farm-saved seed illegal. Most regulatory frameworks studied put severe restrictions on initiatives to support farmers' seed production and to develop small seed enterprises. The level of participation of farmers and their representatives in official bodies that oversee or implement seed laws is commonly low which may explain the poor adaptation of the release procedures to farmers' seed systems.

Important openings in seed laws can be made to allow for diversified seed systems to develop and become recognised, especially through explicitly limiting the scope of the law to the formal seed sector only. This would be possible if the definitions of 'seed' and 'market' were to be adapted. Secondly, a change in the focus of the institutions that are responsible for the implementation of the seed laws, from policing the formal seed system

---

[1] Parts of this chapter have been published earlier as: Louwaars, N.P., 2005. Seed laws: biases and bottlenecks. Grain, July, 2005 p 3 - 7 (http://www.grain.org/seedling/?id=339). It furthermore builds upon Tripp & Louwaars, 1998.

to supporting the production and use of good quality seed in both the formal and farmers' seed systems would be important for the development of diversified seed systems.

3.1 Historical overview of seed regulation

Conventional seed regulatory frameworks aim to promote variety identity and seed quality, and thereby to protect farmers from planting sub-standard seed, while at the same time creating a level playing ground for different seed suppliers in the market. Such objectives are found in the preface to many national seed laws. Seed laws commonly regulate variety testing and release, seed certification and seed quality control, and they establish the institutional framework of national seed councils and certification agencies.

Variety release systems aim at only making varieties of proven value available to farmers through the formal seed system (Louwaars, 2002). Seed certification aims at controlling varietal identity and purity throughout the seed chain (Gastel *et al*., 2002). Seed quality controls check the seed in the market on quality parameters such as viability, purity and seed health, in order to protect farmers from planting poor quality seed and to enhance quality awareness among seed producers (Tripp & van der Burg, 1997). Seed quality control also aims at protecting *bona fide* seed producers from competition by less scrupulous colleagues.

The regulatory frameworks that have been developed in various industrialised countries reflect different levels of state involvement in the formal seed sector (Kloppenburg, 1988). In North America, for example, certification is often a voluntary service, and variety release is fully the responsibility of the seed company. This reflects a confidence in the regulatory effects of the free market: suppliers of poor quality seed would be punished by the customers through declining demand for their products. Customers will demand a certification seal only if that seal has proven its value. It also reflects confidence in the judicial system to solve conflicts in the market. In various European countries on the other hand, public institutions have developed a significant mandate and legal backing for 'policing' seed quality, i.e. for checking all seed in the market and banning substandard seed lots. In some countries, such as The Netherlands, certification agencies have developed as non-government foundations managed by farmers', seed producers' and breeders' organisations. These operate strictly within a national legal framework just like government seed certification agencies in other countries. The involvement of government agencies in Europe emerged mainly from the perception that the customer (farmer) cannot identify the quality of seed simply by looking at it (Fenwick-Kelly, 1989) and that an official quality stamp would avoid misrepresentation in the market. In some developing countries, strong government involvement was also meant to protect often illiterate farmers (Ramamoorty *et al*., 2006). The Europeans particularly focus on including more details in the law, including seed standards and the membership composition of decision-making and advisory bodies.

Seed regulatory frameworks in developing countries have commonly been developed after the emergence of a formal seed sector. From the 1970s onwards there was an especially vigorous development in order to make it possible for as many farmers as possible to take advantage of the benefits of the varieties emerging from the Green Revolution. The FAO-led Seed Industry Development Programme assisted many countries in setting up seed farms, contract grower schemes, and seed conditioning plants for their major food crop seeds (Feistritzer, 1984). Under "Green Revolution" support policies, seeds and other

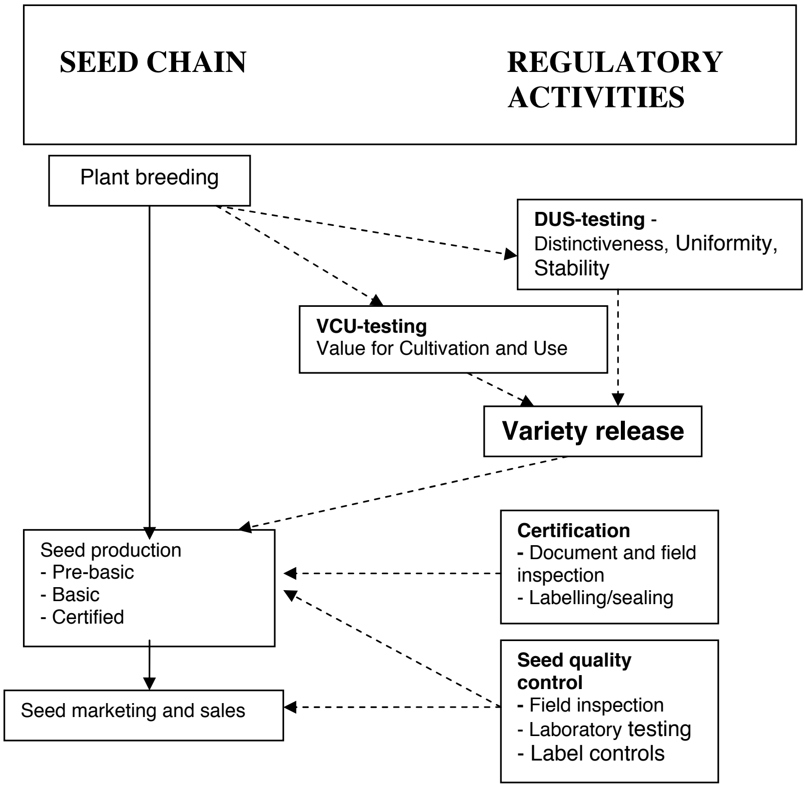

Figure 3.1 Schematic representation of the seed chain (left) and the regulatory functions (right hand side), (this study)

inputs were frequently subsidised in order to facilitate adoption of the new varieties and associated technologies. Within this paradigm, centralised seed production units were built in many countries as public institutions or state enterprises along the lines of the successful private seed industries of Europe and North America.

These formal seed systems subsequently developed specialised in-house or independent seed quality control institutions - similar to the official seed certification agencies in the North - to create quality awareness among both seed producers and customers, and to safeguard the interests of farmers. The Netherlands has supported such programmes and developed seed certification institutions in Kenya and Sri Lanka. In the era of privatisation of public institutions and structural adjustment policies at the end of the 1980s these seed quality control institutions became a driving force behind the development of seed legislation (Louwaars & van Marrewijk, 1996). Such legislation was intended to provide these institutions with the legal mandate and backing considered necessary for performing their task of policing seed production and marketing especially in relation to the emerging private seed sector. Variety release systems had initially been developed as a kind of final stage of the breeder's selection process. Multi-locational variety trial systems were also meant to guide farmers and seed producers in their choice of varieties. Decisions based on this research were regulated in seed law mainly because varietal identity is an important basis for seed certification. Figure 3.1 indicates the main seed regulatory functions in the seed chain from breeding to seed marketing.

Since the seed programmes in developing countries were built by taking effective formal seed systems in the North as their example, many national seed laws were also developed on the basis of Northern examples. Bombin (1980) showed that the first Latin American seed laws were based on the Spanish example, Francophone African countries derived legislation from the French seed law and Commonwealth country seed laws resembled British or US regulations depending on which country was supporting their seed sector (Indian law was close to the US system, whereas Zimbabwean seed law was similar to British legislation). However, whereas in the North farmers' had a strong voice in the seed quality control systems, in many Southern countries this was not the case (Tripp, 1997). Seed regulations were tacked onto bureaucratic structures and imposed upon both seed producers and users.

Given the origin of the seed regulatory framework and variety and seed control institutions in the formal seed sector, and the importance of the farmers' seed sector, it is suggested that these seed laws do not support the further development of farmers' seed systems and may, in fact, act as a disincentive. The analysis focuses on the concepts and components of these laws that potentially affect farmers' seed systems, notably variety release and seed certification procedures. Secondly, given the relevance of the integration of formal and local knowledge and materials, and the need to support a diverse seed system including private, public and farmers' initiatives as described in Chapter 2, an important question is whether such seed laws can support these kind of activities as well as the development of diversified seed systems. Major questions are: i) What impact do variety release procedures have on the types of varieties that are bred and become available for farmers?; ii) What is the impact of certification and seed quality control procedures on initiatives to support farmers' seed systems?; and iii) Can formulations be found in different operational seed laws that can mitigate these negative impacts? Finally, the object of analysing the key elements of laws that hinder support for diversified seed systems is to propose options for developing seed regulations that do encourage diversified seed systems.

A basis for answering these question is provided by an analysis of the forty seed laws presented in Box 3.1. Particular attention is given to variety release procedures, the rules for certification and seed quality control and the level of participation in advisory and implementing bodies. These laws were collected by the author during the course of various consultancies and – in order to ensure a representative geographical coverage – they have been supplemented by a number of laws collected by GRAIN in 2003. The standards and procedures that the industry federations maintain among their members have not been taken into account, even though these also have an important additional impact on the seed sector (leBuanec, 2002).

Box 3.1 Seed acts and regulations consulted	
COUNTRY	**SEED ACTS and REGULATIONS**
	AFRICA
ALGERIA	Law no 05-03 of the 27 Dhou El Hidja 1425 on seeds, plants and the protection of varieties. (08.02.2005) - Executive Decree No. 92-133 on the establishment of National Centre For Control and Certification of Seed and Seedling (28 March 1992)
BOTSWANA	- Seed Certification Act (1976)
CAMEROON	Law n°2001/014 on seed activities (2001)
MALAWI	- Seed Act 1988 (Act No. 5)
MALI	- Decree No. 95-403 on plant protection (November 10, 1995) - Law No. 95-052 and – Law No. 95-062 on fines (12June 1995)
MAURITANIA	- Act No. 96-025 on production, control and commercialisation of seed and certified seedling (July 8, 1996)
MOROCCO	- Act No. 1-69-169 on production and commercialisation of seed and seedling (1969) - Act No. 1-76-472 amending Act No. 1-69-169
NIGER	- Decree No. 90-55 of Ministry of Agriculture implementing rules on seed production, conditioning, control, certification and commercialization (February 1, 1990)
SENEGAL	Act No. 94-81 on the inscription of varieties, production, certification and commerce of seed and seedling (December 23, 1994) - Decree No. 005192 of Ministry of Agriculture on organization of the Direction Board for seed production and control (May 6, 1986) - Decrees of June 17, 1997: 97-602/603/616
SOUTH AFRICA	- Plant Improvement Act No. 53 of 1976 (assented to 29 March 1996)
TANZANIA	The Seeds Act 2003
TUNISIA	- Seeds, Seedlings and New Plant Varieties Act No. 99-42 (May 10, 1999) - Act No. 2000-66 amending Act No. 99-42, and Decrees No. 2000-101/102/1282
ZAMBIA	- Agriculture (Seeds) Act (No. 14 of December 1, 1968) - Plant variety and Seeds Regulations, 1997
	LATIN AMERICA
ARGENTINA	Law on Seed and Phytogenetic Creations (1991)
BOLIVIA	Seed Law 2003 Secretariat Resolution 064/96, Ministerial Resoluitions 101/199, 121/2000, 041-043/2000, 061-067/2001
BRAZIL	- Law No. 10.711 on the national system for seed sand plants and foreign origins (2003)
CHILE	- Seed Law (Law Decree No. 1.764 of April 28, 1977) - Law Decree No. 3.557 of April of December 29, 1980 on Agriculture Protection amending Seed Law - Law No. 18796 of May 12, 1989 amending Seed Law
COLOMBIA	Resolution 00148 – standards for the production, importation, exportation, distribution and commercilisation of seeds (2005)
COSTA RICA	- Law project – Complete reform of the Seed Law (1979) – draft of 1999 - Law Decree of October 14, 1996 amending Law No. 6289 - National Seed Office Law (Law No. 6289 of December 4, 1978)
HONDURAS	- Seeds Law (Decree No. 1046 of July, 1980)
MEXICO	- Federal Law on Seed Production, certification and commercialisation (July 9, 1991 - updated to 2001) - Regulations by MAG to the Law on seed production, certification and commercialisation (May 26, 1993); NOM and NOM-EM rules on imports (1994 - 1996)

NICARAGUA	- Seed Production and Commercialisation Law (Law No. 280 of December 10, 1997) - Regulations to Seeds Production and Commercialisation Law (Presidential Decree No. 26/98 of April 3, 1998)
PARAGUAY	- Law on Seeds and Cultivar Protection (Law No. 385/94) - Decree No. 7797/00 of March 7, 2000 enacting regulations under Law No. 385/94
PERU	- General Seeds Law (Law No. 27262 of May 12, 2000) - General Regulations to Seeds Law (Supreme Decree No. 040-2001-AG)
URUGUAY	- Law No. 16.811 declaring national interest in seeds and new plant varieties and establishing the National Seed Institute (February 21, 1997) - Decree No. 392/997 on INASE responsibility for rules on fines No. 16.811 (October 22, 1997); INASE Regulations on seed conditioning and authorized laboratories (1995)
VENEZUELA	Law on seeda an materials for animal reproduction (2001)
ASIA	
BHUTAN	Seeds act of Bhutan, 2000
CHINA	China seed law 2001
INDIA	- Seeds Act (Act. No. 54 of December 29, 1966) - The Seeds (Amendment) Act, 1972 (No. 55 of 1972) - India Seeds Bill, 2004 - Seeds Rules, 1968 - The Seeds (Amendment) Rules, 1973, 1974, 1981 - Order on seeds of the Ministry of Civil Supplies, 1983 - Seeds Control Order, 1983 - Plants, Fruits and Seeds (Regulation of Import in India) Order, 1989 (October 27, 1989)
INDONESIA	- Presidential Decree on seeds (No. 72 of October 25, 1971) - Decree of the Ministry of Agriculture concerning the implementation of the Presidential Decree No. 72 of 1971 (No. 460 of November 2, 1971)
IRAN	Act on plant varieties registration, control and certification of seeds and seedlings, 2003
NEPAL	Seeds Act 1988
PAKISTAN	Seed Act 1976 Seed (Registration) Rules, 1987
PHILIPPINES	Act No 7308 (1992) Seed Industry Development Act Implementing Rules and Regulations of Republic Act No 7308
REPUBLIC OF KOREA	- Major Agricultural Seed Law (No. 975 of January 15, 1962 - updated to 1975) - Ministry Regulations of Major Agricultural Seeds Law (No. 378 of August 6, 1969 - updated to 1982) - Presidential Decree of Major Agricultural Seeds Law (No. 5173 of July 9, 1970 - updated to 1975)
SINGAPORE	Control of Plants Act (Chapter 57A); 1999 revised edition
SRI LANKA	Sri Lanka Seed Act No 22 of 2003
EUROPE	
ALBANIA	- Law No. 7659 on seeds and seedlings (January 12, 1993) - Official Catalogue of cultivated species and varieties of agricultural crops, 1995 (by the National Seed Institute)
ESTONIA	- Seed and Plant Propagating Act (May 13, 1998)
KYRGYZSTAN	Law on seeds, May 29th 1997
RUSSIAN FEDERATION	- Federal Law No. 149-FZ of 1997 "On seed-growing" (December 17, 1997)

3.2 Description and analysis of conventional regulatory frameworks

3.2.1 Variety testing and registration

The main objective of variety testing is to prevent poorly performing varieties entering the market, which would be a problem for both farmers and competing seed producers. Secondly, such tests provide information about the performance of varieties in different farming conditions (Louwaars, 2002). The bottom line though is that a variety has to be identifiable, i.e. described and characterised. This has become more complicated as the result of two trends:

i) More detailed descriptors are needed when increasing numbers of similar varieties (often from single breeding programmes) come onto the market;
ii) Details become legally more important through the emergence of Plant Variety Protection (PVP, see Chapter 5) (Dhillon *et al*., 2006).

Whereas in many countries descriptors were initially based on the lists used to describe genetic diversity developed by the International Board for Plant Genetic Resources (see for example. Astley *et al*., 1982; Esquinas-Alcazar & Gulick, 1983), today the descriptor lists of the Union for the Protection of New Varieties of Plants (www.UPOV.int) are used more widely. In both descriptor lists, characteristics are included that are as constant as possible under different growing conditions, for example, anthocyanin colorations or pubescence at different parts of the plant. Descriptions should be made under optimal growing conditions to allow the varieties to show their characteristics clearly.

Varieties are also tested for their Value for Cultivation and Use. This implies that the new varieties should be grown next to the most popular varieties in different locations, thus capturing the main agro-ecological conditions in which the crop is commonly grown (Dhillon *et al*., 2006). These tests should be done under farmers' conditions to show agronomically important characteristics as well as the way varieties respond to stresses – pests, diseases and abiotic conditions such as drought, for example -.common to the area. The most significant data is provided when such trials are conducted in farmers' fields under farmers' management. This has the additional advantage that farmers are able to feedback and adoption is enhanced (Freeman *et al*. 2002). However, the latter type of variety trials tend to produce a high level of residual variation when analysed statistically. This creates a strong pressure in favour of researcher managed trials in special testing stations.

- Initial analysis

A variety release system commonly incorporates the following steps (Louwaars, 2002):

a) Application lodged with a formal variety release committee and variety registration, including a variety description;
b) Testing for the Value for Cultivation and Use (VCU) of the variety involving a prescribed number of sites and seasons;
c) Testing for Distinctiveness, Uniformity and Stability (DUS); and finally
d) Analysis of the test results by the committee leading to approval or rejection for formal release.

In each of these stages there can be a bias favouring particular types of varieties (Louwaars, 1997; 2001).

a. Application
Application for variety release commonly includes the payment of a fee. The global trend of reducing public spending has meant that in most countries today, the applicant has to fund the testing system by paying fees at levels that approach the total cost of tests. The result is that both public and private breeders limit the number of varieties that they submit for official release to those that are likely to perform well in all test locations. Varieties with specific adaptation to particular agro-ecological niches or uses are less likely to be presented. This tends to contribute to a shift in the breeding priorities toward varieties with a wide adaptation, i.e. that do well in all the trials, instead of breeding for specific adaptations which suit the diverse characteristics of most small-scale farmers' conditions (Simmonds, 1991; Ceccarelli *et al.*1992, Hardon, 1995). This contributes to adapting the breeding objectives to the requirements of the release authorities rather than to the needs of farmers (Tripp & Louwaars, 1997a; Dhillon *et al.*, 2006).

b. Testing
The management of many variety testing systems further reduces the number of approved varieties. High input levels are often used to improve the trials from a statistical point of view (Tripp & Louwaars, 1997a). Sometimes there is also a deliberate policy of representing the conditions of the "better farmers" in order to motivate other farmers to follow this example. In addition, high input levels provide 'beautiful crops' that make a trial presentable to visitors. The liberal application of fertilisers and pesticides conceal environmental variations in the trial, thus reducing residual variance that could otherwise delay release or obstruct it altogether. But high input levels are a major reason for the poor relevance of trial results for small-scale farmers, and thus for the reluctance to adopt varieties that are produced by public breeding (Ceccarelli *et al.*, 2003). For example, it is unlikely that the official sorghum trial results in India are valuable for the majority of farmers, since average yields in the 1989/1990 trials were three times the farmers' average yields (Virk *et al.*, 1996).

c. Testing for DUS
Variety release committees commonly consider appropriateness for the production of certified seed to be an important criterion. A variety needs to be morphologically identifiable and thus stable and distinct from existing varieties. Both factors contribute to the need for a certain level of genetic uniformity. The uniformity standards of seed certification systems are commonly very high and allow only a few off-type plants per hectare. Releasing varieties to a seed certification system thus implies breeding for uniformity, even where this has no agronomic advantage. Uniform varieties may not be the best option for all farmers (Allard, 1961, Wortmann *et al.*, 1996), especially where ecological diversity (in time and space) cannot be matched by a single-genotype variety even if it has been selected for broad adaptability and yield stability over a range of growing conditions.

This legal uniformity requirement was tested in the Netherlands in the early 1980s when a wheat breeder applied for the release of a genetically heterogeneous multi-line variety that he called 'Tumult' (meaning 'uproar'). It was accepted for testing for VCU as a single variety only after a lengthy debate by the releasing authority. The components finally had to be tested individually for DUS. This multi-line variety application challenged the regulatory system, but did not become a commercial success, mainly because the delays in both the breeding and the testing processes meant that more modern varieties were already available at the time of release (Louwaars, 1997).

d. Evaluation
The evaluation of trials using simple statistical analysis methods and a selection of varieties that do best on average over all testing locations leads to a bias in favour of breeding for wide adaptation (Ceccarelli, 1989). Since trials are pooled in one calculation, the variety having the highest average yield is considered the best. This may not be the best variety in any of the testing sites. Standard variety release procedures rarely accept a variety that is specifically adapted to particular conditions, even though national variety lists contain regional recommendations (Ceccarelli, 1994). The trial system is biased against breeding for partial (horizontal) resistance, which is in most cases polygenic and more durable. Such varieties are resistant, but not immune to disease. They may thus carry disease symptoms and for this reason are liable to be rejected in a release system (Louwaars, 2001). Additionally, the small size of the research plots used in the trials makes it difficult to identify horizontal resistance.

Evaluation of variety trials by release committees is usually based entirely on the statistical analysis of measured characteristics. Yield becomes the main (or only) decisive characteristic. Important characteristics for smaller scale farmers may not be taken into account. These include, for example, aptitude for intercropping, shattering (soybean), lodging when harvesting is delayed (maize), cooking time of the produce (beans), and the yield and quality of secondary products (straw for construction or fodder). Breeding thus tends to concentrate on yield alone, without giving credit to the diverse needs of farmers (Louwaars, 2002). Variety release committees that realise such limitations have been initiating on-farm variety tests but still find it difficult to weigh the often qualitative observations with the hard yield data from the official trials.

e. Participation
Lack of participation and transparency in the closed system of formal variety release leads to conservative trial designs and management (Tripp, 1997). In many countries it is only recently that parallel demonstration trials by the extension service, non governmental organizations (NGOs) or private seed companies have been taken into account in release decision making. Official on-farm variety trials are becoming increasingly popular with variety release systems. This positive development, however, hardly ever contributes to releasing more adapted varieties because such on-farm trials are either completely researcher managed, and thus very similar to on-station trials or the results cannot be analysed statistically often leading to a denial of the results obtained (Tripp & Louwaars, 1997a). The non-quantitative observations by farmers can certainly be taken into account, but are difficult to include in the statistical reports. In developing countries, farmers are rarely well-represented in the Variety Release Committees, or in the evaluation of varieties. Improved representation would likely lead to higher system transparency .

In brief
In conclusion, standard variety release procedures commonly result in the approval of few, uniform and widely adapted varieties that often do not respond to the diverse needs of farmers (Louwaars, 2002).
Conclusions drawn from the above analysis indicate that variety release could become a goal in itself whenever regulatory systems are too rigid. Release is the yardstick by which the effectiveness of public plant breeding programmes is measured. The reward system for breeders is commonly based on the number of varieties released, not on how frequently they are used by farmers. Hence, the objectives of plant breeders are likely to be adapted to variety release procedure rather than to the farmers' needs.

3.2.2 Seed certification and quality control

Seed certification and quality control are meant to provide a service to farmers who purchase seed, since neither the identity of the variety nor most other quality parameters of the seed can be observed from a visual inspection of the seed itself. Farmers would otherwise have to depend on trust with regard to seed quality. Moreover, farmers need information about the varieties they plant in order to plan their operations including when to plant in relation to the time the variety needs to mature and whether the variety will deliver products that are suitable for the intended use. As such, seed certification and quality control are extremely useful for all farmers who purchase seed.

Seed certification is a kind of chain-control, whereby varietal identity and purity are checked from the very first generation (commonly called breeder's seed or pre-basic seed) through a prescribed number of generations to arrive at sufficient quantities of seed that can be distributed to farmers. Every generation of seed has its own procedures and standards which are followed up by checking of documents, seed production fields and seed conditioning plants (Wellving *et al.*, 1984; Uganda Seed Project, 1991). Standards include, for example, the distance to neighbouring fields growing the same crop and to weeds that may cross with the seed crop and the number of allowable off-types in any seed field. Certification also involves strict procedures for labelling and sealing seed packs. Seed certification thus requires a well organised (and thus formal) seed production system and is reserved for well-described and stable varieties. Harmonised procedures for seed certification have been developed under the auspices of the Organisation for Economic Cooperation and Development (OECD-Seed Schemes), and are also used by a number of non-OECD members (OECD, 2005a).

Certification goes hand in hand with seed quality control in which the most important physiological, physical and sanitary seed qualities (viability, purity, health) are tested in a laboratory, commonly using procedures that are harmonised internationally by the International Seed Testing Association (ISTA, 2005). Different primary objectives have formed the basis of seed quality control and certification procedures. For example, potato seed certification was introduced in 1900 in Germany to cope with seed transmitted diseases (Shepard & Claflin, 1975). In grasses, problems associated to varietal identity and weed seeds triggered the emergence of certification in Oregon in 1937 (Mueller Warrant *et al.*, 2003).

The results of seed quality tests can be communicated to the market either by printing the test results and the testing date on a label (as used in the USA), or by banning seed from the market that does not comply with certain minimum standards for any of the quality criteria (as used in Europe). Seed quality control is thus an 'end of the line' check that can also be done in combination with certification, but which might also be applied to non-certified seed. In the latter case the customer is informed of the seed quality characteristics, but no guarantee is offered for the varietal aspects of the seed that is purchased. Several countries have a special seed class for this tested but not-certified seed, which is commonly called 'commercial seed' (as opposed to 'certified seed'). The technical operations of seed quality control and certification are described for developing countries in a practical manner by Wellving (1984).

Seed certification and quality control are performed by government agencies, by specialised independent organisations or by the seed companies themselves (Gastel *et al.*, 2002). In the latter case a check on (and certification of) the procedures and/or the qualifications of the staff performing the operations is common.

- Initial analysis
Seed certification, being the check on varietal identity and purity, has a marked effect on breeding strategies (Louwaars, 2001). According to the certification rules, varieties have to be stable in order to make the certification of the varietal identity possible. Only uniform varieties can meet the required levels of stability but such uniform varieties are not necessarily the best option for all farmers (see above).

Seed certification and quality control is costly and time consuming. The administration, field inspections, seed sampling and testing in a specialised laboratory add to the cost of seed production. The smaller the production units and the wider these are dispersed, the higher such costs will be (Gastel *et al.*, 2002). Both the level of administration required and the costs involved make it very difficult for countries to control all the seed that is produced and used in every part of the country. Certification is provided in most countries for only a few major food and industrial crops irrespective of what their seed laws prescribe. In addition, financial interests involved in accepting or rejecting seed production fields or seed lots invite rent seeking, which is aggravated where inspectors are government employees with poor salaries (Tripp & Louwaars, 1998).

Procedures for seed certification and seed testing are fairly well harmonised through the OECD Seed Schemes and the seed rules of ISTA, but the regulatory framework in which these are applied differs from country to country.

3.3 Analysis of seed regulations in several countries

3.3.1 Seed regulations

The seed laws studied (Box 3.1) begin by stating the objective(s) followed by definitions. These definitions to a large extent determine the scope of the law, notably the definition of “seed” and “variety”. Major examples will be discussed below. The next chapter in these laws commonly focuses on organisation, i.e. most seed laws introduce a ‘National Seed Board’ that will oversee and guide developments in the seed sector, advise the minister on policies and develop procedures and standards for the release of varieties and seed certification and quality control. The law may specify the establishment of committees, such as a variety release committee and seed standards committee or allow the board to develop such committees. These boards and committees commonly consist of senior representatives of different departments of the Ministry of Agriculture but can include other stakeholders as well. The number of stakeholder members relative to the public sector members and the way that they are selected and appointed has a significant impact on the level of representation of the interested parties.

The laws then go on to cover the technical and procedural issues of variety release and seed quality control. Laws differ in that some describe the procedures and standards in the law itself or rule that these details are referred to in regulations, in which case the law prescribes responsibilities and procedures for the development of such regulations. Finally, the laws prescribe sanctions for various actions.

The key issues that potentially determine the impact of such laws on diversified seed systems are the representation of stakeholders in important bodies (3.3.2), the scope of the law, which is largely regulated by the definitions (3.3.3), and the standards (3.3.4). These issues will be analysed investigating a range of seed laws (Box 3.1).

3.3.2 Representation in seed boards

In most countries Seed Boards are heavily biased towards the public sector; single representatives of the private sector and farmers are often included in addition to a range of government departments and institutes. The Philippine Seed Industry Development Act may serve as an example. The Seed Industry Development Council consists of: the Department of Agriculture, the Bureau of Plant Industry, the College of Agriculture University, the Institute of Plant Breeding, the Philippine Council for Agriculture Forestry and Natural Resources Research and Development, the Philippine Rice Research Institute, two representatives from accredited farmers' organizations and one representative from the seed industry. In India (2004 Bill) the Central Seed Committee consists of *ex officio* members of public national (7) and regional or state (5) offices, two farmers and seed industry representatives each and two independent experts. In other countries the membership is more evenly distributed, such as Argentina, where the National Seed Commission consists of 5 officials and 5 representatives of the private sector (including breeders, seed companies and farmers).

A major difficulty in such boards is the representation of farmers (Tripp & Louwaars, 1997a). Often, an official of the extension service or a (token) 'progressive farmer' is presumed to represent the needs of the farming community. Even where a representative of the National Farmers' Union is delegated, there is no guarantee that the different types of farmers are well represented. In several countries, farmers' unions have a strong bias towards commercial farmers; in some they are dominated by smallholders. Neither option adequately reflects the diverse interests of different types of farmers.

3.3.3 Scope of seed laws

Seed regulations are usually only intended to apply to the formal sector. Seed laws regulate the responsibilities for establishing procedures and standards for the release of new varieties and for seed certification and quality control in the chain approach that characterises the formal system (Fig 3.1). However, many seed laws have effects beyond the formal seed sector. For example, many seed laws in states of the former Soviet Union prescribe that all seed has to be certified, which in fact outlaws the saving of seed on-farm. This is also the case in the seed laws of Chile and Bhutan, for example although in the latter country genetic resources are excluded which creates a major ambiguity. More common is the rule that only seed that is commercialised is regulated. This is the case in the seed laws of Cameroon, Niger, Senegal, and many other countries. In most of these laws the term "commercialised" is not very well defined. The seed laws of South Africa and Malawi, however, specify that exchange and barter is included in the word "sell". In these seed laws the selling or even the exchange of seed among farmers is illegal if seed production is not certified and the seed is not officially tested and labelled. In Malawi strict rules apply only to hybrid maize, tobacco and sunflower. A voluntary system applies to other crops.

Also the variety lists may have openings for wider application. Most seed laws state that only seed of varieties that are registered after their value for cultivation and use (and often also DUS) have been successful testing can be produced. Some countries allow varieties that do not meet the criteria if they are important for export or for national production (e.g. Algeria). Such clauses can be used to promote non-uniform farmers' varieties, but in most case seed quality procedures still apply which again makes it difficult to apply the rules to farmers' seed systems. Other countries specifically include the possibility of registering traditional or local varieties (Mozambique). In Europe, the common catalogue lists all varieties that can be commercialised but different rules may apply to different crops, e.g. in the Netherlands, field crops are registered only after full VCU and DUS testing and all seed lots are certified; vegetables are not VCU tested and vegetatively propagated ornamentals are neither VCU tested nor certified. In the EU, the debate on organic farming has put pressure on the variety testing system. This has not resulted in exempting organic varieties from the rules, but in some countries by adapting the testing criteria to put more weight on disease resistances and weed tolerance characteristics that are particularly important in that sector (Osman & Lammerts van Bueren, 2003). The recent EU regulations on so called ‘conservation varieties’, which are exempted from the strict uniformity rules of the EU list of varieties, may facilitate the marketing of old heterogeneous varieties which may be important for parts of the organic sector.

In most seed laws that have a wide coverage, the term “seed” is used in a generic way, i.e. meaning any part of any plant species capable of (or intended for) replication. This is included in the laws of countries including those where facilities for variety testing and release and seed certification and control may not be operational for many crops. Some countries, therefore, make most of the regulations applicable to a certain number of crops and/or varieties only. These are known as ‘prescribed’ (Zambia, Malawi), ‘notified’ (India, Bangladesh), or ‘regulated’ (Indonesia) crops. This means in practice that variety and seed regulations apply only to these crops. Yet, since all major food crops are listed in these countries, major problems of implementation remain with local seed initiatives using local varieties or non-certified seed.

Among the 40 seed laws examined here, some examples have been found of a regulated formal seed systems without farmers’ seed systems being touched. Indonesia (1971) introduced an explicit exemption for farm-produced seed that is marketed within the village and this at least provides an important opening for local seed production and dissemination. The law in Cameroon contains an exception for farmers’ seed (‘semences de ferme’) but does not specify whether this applies only to saving seed on-farm or also the exchange, barter and local sale of seed. In its recent act on Plant Breeders and Farmers Rights India includes the right of farmers to “save, use, exchange, share and sell seed” provided the seed is not branded and conforms to quality requirements (art 43.1). However, it is not clear how this right should be read in the light of the new Seed Act of 2005 which introduces compulsory certification (Bala Ravi, 2005).

In some countries the laws apply to packed and certified seed only, leaving the farmers’ seed system untouched. These laws basically protect the seed label and are reserved for truly controlled seed; seed should not be sold as “Government-certified seed” (Korea) or “Government-tested seed” (Botswana) and the Morocco law reserves the word ‘seed’ for controlled seed only.

3.3.4 Standards for certification and release

Most countries have detailed field standards such as field isolation, number of allowable off types and noxious weeds, and sampling procedures and laboratory standards for viability (and germination), purity (inert matter, weed seeds, other crop seeds and other distinguishable variety deeds), seed moisture and seed health. Most laws, however, refer to the implementing regulations for such details. The advantage of this arrangement is that standards can be altered through procedures laid down by the Ministry of Agriculture avoiding the lengthy route of gaining parliamentary approval.

In some countries, an alternative to full quality control is introduced for certain crops and situations: 'quality declared seed' (FAO, 1993). This introduces a system in which a prescribed percentage of all production fields and seed lots are tested, thus giving greater responsibility to the seed producer and seed trader. The main reason for introducing the system is to reduce the burden on the government in inspecting and testing all seed lots in the country. Sometimes the standards are also adapted, i.e. that quality declared seed becomes a separate seed class. This system was developed in Southern Africa. Zambia actively uses the system for crops other than the five main staples. The Tanzania Seed Act (2003) has a provision that quality declared seed sales among neighbouring farmers is allowed but this is usually never checked.

3.4 Potential effects of seed regulations on seed systems

3.4.1 The impact on diversified seed systems

The conventional seed regulatory frameworks currently operating in many developing countries are intended to guide public and private actors in different sectors of the formal seed chain. These frameworks and their implementation can have a range of effects on more actors in the seed sector than they were originally designed for including farmers who produce and exchange seed of both local and so-called improved varieties and public and private actors in different sectors of the formal seed chain.

The letter of the law often prohibits farmers' seed systems when they involve the production and local exchange of non-tested seed of, for example, non-released varieties (Almekinders & Louwaars, 1999). In practice, however, reports on actual legal cases against smallholder farmers are few. The same rules also have a marked effect on activities to support farmers' seed systems and aim at integration, such as:

- Re-establishing genetic diversity after a disaster (Richards *et al.*, 1997);
- Participatory variety selection and plant breeding initiatives that rely on informal dissemination of selections (Witcombe & Joshi, 1996);
- The organisation of seed fairs that aim at sharing locally adapted or selected materials (Dominguez *et al.*, 2001)
- The production of seed of non-released varieties for emergency seed provision (Louwaars & Tripp, 1999).
- Support to the development of small-scale seed enterprises (Rohrbach *et al.*, 1997; Kugbei *et al.*, 2000).

There are a few documented cases where seed law has been used to actually stop traditional practices in farmers' seed systems or seed-related initiatives among civil society organisations. One was in Zimbabwe where ENDA - a non-governmental organisation - was forced to cease the production of open-pollinated maize seed for emergency provision in war-struck Mozambique in the 1990s. The Zimbabwean seed law prohibited the marketing of non-hybrid maize seed and the activity was stopped following threats of legal action. Another case occurred in Indonesia where farmers were forced to use modern rice varieties of particular (insect resistance) classes. More common are cases where on-farm trials of non-released varieties have been affected when these aimed at feeding new materials into the farmers' seed system (own experience in the Ugandan variety release committee in 1990, and van Gastel, unpublished)

Furthermore, regulations also can discourage the emergence of a private seed sector:

- Commercial investments in the seed sector may be discouraged when, for example, foreign companies have first to go through several years of variety testing before they can start marketing their seed or when they have to depend on local seed certification authorities that are closely linked to the existing (public) seed enterprises (Gisselquist & van der Meer, 1996).
- Small-scale local seed enterprises may be obstructed when – from the very start - they are unable to comply with all the rules relating to seed quality control or when they are prevented from supplying local varieties to a niche market (Rohrbach *et al.*, 1997).

One solution to the danger of obstructing the development of the formal seed sector through regulations is to adopt a voluntary system of seed certification and quality control, combined with a trueness-to-labelling requirement instead of compulsory variety release and seed certification and testing (Gisselquist & vand er Meer, 2001). Such a voluntary system is currently being promoted in various regional seed law harmonisation exercises, notably in Africa. They are hailed as an important step forward in promoting a private seed sector and especially the involvement of multinational seed corporations in the continent (GRAIN, 2005). This voluntary approach could provide room for local initiatives as well. Seed producers have the choice of either having their varieties officially recommended and their seed lots certified and tested or selling their seed on the basis of trust. Farmers have a choice in the market to buy seed with or without an official certification label (Gisselquist, 2002). Voluntary systems operate in the USA where state seed laws merely regulate the labelling requirements of the trade in seed (trueness-to labelling). Farmers rely on branded seed and thus on the information and trustworthiness of the seed company. Opponents of extending this system to developing countries point to the market failures that arise from a lack of competition in seed markets resulting in insufficient stimulus to provide quality and the lack of knowledge among farmers in developing countries who may not be able to read the information printed on the label (van der Meer, 2002). The fear is that voluntary seed controls could encourage fly-by-night seed suppliers. Several countries are relaxing their seed laws, but the movement towards compulsory controls in India after several decades of operating a voluntary system, for example, has been motivated by the desire to protect farmers.

An alternative is to include non-certified seed classes in the otherwise compulsory system, often referred to as ‘Commercial Seed’. Here because only seed testing requirements are prescribed the burden of certification is reduced. A similar approach is taken in those countries where the farmers’ seed systems are explicitly excluded from the requirements of the seed law. However, in all these cases it is difficult to make a clear demarcation between exchange between farmers and small-scale commercial sales. India introduced the concept of branding in this debate – seed is considered commercial when packed in containers that are marked with company names or logos. This does not solve the so-called brown bagging. In Argentine this has been at the centre of a debate where large-scale evasion of certification (and royalty) requirement by grain traders is common who provide graded grain as seed to farmers ‘from the back of the truck’ that collects the harvest. This would be considered un-regulated seed under the Indian definition.

3.4.2 Limitations to the implementation of the seed law

Quite often it is the implementation rather than the letter of the law that causes problems in the system. The most important factor here is the inefficiency of variety and seed control institutions (Tripp & Louwaars, 1998). Their procedures can lead to excessive delays in the release of varieties and seed lots. Variety release committees, for example, often consist of high-ranking persons, which creates severe problems in planning meetings and there is the risk of absenteeism since these individuals may have other pressing commitments, Meeting have been known to be cancelled for several years. These and other bureaucratic procedures can lead to a delay in the release of good varieties (Lemonius, 2003). There are cases where new varieties have not been released for eight years or more because of inefficient official variety tests (Anon, 2003; own observation in, for example, Yemen in the 1990s). Every year lost because of legal or procedural requirements contributes to missed opportunities for farmers. Tripp and Louwaars (1997a) wonder how such losses compare with the contributions that the variety release process makes to safeguarding farmers from inappropriate varieties.

Such procedures are also considered to be the main reason why the production of certified soybean seed is almost impossible in Indonesia. The time required for sampling, testing and reporting of the test results of soybean seed in Eastern Java is - in this hot and humid region – enough to cause the seed quality to deteriorate beyond acceptable limits. Farmers' methods of transporting freshly harvested seed in one farming system to another (from hills to dry paddy fields and vice versa) is much more effective (van Santen, 1994). Inadequate funding of certification organisations can lead to insufficient or late inspections and labelling which in turn can result in seed coming to the market after the start of the main planting season.

A second problem relates to the setting of seed standards. In variety evaluation, for instance, it is difficult to include the multiple varietal criteria that farmers consider important in the more typical focus on yield data and qualitative disease observations. Excessively strict seed quality standards result in high rejection levels and insufficient or overly expensive seed. This in turn may lead to pressure to suspend standards in order to meet the requirements of government development projects (Chaudhry *et al*., 1990).

Even though seed regulations may not be fully implemented they can have a very significant impact on the seed sector. This is illustrated by a case in Kenya, where in 2003 the implementing organisation, the Kenya Plant Health Inspection Service, ordered that all seed has to be certified using the OECD procedures. This new interpretation of the seed law effectively banned the major private maize seed suppliers from the market (except Kenya Seed Company), since they had their production fields in Uganda and Malawi where the control systems have not been able to get OECD approval for their seed certification systems (Louwaars *et al.,* 2005).

3.4.3 The performance and cost of seed regulation

Seed certification and control creates a cost that needs to be covered either by government subsidies or by the seed buyer. Also the cost of multi-locational testing of new varieties can be substantial. When this is done as a final part of the breeding programme in public institutions it usually does not appear as a separate cost item for breeders. Covering travel costs to visit their trials areas can be a serious problem. When, however, variety testing is performed as a special task by an independent organisation, which is usually the case when private sector varieties also need to be tested, all trial costs must to be calculated and a significant cash contribution is required to release a variety. This can lead to a stronger selection of varieties that are entered into the trials, in favour of varieties that have a higher chance to meet the requirements of the Variety Release Committee, thus reducing the chance of identifying varieties for specific regions or uses.

In order to facilitate variety release and provide farmers with a wider choice in varieties, countries in the SADC region and in the East African Community are developing a regional approach to variety testing that allows varieties that are admitted in one country to be admitted to the others as well (GRAIN, 2005). This is similar to the Common Catalogue applicable in the European Union. This catalogue includes all varieties approved for national release in any of the member countries (after one year) but it does not promote the use of specifically adapted varieties.

A major issue in seed certification is the cost of grower registration, field inspection, sampling and testing, which can be very high when it is done by one central public organisation. The cost of transporting seed inspectors to the different production regions can be significant. Sri Lanka has reduced these costs by decentralising the Seed Certification Service and stationing inspectors in all seed production zones. This can, however, create problems of patronage if inspectors become too familiar with the seed producers in their region and find it hard to judge the quality of seed impartially. The costs associated with seed certification and quality control can also involve a significant cash investment for seed producers and can result in prohibitive seed prices. Reusché and Chopra (1992) claim that regulatory costs should not exceed 5% of the seed price. Van Gastel *et al*. (2002) point out some options with respect to quality control systems that operate internally or externally of the seed production organisation. Even though internal quality control has the advantage that seed producers do not have to pay for the inefficiencies of the centralised certification system, centralised systems can have advantages of scale. Giving more responsibility to the seed producers in this respect may be proposed to stimulate private enterprise. But policy makers need to be aware that such systems are likely to benefit large seed companies that have the capacity to develop their own internal quality control systems rather than small and emerging seed enterprises.

Tripp (2002) pinpoints another basic shortcoming in the operation of the seed control system: in most countries control concentrates on the chain that extends from breeders to the conditioning of the certified seed. Farmers need to be assured of the quality of the final product - the seed that he or she purchases. Yet germination and seedling vigour, which are very important quality factors for farmers, are determined to a large extent by storage conditions in the marketing chain. Most seed quality control systems do not check seed quality parameters at the retail level because of logistical limitations. Storage conditions are likely to be the least controlled at that level.

3.4.4 Summarising the impact of poorly designed seed regulations

In the framework of farmers' and formal seed systems developed in Chapter 2 the activities that are particularly affected by poorly adapted seed regulations are indicated in Figure 3.2.
First, the formal seed system is constrained by a) overly tight variety release procedures and by b) costly, inefficient or non-transparent certification and quality controls
The farmers' seed system may be constrained by c) disallowing the use of farm-saved seed altogether or d) at least by making the sharing of seeds illegal. The integration of seed systems is made illegal or is at least discouraged at the level of e) the reintroduction of genebank materials, or f) the testing of yet unreleased varieties on-farm. Participation in plant breeding is f) discouraged by the fact that the results of such participation would be unlikely to comply with the variety release criteria. Wider assistance to farmers' seed systems by introducing adaptive seed technologies g) cannot be supported when farmers' seed systems are officially non-existent ; and the same restriction h) applies to helping small seed enterprise development

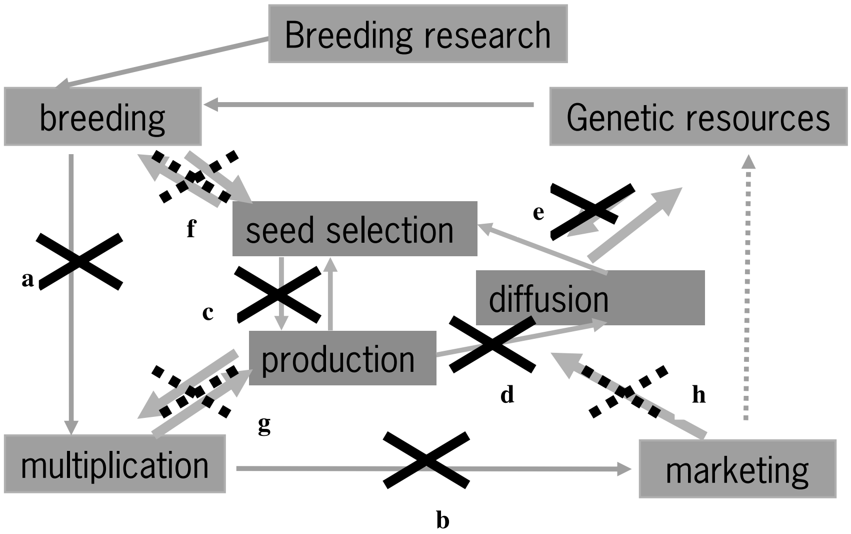

Figure 3.2 Seed systems and the potential effects of poorly designed seed laws . Derived from Fig. 2.5 with crosses through links that are blocked and dotted crosses at links that are affected by poorly designed seed laws (this thesis) - see further explanation in the text below.

.
Figure 3.2 shows that even though seed regulations are designed to support and control the formal system, they may not live up to expectations when poorly designed. In most cases this would mean that they are focusing too much on control and that their implementation has become too bureaucratic. They are also likely to negatively affect the farmers' seed systems and either outlaw or at least provide disincentives for working with farmers to combine the strengths of formal and farmers' seed systems.

3.5 Regulatory options

Chapter 2 has shown that diverse seed systems in different situations include various levels of public, private and farmers' involvement. The diversity of situations and goals of legislation form a justification for challenging blueprint solutions to seed system development and thus for blueprint policy and regulatory advice. In the words of Ayres and Braithwaite (1992, p.5) on deregulation trends: ".. there are no optimal or best regulatory solutions, just solutions that respond better than others to the plural configurations of support and opposition at a particular moment in history". This section thus merely provides options that may fit and complement a range of existing provisions and needs.

Gisselquist and van der Meer (2001) propose 'good practice seed regulations' that are based on the premise that private enterprise should be stimulated. This model is the basis for the regional seed law harmonisation programmes of the Sub Saharan African Seed Initiative (SSASI) in the SADC and ASARECA regions in Southern and Eastern Africa. The main features are:

- Easy entrance to the market in order to stimulate sufficient competition that is essential for reducing market failure;
- Priority to 'truth-in-labelling' possibly in combination with minimum standards and the release of varieties by the seed producers and not the government;
- No or automatic licensing of seed producers and traders;
- Seed export controls in exceptional cases only; seed import controls only for phytosanitary reasons, including the risk of invasive introductions (biosafety measures);
- Government to provide services (at cost) with respect to issuing seed certification and quality certificates, phytosanitary certificates and intellectual property certificates;
- Small public institutions should oversee and manage the above system.

This approach reduces seed controls to the bare minimum removing almost all regulatory blockages to initiatives for linking local and formal seed systems. By lifting official variety release requirements the proposed system will avoid problems might otherwise be encountered in participatory variety selection and breeding. Removal of compulsory seed certification avoids regulatory problems with farmer-to-farmer seed exchange.

The elegance of this proposal is that it forces the public seed quality control institutions to show their added value for the seed producers and the farmers that they intend to protect. If the certification label is identified in the market as a quality mark, the certification services will be sought after. If they cannot show a clear advantage, seed producers are likely to develop their own quality brand. Some certification systems have actively 'marketed' their logos and the labels on the seed to increase the impact of the system, but in most cases, knowledge about the labels is mainly restricted to educated farmers (Tripp & Pal, 2000). However, assuming that larger seed producers will choose to rely on their own brand and not use the services of the certification system, the government will have to maintain an expensive human and institutional capacity to certify and test seed produced by smaller (and often more remote) seed producers. This public good argument may be compared with the origin of seed certification in many American states which were set up with the help of universities as an educational tool to create awareness about seed quality among farmers using university-released varieties. Experience with seed certification institutions in developing countries indicates that it is unlikely that institutions can be run on a cost-recovery basis in these countries if the objective is primarily educational. Secondly, compulsory seed quality control is also a way of creating a level playing field for competing companies. This was the basis for the seed sector in the Netherlands to establish an inspection service. When all seed producers have to meet the same minimum quality requirements, companies that are less quality oriented – and who are able to offer their seed at a lower price – are effectively banned from the market. This argument in favour of compulsory controls is likely to hold in many developing countries where businesses are often charged with cheating poor and illiterate customers (Sperling, 2001b).

Thirdly, the same advice favours the introduction of intellectual property rights (see Chapter 5) as an additional regulatory requirement in developing countries. This would probably introduce novel blockages into different seed systems.

A solution might be to introduce compulsory quality control requirements for packed and labelled seed that leaves non-packed seed untouched. This could be effected by minor change in the seed laws notably at the level of definition. It would allow local seed systems to continue operating without restriction and at the same time regulate the formal system in such a way that it would be able to develop its own brands in the market. This should go hand in hand with educational activities to prevent seed suppliers who do not intend to develop a quality brand from selling unpacked seed on a large scale (brown-bagging).

Relaxed variety release procedures may be necessary to provide for more diversity in terms of locally adapted varieties and selections. Release could be based on the assumption that a variety should not be significantly worse than the standard shown by a number of (on-farm) trials by the applicant. For example, cauliflower seed that cannot set a head under prevailing climatic conditions (authors' experience in Yemen, 1996) should be prevented from coming onto market. Making such trials compulsory stimulates seed suppliers to test their materials. Serious companies already do this to obtain information and at the same time demonstrate the new products. Seed importers are sometimes less active in this field.

The introduction of opportunities to certify internal quality control operations is likely to provide competition for the government seed certification and control institutions. Since they have the important task of stimulating seed quality awareness among farmers and supporting grass root seed initiatives (as in Zambia) these certifying institutions should be financed at least partly by the Government. Countries could also subsidise private seed quality control organisations.

The above options are based mainly on relaxing the regulatory system to an extent that allows farmers' seed systems to remain untouched. The main disadvantage is that consumer protection may be compromised as a result of the seed law. A very different option is to include farmers' seed systems in the regulatory framework. The EU is introducing the concept of 'Conservation Varieties' into its system to exclude particular (described) varieties from the normal uniformity and other release requirements and to allow - without certification - the marketing seed of old heterogeneous varieties. The seed still has to conform to normal seed testing standards. This arrangement does not, however, provide opportunities for 'new farmer varieties' to be marketed if they are not uniform (Salazar *et al*, 2007). A main feature of this system in Europe is that it can be assumed that the farmers are well educated and that only farmers who specifically want to plant old varieties for a specific purpose will look for the seed and they will know its characteristics. The chances are small that illegitimate seed producers will be able to sell poor quality seed under this label.

Even though countries need to take into account their national seed systems when designing their seed regulatory framework, the option of regional cooperation, for example, in East Africa, needs to be taken seriously (Rohrbach *et al.*, 2003). Cooperation can create a larger market allowing for a larger number of commercial companies. This can create competition and lead to less market failure that would otherwise need to be compensated through farmer protection through regulation. Even if this is possible, countries need to realise that some crop seeds can not be commercialised because of the low commercial value of the seed or the fragmented needs of farmers who require an expensive portfolio of many varieties that the private sector is unlikely to maintain.

Finally, at the level of implementation great improvements can be made. The seed certification and quality control institutions often harbour a very significant human resource base for increasing seed quality. However, such institutions are commonly designed to operate as a kind of police force that is not primarily charged with the task of increasing quality, but with the task of banning sub-standard seed from the market. Changing the 'corporate culture' of the certification authorities to a service-oriented role could optimally use that resource for supporting agricultural development. In some countries, notably Sri Lanka and Zambia, the seed certification officials are actively involved in training farmer groups that do not belong to the traditional (formal) sector as far as seed quality is concerned, thus stimulating farmers' quality awareness in their own seed production activities. At the same time they 'police' the formal sector according to the strict procedures and standards that their national laws charge them to perform. It was a change in attitude rather than a change in regulations that stimulated these institutions to add an additional focus to their work. It is striking that in some countries with an open attitude the term 'Service' is in the name of the certification organisation (Seed Certification Service in Sri Lanka), where in other countries they are named "Seed Certification Authority" (as in Bangladesh).

3.6 Conclusions

Farmers' seed systems and formal seed systems have complementary roles in supporting agricultural development and the management of plant genetic resources. Seed regulatory frameworks provide legal boundaries in which both systems have to operate even though in most countries these have been designed for the formal sector only. The scope of these laws determine, to a large extent, the degree of freedom that farmers have in handling their own seed.

Seed laws show great similarity among countries with regard to their organisation and focus, but important differences have been observed with regard to the definitions and key articles that impact on the application of the law as far as different kinds of seeds are concerned.

Variety controls tend to limit the number of varieties available in the market and tend to direct plant breeding to wide adaptation and high-input agriculture. This is arguably not optimal for many smallholder producers. Because varieties selected in participatory breeding programmes tend not to be eligible for official release because of a lack of uniformity or width of adaptation. It can be concluded that such variety controls do not support the integration of seed systems at the level of crop improvement.

Many countries have defined requirements for seed certification and quality control in such a way that under national law farmers' seed production and especially exchange and sale of farm-saved seed has become illegal despite the fact that for most crops farmers' seed systems provide by far the largest amounts of seed used. Even though these rules are hardly ever implemented at the level of smallholder farmers, they tend to put severe restrictions on local initiatives to support farmers' seed production and to develop small scale seed enterprises. The incomplete implementation of such laws to certain crops or components of the market, however, challenge the credibility of the laws and implementing institutions.

The regulations derived from the linear approach to seed system development have a strong 'management by law' character, where regulations are designed 'up front' to lead developments on the ground. The level of participation of farmers and their representatives in official bodies that oversee or implement the seed laws is commonly low which could contribute to the poor adaptation to farmers' seed systems.

Important openings can be made in seed laws that allow for support to diversified seed systems, especially through altering the scope of the seed law which should only regulate the formal sector. A change in focus of the institutions that are responsible for the implementation of the seed laws from a role of policing the formal seed system to the task of increasing seed quality awareness and actual seed quality in all seed systems is important for the development of diversified seed systems. Adapting seed regulations to the needs of the private sector only is not likely to be sufficient to serve the different roles that seed regulations need to fulfil.

In their choices for the development of their own seed laws, governments have to take into account the current and preferred structure of their seed systems, including a realistic analysis of the commercial opportunities for different crops.

The outcomes of this analysis of conventional seed laws indicates the need to study other regulatory issues as well, notably those on biodiversity (Chapter 4) and intellectual property rights (Chapter 5).

4. Policies on genetic resources and their implementation[2]

Abstract

Genetic resources are the building blocks of crop improvement. They have developed as a result of millennia of natural processes and of conscious and unintentional human selection. Concerns about the reduction of global crop genetic diversity led to the definition of a number of values attributed to genetic resources. This chapter analyses the values that implicitly or explicitly form an important basis of the policies and regulations that introduce new rights over these resources. These regulations deal with the conservation and use of genetic resources and with access to the resources and the sharing of the benefits arising from their use. Since these agreements may not primarily focus on agriculture, it is relevant to analyse the actual and potential impact of these policies and regulations on seed systems, and in particular on farmers' seed systems in developing countries. Opportunities to link farmers' and formal seed systems must also be assessed.

International agreements are commonly implemented through national law. After analysing the international policy framework, three distinct regional strategies for implementing the provisions of the Convention on Biological Diversity (CBD) are analysed with regard to their effect on access to genetic resources. By doing this the proposition is that the CBD fails to support seed system development is analysed. The potential and extent of the International Treaty on Plant Genetic Resources for Food and Agriculture (IT PGRFA) to correct this is assessed.

Restrictive national regimes for access to genetic resources based on the CBD can impact on seed systems, in particular by reducing the availability of genetic resources for plant breeding in the public and private formal sector, in farmer-participatory approaches, and in the sharing of seed among communities. Since developing countries currently obtain larger numbers of genetic resources from genebanks worldwide than industrialised countries, it is concluded that developing country farmers are bound to be negatively affected by severe access restrictions. The Multilateral System of the IT PGRFA is expected to facilitate access and benefit sharing for many important food crops and pasture species, but it is too early to assess its actual effects.

4.1 Introduction

The Convention on Biological Diversity (CBD) defines genetic resources as 'genetic material of actual or potential value'; 'genetic material' is defined as 'any material of plant, animal, microbial or other origin containing functional units of heredity' (CBD, 1992, Article 2:http:// www.cbd.int). Genetic resources provide the essential building blocks of plant breeding and the genetic composition of seed is a key seed quality element that determines the success of a crop.

---

[2] Parts of this chapter have been derived from: Niels P. Louwaars, Eva Thörn, José Esquinas-Alcazar, Shumin Wang, Abebe Demissie & Clive Stannard, 2006. Access to plant genetic resources for genomic research for the poor: from global policies to target-oriented rules. Plant Genetic Resources 4(1): 54 – 63.

- The origin of genetic resources in agriculture

Genetic resources for food and agriculture have been developed over the course of some 10,000 years and can be traced back to the origins of agriculture itself.

Farmers and collectors identified edible plant species and within these they identified plants with superior edible parts. The combination of farmer and natural selection in agro-ecosystems resulted in the domestication of crops (Zeven & de Wet, 1982; Harris & Hillman, 1989). The resulting genetic diversity within these crops in conjunction with the regular evolutionary forces of selection and the creation of variation allowed these emerging crops to adapt to local agricultural systems and spread around the globe and sub-populations gradually became more specialised.

Natural selection is complemented by farmers' selection. Farmers' selection is partly conscious and partly unintentional (Almekinders & Louwaars, 1999). Conscious selection is performed by farmer-seed specialists who either select plants in the field and harvest them separately for the next season's planting, or select ears or individual seeds from the harvested bulk. The selection criteria may differ among different individuals and communities. Farmers generally have an ideotype for their variety – either a single ideal plant/seed type or an ideal level of diversity that they want to achieve in their next crops (Sperling *et al*., 1993).

Unintentional selection is performed when particular agronomic practices have a selective effect. This can create a specific adaptation of the crop to the ecological conditions in which it grows, i.e. a combination of day length, soil, temperature and rainfall regimes, and the farmers' operations. This component of natural selection may work in the direction of the ideotype, but in some cases it will not. For example, using harvested grain as seed creates a selection pressure against shattering; mechanized weeding creates a selective pressure in favour of erect plant types. Louwaars & van Marrewijk (1996) illustrate some common practices that create a selective pressure against ideal crop characteristics: late harvesting gradually extends the maturity period of the crop beyond the length of the average season; seed transmission of bean diseases is supported when the early pods of a bean plant are used for food and the latter ones are used for seed; and when off-type tomatoes or melons are used for seed because the best shaped fruits can be sold for a better price this results in a selection in favour of poor fruit quality.

Whereas selection only decreases diversity, mutations, introgression from neighbouring crops and weeds, and introduction of new materials increase it. These mechanisms to increase diversity are essential to safeguarding the resilience of the crop - to allow for improvements and adaptation to changing farming systems – and in cross fertilizing species in addition to reduce risks associated with inbreeding. Access to materials is valued and stimulated in many agricultural communities, for example, gifts of seeds are common in wedding ceremonies and other cultural expressions. Physical (e.g. mountain ranges) and cultural barriers (tribal relations) can restrict the free movement of genetic materials among farming communities (Green, 1987). The perception that farmers are looking for 'things to try' (Reijntjes *et al*., 1992) and that many are keen experimenters (Richards, 1985, Rhoades, 1987, van der Ploeg, 1990, Voss, 1989, Bertuso *et al*., 2005) is part of this same deeply rooted farmers' culture. A specific type is the keen eye that some farmers have developed for potentially valuable off-type plants in their crops (Richards, 1985; Salazar, 1992) and farmers may consciously avoid crossing their crops with neighbouring crops or weeds and on the other hand promote introgression (see Merrick, 1989). Rhoades and Bebbington (1991: 251) distinguish curiosity experiments, adaptation experiments and problem solving experiments. Experiments with introduced seeds can fall in either category depending on the situation.

- Concern about genetic resources
The term genetic resources is of rather recent date and follows the global search for the geographic origin of crop species by de Candolle (1882) and the systematic collection of genetic diversity by Vavilov (1926, 1951). They showed that genetic resources are not evenly distributed in the world. Vavilov's map of the centres of origin, later more correctly termed primary centres of diversity (Harlan & de Wet, 1971), showed that the majority of these geographic regions are located in developing countries. Systematic collection of genetic diversity started during Vavilov's research and national genebanks starting in the Soviet Union and the USA - were established as a result. A systematic collection at the species level of domesticated and undomesticated plants is much older and led to the establishment of botanical gardens.

The importance of genetic resources for agricultural production was first identified in 1890 by Ritter von Proskewetz and Schindler (quoted by Bommer, 1991) who reported on the value of landraces in relation to bred varieties. The need for genetic resource centres was suggested where genetic resources could be collected, characterized, evaluated and documented. Harlan & Martini (1936) reached the global scientific community with their concern that advances in barley breeding would soon be limited by the lack of available genetic diversity. The value of genetic resources became apparent to the larger public during the leaf blight epidemic in the USA in 1972, which wiped out susceptible maize hybrids, i.e. all hybrids that contained a common source of male sterility – a source that was genetically linked to the lack of resistance (Ullstrup, 1972; Tanksley & McCouch, 1997). The seed industry was very quick in making alternative seeds available to farmers, but the observed risk had a significant impact on the community of plant breeders.

The importance of the conservation of genetic resources at the global level was spurred by the realization that one of the side-effects of the Green Revolution was the massive replacement of genetically diverse landraces in the centres of diversity by uniform varieties originating from a narrow genetic base at the international agricultural research centres. The first international panel of experts on plant exploration and introduction was established by the Food and Agriculture Organisation (FAO) in 1965, followed by the first International Technical Conference on Plant Genetic Resources (PGR) in 1967 (Esquinas-Alcázar, 2005). This process has been important in the establishment of the International Board on Plant Genetic Resources at FAO in 1974, which evolved into the International Plant Genetic Resources Institute under the Consultative Group on International Agricultural Research (CGIAR), recently renamed 'Bioversity International'.

- This chapter
The recognition that biological diversity was eroding led to debates on the values of genetic resources and this played a key role in the development of international agreements on biodiversity, notably the Convention on Biological Diversity (CBD) and the International Undertaking (later Treaty) on Plant Genetic Resources for Food and Agriculture (IU PGRFA). These are being implemented through national policies and regulatory frameworks.

The CBD originated within a wider concept of biodiversity. The proposition therefore is that national frameworks based on this convention may not support or even present disincentives to the further development of seed systems. Relevant questions are i) What are the key elements that determine whether agricultural genetic resources are special with regard to the objectives of the CBD?; ii) What are the likely impacts of restrictive regulations on access to genetic resources on different types of seed systems?; iii) Does the CBD necessarily lead to restrictive access regimes? Furthermore, since the IT PGRFA is based on the unique character of agricultural genetic resources that have largely developed in farming systems and on the handling of seeds by farmers themselves, the issue of whether this agreement is likely to support the diverse seed systems that farmers use is analysed in the following sections.

Exploring this proposition and these qustions, this chapter analyses the different values of genetic resources (4.2) that implicitly or explicitly form an important basis of the policies and regulations that introduce new rights over these resources. It analyses the special nature of agricultural genetic resources (4.3). This forms the basis for an analysis of different regional implementation strategies of the CBD with regard to access to genetic resources. Three distinct regional approaches are described (4.4) and analysed with regard to the impact of such strategies on seed systems (4.5).

4.2 Values of genetic resources that warrant conservation

4.2.1. The different values of genetic resources

Seeds are valued in traditional farming communities, and these values go beyond their immediate economic value (Brush, 1996, 2000). The value of the seed compared to grain is that the seed represents a future value – the value that the future crop represents. This alone warrants the extra attention that farmers give to the selection, drying and careful storing of seed. The dependence of farming communities on the crops they grow, and the realization that these crops and their distinctive features originate in the seed has given rise to the special position accorded to seed in the culture of farming communities (Gonzales, 1999).

Since genetic resources are hardly traded, their value is difficult to assess (National Academy of Sciences, 1993, p 303). Establishing value is complicated by the fact that genetic resources are associated with different types of values. Brush (2000) identifies three types: direct use, indirect use, and option values.

- *Direct use values* refer to the value from actual use, such as the value in agriculture, which includes the value of diversity in the field for yield stability (Clawson, 1975), and the value for consumption, including adaptation to local food processing methods (Brush, 1992). Direct use value forms the main drivers for farmers to maintain diverse local crops (Bellon, 1996).

- *Indirect use values* refer to the environmental services rendered by specific varieties, such as their ability to intercropping with other species and their contribution to sustainable farming systems (Brush, 2000).

- *The option value* is derived from the potential use of genetic resources in the future, such as their ability to contribute to plant breeding when new breeding objectives arise, for example, in the form of resistances to new (pathotypes of) diseases, adaptations to changing cropping systems, or contributions to new consumption qualities. The option value is illustrated by comparing the speed at which in the early 1970s the major maize disease epidemic was resolved by using available genetic resources. This can be compared to the disastrous consequences of the potato famine in Ireland in the mid 19th century which was largely attributable to the narrow genetic base of the crop (Esquinas-Alcázar, 2005).

Birol (2002) adds two additional values: *Existence value* and *bequest value*. The former is the value that is derived from sheer existence: the satisfaction of knowing that a particular asset exists and it includes the value derived from the link between culture and genetic resources which is very strong in certain crops and cultures (Zimmerer, 1996). Bequest value is defined as the 'benefit accruing to any individual from the knowledge that others might benefit from the resource'. This is the basis of the value of presents in the form of seeds in various cultures.

The value of genetic resources – such as those referred to above - are usually not expressed in monetary terms in traditional farming communities where seed is freely exchanged among farmers. Smale (2006) analyses the issue in terms of public and private goods. Where the seed itself is rival and its use may be easily exclusive, the genetic resources embodied in that seed have a high public good character – their use by one farmer does not compete with their use by others. Exclusion is very difficult to realise (except maybe in commercial hybrids and potentially in V-GURTS). This public good character of genetic resources in combination with their immense value for farming has resulted in a deeply rooted 'law of the land' incorporating the practice of free exchange which has persisted in present-day agriculture.

i) The principle of free exchange was intentionally used during the Green Revolution to make best use of the scientifically achieved improvements in crops. The 'lateral spread system' - a formally adopted mechanism to promote farmer-to-farmer exchange of improved varieties in order to reach remote and resource-poor farmers - built on this farmers' mechanism (Vervoorn, 1996).

ii) Plant Breeder's Rights (PBR) systems that developed in the USA and Europe in the 1930s also included aspects of this 'law of the land'. They allowed the use of protected seed in further breeding, and included liberal exemptions for saving and exchanging protected variety seeds. These features are unknown in the patent systems from which PBR was derived (Chapter 5).

iii) At the international level, this traditional mechanism was codified in the International Undertaking on Plant Genetic Resources for Food and Agriculture (1983) which confirmed that genetic resources were the "heritage of mankind".

4.2.2 Economic considerations for the conservation of genetic resources

In situations where the direct use value of genetic resources is high, such as in landraces in ecologically diverse regions in developing countries, this may offer sufficient incentives for 'autonomous' on-farm management strategies. In addition, some materials that have been well described and that can be considered to have a commercial value in breeding in the foreseeable future are commonly maintained in genebanks and by public and private breeding programmes as part of their working collections. Smale *et al.* (2006) includes these in the category of 'private values' as opposed to the public values and this forms the basis of the considerations discussed below.

The main driver of global investments in conservation is the option value of genetic resources, the value understood in terms of its contribution to future plant breeding. This value presses itself as the increased value of seed in the market or gains to agriculture in terms of quantity and quality (market value) of product that results from the use of conserved resources. The option value of a single genetic resource cannot be calculated beforehand, but the option value of a collection expresses itself in the value of the unique genes and gene complexes that will prove useful in the future (Smale, 2006).

In assessing the different values, the distance between the *ex situ* collection and the final users (consumers, farmers, seed producers, breeders) in time and space creates methodological problems for economists (Drucker *et al.*, 2005). Day Rubinstein *et al.* (2005) suggest that the economic analysis of conservation efforts must begin with recognising that private incentives for conservation will probably be insufficient to achieve a level of crop genetic diversity that is socially optimal. They identify public policy as playing an important role in conservation. They calculate that a one-time, permanent yield increase in the past from the genetic improvement of five major crops generated an estimated $ 8.1 billion gain in economic welfare worldwide. This increase was made possible because genetic resources and investments in plant breeding and seed production were combined. Smale *et al.*(1998) concluded that any calculation of the option value of genetic resources by definition remains guesswork. Zohrabian *et al.* (2003), however, modelled the value of genetic resource conservation and conclude that the "lower bound estimate of benefit is significantly higher than the upper-bound cost of conserving and accession." Such models are useful in supporting public investments in conservation. The Global Crop Development Trust is currently aiming at a fund of 260 million US Dollars, which would guarantee the perpetual funding requirements of global collections of the major food crops (www.croptrust.org).

Whereas it is already difficult to make investment decisions based on models to assess the option value of particular collections of genetic resources the methodological complexity is considerably increases when bequest and existence values are included in these models.

4.3 Rights over genetic resources at the international level: four platforms

4.3.1 Four platforms

Calculations on the value of genetic resources do not only operate as an incentive to conserve, they are also an important driver in the political debate between providers and users of genetic resources on rights over genetic resources, including the right of providers to share in the benefits arising from use. Fowler and Hodgkin (2004) phrase it as follows: "Today's debates are confounded by complex claims of rights and the seemingly irresistible lure of thinking of these resources as having great economic value."

This debate started in the late 1970s during the first global wave of concentration in the seed industry (Mooney, 1979). In order to lay an institutional foundation for benefits to reach the farmers who developed and maintain genetic diversity, access to genetic resources needed to be regulated. International debates in four sectors contributed to this discussion, i.e. the sectors dealing with agriculture, environment, trade and culture. A brief overview is presented here but the outcome of the debate in the trade sector is discussed further in Chapter 5.

- The agricultural sector (before 1993)
The perception that plant species can be a strategic resource developed in the early colonial period when the emerging global powers were keen on containing valuable crops within their colonies (Plucknett *et al.*, 1987). An example at the species level is the control over cloves and other spices in the Moluccas by the Dutch "United Patented East India Company" (in Dutch: *Vereenigde Geoctroyeerde Oostindische Compagnie*, Wennekes,

1996, p.135), which powerfully defended its monopoly with varying degrees of success. Up to the 20th century, produce marketing boards for tropical crops resisted sharing their best materials with potential competitors. More recently there have been formal (Smale & Day-Rubinstein, 2002) and informal (Fowler & Mooney, 1990) embargoes on the export of genebank materials of crops. Where institutional hindrances have occurred, farmers generally maintained the concept of free exchange.

The global debate about the conservation and availability of genetic resources in the agricultural sector emerged in the late 1950s. This debate led to genetic resources being designated as the heritage of mankind. At the same time, systems of limited intellectual property rights were developed to supported investments in plant breeding (see Chapter 5). The “enormous contribution that farmers of all regions have made to the conservation and development of plant genetic resources, which constitute the basis of plant production throughout the world” was internationally recognised in the voluntary International Undertaking on Plant Genetic Resources for Food and Agriculture (IU PGRFA: http://www.fao.org/ag/cgrfa/IU.htm). This recognition became the basis of the concept of Farmers’ Rights, “vested in the International Community, as trustee for present and future generations of farmers, for the purpose of ensuring full benefits to farmers, and supporting the continuation of their contributions”. The International Undertaking was an important agreement that put plant genetic resources high on the political agenda. It stimulated government support for national and international initiatives concerned with conserving genetic resources through the Global Plan of Action (GPA). The voluntary nature of the IU PGRFA, the lack of compliance mechanisms, and the failure of the financial mechanism of the Global Plan of Action to support tangible measures that would confirm Farmers’ Rights considerably limited the impact of the Undertaking at the political level.

- The environmental sector
The debate on biodiversity in the environmental sector culminated in the UN Conference on the Environment and Development (UNCED) in Rio de Janeiro in 1992. A chapter of the Agenda 21 deals with biodiversity. Through the Convention on Biological Diversity (CBD, 1993), which is a binding international agreement, biodiversity became a natural resource under the sovereignty of nations that could be traded. Biological diversity encompasses all genetic resources including both natural and agricultural species. While, under the CBD, Parties are responsible for conserving biodiversity and promoting its sustainable use, they may set conditions to accessing genetic resources making it subject to a contract that provides for prior informed consent, mutually agreed terms and some form of benefit-sharing. Countries are free to negotiate and design such bilateral access agreements.

The CBD thus explicitly overrode the “heritage of mankind” principle of the IU PGRFA. The result is that transfers of genetic resources are most often accompanied by individually negotiated contracts. In 2002, the “Bonn Guidelines on access to genetic resources and the fair and equitable sharing of the benefits arising from their utilization” were agreed (Decision VI 24 of the Conference of Parties of the CBD) as a non-binding instrument that would guide countries in their access and benefit sharing policies and implementation strategies. The more recent discussions within the framework of the CBD on a binding international regime for access and benefit sharing have to date (mid-2007) not resulted in agreement. Negotiations on an International Regime are expected to be concluded by 2010.

- The trade sector
The debate in the trade sector led to the Marrakech agreement, the establishment of the World Trade Organisation (WTO), and the Agreement on Trade Related Aspects of

Intellectual property Rights (TRIPS). The TRIPS Agreement specifies minimum standards for IPRs in the territories of member countries of the WTO. TRIPS requires that all products and processes must be patentable although Article 27(3) indicates that “plants and animals other than micro-organisms, and essentially biological processes for the production of plants or animals other than non-biological and microbiological processes” provided that plant varieties are protected by “patents, or by an effective *sui generis* system, or by a combination thereof” are excluded. The individual rights conferred by IPR can thus restrict the free availability of genetic resources. Here TRIPS also breaks with the “heritage of mankind” principle. However, current *sui generis* plant variety protection, such as those national systems that comply with one of the Conventions of the International Union for the Protection of New Varieties of Plants (UPOV), do provide for the free availability of all materials, including protected varieties for further breeding under the so-called “breeder’s exemption”. This is fundamentally different when varieties are protected by utility patents in the USA, or fall under the scope of a patent not directed at the variety itself. Since the research exemption in the patent system in some countries (e.g. the USA) is restricted to research that focuses purely on understanding how the product was made and excludes any research that could lead to further uses, the patent system considerably restricts the availability of patented genetic resources. This is considered by some as a misuse of the patent system (Louwaars, 2006).

- Responses by the agricultural sector
The concept of genetic resources as a “heritage of mankind” that should be available without restriction could not be maintained. As early as 1991, the parties of the International Undertaking recognized that “the concept of mankind's heritage, as applied in the International Undertaking on Plant Genetic Resources, [was] subject to the sovereignty of the states over their plant genetic resources” (FAO Conference, 1991, quoted by Andersen, 2003). Similarly, the extended coverage of intellectual property rights provided by TRIPS and the resulting restrictions on the availability of commercial seeds did not fully conform to the spirit of the IU PGRFA. The Undertaking was formally adapted in 1995. This was also the start of the process towards the binding International Treaty on PGRFA which was adopted in 2001 (Esquinas-Alcázar, 2005).

The International Treaty on PGRFA should be seen as an agreement between states who – within their sovereign rights as confirmed by the CBD – agree to make special arrangements for plant genetic resources for food and agriculture (PGRFA). It has the same objectives as the CBD: the conservation and sustainable use of genetic resources and the fair and equitable sharing of the benefits arising out of their use. The Treaty specifies the responsibilities of contracting parties with regard to conservation (Art.5) and sustainable use (Art 6) of PGRFA in much more detail than CBD prescriptions for genetic resources in general. Farmers’ Rights are formulated (Art 9) and the Treaty introduces a multilateral system of access and benefit-sharing (Art. 10) for a number of important food and fodder crops. Whereas CBD-based national legislation (see below) requiring bilateral negotiations between parties may hinder exchange and use this system is intended to facilitate these processes (Art.12). It also introduces multilateral mechanisms for benefit sharing through its Funding Strategy (Art. 18). The Treaty links into a number of existing and relevant institutions such as the Global Plan of Action (FAO, 1996), the system of ex situ collections held by the centres of the CGIAR, (FAO, 1995), the international PGRFA networks (www.fao.org/ag/agp/agps/pgr/regnet.htm), the global information system on PGRFA (www.fao.org/ag/cgrfa/PGR.htm) and - since the first session of its Governing Body - the Global Crop Diversity Trust (www.croptrust.org).

The Treaty came into force in June 2004, but it’s Governing Body, which had to resolve major implementation issues did not meet until June 2006. Many important decisions were taken but some are still pending including compliance arrangements and the implementation of the Funding Strategy (Visser & Louwaars, 2006).

- The cultural sector
The debate in the CBD on the rights of indigenous communities, the debate in the FAO-Commission on PGRFA on genetic resources and Farmers' Rights, and the debate in the World Intellectual Property Organisation on rights over expressions of folklore, led to the decision to establish an "Intergovernmental Committee on genetic resources, traditional knowledge and folklore" (IGC). This committee is charged developing a strategy for an equitable system that is in line with intellectual property rights systems that will protect genetic resources, traditional knowledge and folklore. The Committee has to deal with some fundamental questions. First, how can communal rights over these three interrelated issues be combined with the private (individual) rights in most traditional IPR systems? More specifically, how do such 'soft' rights relate to 'hard' patent right, copyright, trade secret and plant breeder's rights systems. In addition, what will be the relation between communal rights and national sovereignty (over genetic resources) requires careful consideration.

Traditional healers use their extensive knowledge of genetic resources in their work, which may have a value for the modern pharmaceutical sector. Also farmers' traditional knowledge can be relevant to the plant breeding and seed sectors. The value of genetic resources often depends on the information farmers provide at the time of collection. The question is whether the use of this knowledge should result in giving the knowledge provider the right to control the use of this knowledge - and subsequently the genetic resources - in exclusive or non-exclusive ways. Other major issues include whether and how benefits derived from the use of such knowledge should be shared and how can the use made of traditional knowledge during the process of exploitation genetic resources be formally recognize so that it can be protected. The IGC is likely to require a few more years to come to a conclusion.

4.3.2 The unique character of agricultural biodiversity

Environmental and trade negotiations did not specifically target genetic resources for food and agriculture and hardly any special provisions were made that took account of their unique nature (Esquinas-Alcázar, 2005). The TRIPS Agreement makes special provisions in Article 27 in relation to the protection of plants and animals. Only the second conference of parties of the CBD, Decision II.15, recognized "the special nature of agricultural biodiversity, its distinctive features and problems, needing distinctive solutions. . ." (CBD, 1996). This has led to different programmes, but not to initiatives within the CBD to make special institutional arrangements for access and benefit sharing of genetic resources for food and agriculture. The latter is being primarily implemented by the Commission on Genetic Resources for Food and Agriculture of the FAO.

Genetic resources for agriculture are categorically different from wild genetic resources, for a number of reasons (Stannard *et al.,* 2004).

(i) They are essentially *man-made*, that is, they have been consciously developed and selected by farmers since the origins of agriculture, 10,000 years ago. Much of the genetic diversity of cultivated plants can only survive through continued human conservation and maintenance. Scientific plant breeders have built upon this rich inheritance for little more than a century. The complex pedigrees of most improved varieties resulting from such scientific plant breeding programmes complicate attempts to trace specific genes, and to infer their possible relative values.

(ii) They are not randomly distributed throughout the world, but to some extent concentrated in the so-called "centres of origin and diversity" of cultivated plants and their wild relatives, which are largely located in tropical and sub-tropical areas (Vavilov, 1951; Harlan & de Wet, 1971).

(iii) Because of the diffusion of agriculture throughout the world, and because of the association of major crops with the spread of civilizations, many crop genes, genotypes and populations have spread, and continued their development in farmers' seed systems all over the planet (Almekinders *et al*., 1994), enriching crop genepools by adaptation to a wide variety of agro-ecosystems. Moreover, plant genetic resources for food and agriculture have been systematically and freely collected and exchanged until recently, and a large proportion have been incorporated into *ex situ* collections. This means that the origin of a genetic resource can often no longer be established, and that it is therefore not clear who is responsible for granting access.

(iv) There is much greater inter-dependence among countries for plant genetic resources for food and agriculture than for any other kind of biodiversity (Flores - Palacios, 1997). Continued agricultural progress implies the need for continued access to the global stock of plant genetic resources for food and agriculture. No region can afford to be isolated or isolate itself from the genetic diversity of other parts of the world (Smale & Day-Rubinstein, 2002). Even a diversity-rich country like China depends on foreign germplasm, both at the species level (important crops like cotton, maize, groundnut as well as many fruits and vegetables), at the level of foreign varieties of old crops in the country such as rice materials from Nongken 58 from Japan, IR8 from IRRI and highland rice from Brazil and for parent lines for Chinese breeding programmes, such as the wheat variety Orofen, which is included in the pedigree of 245 released varieties in China (Shumin Wang, personal communication).

4.3.3 Preliminary analysis

In view of the specific features of agricultural genetic resources, both the environmental and trade sectors have developed generic rules that can have different outcomes in the agricultural sector from those intended for the sectors that they were primarily intending to serve. The International Treaty may be seen as a 'repair mechanism' that could be used to remove the potential unintended effects of the CBD on future food security. It does not, however, explicitly correct potential negative impacts that could stem from the application of IPRs by the trade sector. Similarly, key differences between agriculture and other sectors may not be fully recognised in the current debate on the protection of traditional knowledge. For example, the difference in knowledge transfer in the agricultural and medicinal uses of genetic resources could create important consequences for policy. Knowledge about the specific features of genetic resources is commonly widely shared in a community, whereas pharmaceutical knowledge is often secret and only transferred from one traditional healer to another. The IGC, therefore, has the responsibility for developing rules that can serve both sectors well and this may have to involve specific adaptations to IPR systems.

In short, different rights systems apply to genetic resources: national sovereignty, private intellectual property rights and communal rights. These concepts have been developed independently in policy sectors that may not have taken the unique character of agricultural genetic resources into consideration. This leads to a complex international policy arena with agreements that seemingly contradict each other, if not in legal terms then at least in spirit. This creates significant problems for national policy makers who have to translate the international agreements into coherent national policies (see Chapter

6). In turn, this is one of the major reasons why many countries still do not have operational access legislation even though many ratified the CBD more than 10 years ago. It is also the reason why the initial deadline for the national implementation of TRIPS in least developing countries was extended for 7.5 years in 2005.

4.4 National and regional implementation of access to genetic resources

A wide variety of choices can be made in analysing national law to regulate access to genetic resources in the exercise of sovereign rights, including in relation to intellectual property rights. To illustrate the range of choices, three examples are analysed: the African Union's "African Model Law for the Protection of the Rights of Local Communities, Farmers and Breeders, and for the Regulation of Access to Biological Resources in Relation to International Law and Institutions" - in short: the African Model Law (GRAIN, 2000); the 'Nordic approach' of the Nordic countries with regard to access to genetic resources, and the 'Common Regime on Access to Genetic Resources' of the Andean Community. The titles - model law, approach and regime - already indicate important differences of approach.

4.4.1 The 'African Model Law'

In 1996, the countries of the Organisation of African Unity organized a conference on medicinal plants, in which they decided to develop a comprehensive framework for the protection and utilization of Africa's natural plant resources in the light of the CBD and TRIPS. It was one of the first attempts anywhere to translate the obligations that stemmed from these two agreements in one '*sui generis*' legal framework. The resulting "Model Law" is not in itself legally binding, but provides the countries of the African Union with a model for their own national regulatory systems. The basic principles underlying the Model Law are derived from the regional focus on food sovereignty and food security, state sovereignty, and on the principles of the CBD and TRIPS.

The importance given to genetic resources derives from the recognition that over 90% of the continent's food is produced in farming systems that are highly dependent on agricultural biodiversity, and on farmers' seed systems. On the basis that the State has the responsibility to defend the rights of the people, the Model Law stipulates that private rights such as IPRs should be designed in such a way that national and local control over food production is maintained and that inter-generational rights and obligations of communities over genetic resources are respected. The Model Law recognizes the rights of both breeders and communities over their genetic resources and it protects indigenous knowledge. It invites communities to participate in the development and implementation of policies on matters affecting biological resources and associated knowledge, including the model law itself at national and local levels. This applies in particular to the role of communities in providing access to genetic resources and sharing the benefits derived from the utilization of these resources. The Law also pursues gender equity in this field.

According to the Model Law, the authority to provide access to genetic resources rests with national governments. Access should be governed by principles of fairness and equity, *i.e.* based on prior informed consent - including the written consent of both the state and the community - and on mutually agreed terms, with the benefits being shared in a fair and equitable manner. Access regulations should not unnecessarily restrict traditional systems of access among farmers and communities.

Fair and equitable benefit-sharing can be stipulated in access agreements in several ways. The sharing of monetary benefits foresees payment of a specific percentage of the net benefits, for example 50%, which should go to the communities that maintain and supply genetic resources. There is also emphasis on non-monetary benefits, such as participation in research, and development assistance designed to add value to the genetic resources in question at the local level. The Model Law foresees the establishment of a Community Gene Fund which should channel these benefits to the communities.

The Model Law also proposes a plant breeder's rights system in line with the above provisions. This recognizes the rights of breeders that develop varieties (including farmer-breeders), but provides that the exclusive rights of commercial breeders do not impinge on the customary practices of seed-saving. The exchange and sale of seed of any variety, including protected varieties by local farmers is permitted. The Model Law clearly states, however, that the granting of utility patents on life forms, including parts of organisms such as cells and genes, for example cannot be made consistent with the Model Law and that these protection systems should not be recognized in Africa.

The African Model Law in its provisions and operations does not make a distinction between medicinal, industrial or agricultural use of genetic resources. It strongly focuses on the regulation of access and the wide participation of stakeholders. It was developed before the adoption and coming into force of the International Treaty on Plant Genetic Resources for Food and Agriculture and is therefore strongly rooted in the CBD.

The Model Law has been broadly debated in many African countries, but few countries have yet developed a national law that combines genetic resources and IPR issues in one regulatory framework. Namibia has gone some way in developing such a system, and draft legislation in Uganda not only includes a number of issues from the Model Law but also requires that genetic resources within the country cannot be used until explicit prior and informed consent has been obtained from communities and farmers and benefit-sharing agreements have been drawn up.

4.4.2 The 'Nordic Approach'

Since the 1950s, the Nordic countries in Europe have developed regional co-operation through two organisations: the Nordic Council which includes members from the national parliaments, and the Nordic Council of Ministers. One area of co-operation is food and agriculture. In 1979, the Nordic Genebank (NGB) was established within this co-operative frame-work. It was given the mandate to conserve and document the genetic variation in material of plant species originating in the Nordic countries useful for agriculture and horticulture.

In the light of recent international developments regarding legal regimes for plant genetic resources, the Nordic Genetic Resources Council initiated a project to analyse these developments and assess the legal status of Nordic genetic resources. The recommendations in the project report, "Access and Rights to Genetic Resources – A Nordic Approach", (Evjen, 2003:16) formed the basis for discussions within the Nordic Council of Ministers and in the summer of 2003 these resulted in the Nordic Ministerial Declaration on Access to and Rights over Genetic Resources (number ANP 2004:745).

In order to reflect the common Nordic understanding of the importance of genetic resources for development, and therefore the view that it is necessary to facilitate access to plant genetic resources through genebanks, the Declaration puts all accessions of the NGB under common Nordic management and control, making them available in the public domain. It further states that the NGB's relevant material shall be included in the International Treaty's Multilateral System upon the Treaty's ratification by all Nordic countries. It recommends individual Nordic governments to confirm and implement the Declaration by taking appropriate decisions.

As a consequence of the Declaration, the NGB has officially stated that access to all its accessions - and not only those covered by the Treaty's Multilateral System - will be facilitated for all purposes and not confined to use in food and agriculture. It has adopted a provisional Material Transfer Agreement (MTA), based on that used by International Agricultural Research Centres as a consequence of their having, in 1994, put their *ex situ* collections into the International Network of *Ex Situ* Collections under the auspices of FAO (www.fao.org/ag/cgrfa/exsitu.htm). By these agreements, they hold their materials "in trust for the international community", under the policy guidance of the FAO Commission on Genetic Resources for Food and Agriculture. The MTA specifies, among other things that, in accordance with Article 12.3d of the International Treaty, the recipient shall not claim any intellectual property or other rights that limit the facilitated access to plant genetic resources for food and agriculture, or their genetic parts or components, in the form received. Moreover, it has been decided that the NGB will not claim any monetary benefits upon commercialisation of a product derived these materials as a condition of access.

The Nordic Ministerial Declaration furthermore recommends that the Nordic countries determine the legal status of their plant genetic resources and their wild relatives, including *in situ* resources so they can provide free access to all their domestic plant genetic resources.

The policy is, therefore, that plant genetic resources as well as other genetic resources, shall be accessible with a minimum of restrictions and bureaucracy and that all cultivated species should - in due course - be included in the Multilateral System of the International Treaty. Legislation is not considered necessary because the countries have ratified the Treaty.

4.4.3 The 'Common Regime' of the Andean Community

The Andean Community was relatively early with the 'Common Regime on Access to Genetic Resources" as Decision 391 was taken in 1996. Bolivia, Colombia, Ecuador, Peru and Venezuela concluded this detailed access legislation model which prescribes the role of a National Authority and defines application procedures and monitoring mechanisms in each of the countries. Even though contracts are signed with the National Authority, consent has to be sought from the landowner in the area where prospecting is to take place, the 'entity responsible for *ex situ* conservation' and the actual owner of the biological resources containing the genetic information. The Decision puts special emphasis on 'intangible' resources, including the associated local knowledge. Arrangements have to be made for the equitable sharing of benefits arising out of the use of traditional knowledge, innovation and practices. Despite the subsequent provision of a model application form and contract in Resolutions 414 and 415 (in 1996), and compliance provisions in Declaration 486 of 2000 which includes the requirement that unless access contracts are submitted in patent applications patents can be declared void, implementation of the system at the national level is poor. Carrisoza (2004) identifies social protest, legal differences and institutional limitations as the reason for the slow development of national systems. One major problem is interpreting how genetic resources should be used in research (Lapeña & Ruiz, 2004).

Implementation in Colombia is poor, according to Garforth *et al*. (2005) because genetic resources have a low policy profile and there is a lack of technical expertise. Out of 20 applications, only two were concluded in the first seven years of the operation of the national law that is based on the Andean Community decisions. In Venezuela, 12 projects have been approved and five framework agreements with universities concluded in the same period. The Venezuelan law specifies that in addition to Decision 391 access can be limited if it is necessary to conserve endemic species and ecosystems or protect human health. Furthermore, it stipulates very specific monitoring requirements including regular reporting on research and commercialization and rules that deal with the application of intellectual property rights. Despite these details, Cabrera (2003) identifies a number of gaps in the law and the procedures associated with implementation and indicates that coordination between authorities is poor.

The strict national rules arising out of Decision 391 have, therefore, lead to few approvals for access to genetic resources. Most of those granted have been for the industrial use of natural biodiversity and not for crop genetic resources. In Peru, the lack of coordination among national authorities has also been identified as a major bottleneck. For example, the export of a number of potato seeds that had been collected under permit from the Ministry of Agriculture is still being blocked primarily because of a lack of clarity about the responsibilities of the ministries involved (Hoekstra, pers. comm.). This is consistent with a remark in a review of the experiences with implementing Access and Benefit Sharing regulations under the CBD in the United Kingdom (Latorre, 2005): “The biggest problems are countries where the authority remains unclear. . .”.
Correa (in press) explains these bottlenecks as being the direct result of the fact that the promotion of access and the facilitation of partnerships is not explicitly mentioned as one of the functions of National Competent Authorities or the Andean Committee on Genetic Resources.

4.4.4 Analysis

The three regional approaches differ in the weight they give to the different objectives of the CBD, their legal status and in the level of implementation.

The Andean example concentrates fully on regulating access in order to avoid ‘biopiracy’ - the illegitimate use of genetic resources for commercial benefit. The African example seeks to develop a system that combines several objectives: conservation (gene fund), benefit sharing (regulating access), stimulating use (breeder’s rights) and protecting traditional knowledge. The Nordic example concentrates on promoting use and furthering existing conservation efforts.

There are clear differences in the legal basis of the three examples. The African example is intended as a model for national legislators. Countries are free to take the whole model as a national system, to pick some articles or concepts or to develop their own legislation independently. There is no African country that has included the model in its national legislation. The Andean decision, on the other hand, is part and parcel of the national legislation of the member states that are, however, free to develop additional legislation. The Nordic approach is not legally binding as such but through the firm backing of the Nordic Council of Ministers it is *de facto* binding on the member states.

The three regional approaches also differ in levels of implementation. The Andean Pact example is very detailed. However, implementation depends on national institutions. These not only have the right to add their own interpretation but they also have to harmonise the provisions of the Pact with a multitude of other national regulations. In the African Model Law implementation is the responsibility of national institutions. The Nordic approach is to situate this responsibility at the regional level.

The analysis for the three elements objectives, status, and implementation indicates that the impact of the regional policies on actual access to genetic resources is very different. The Nordic approach being the most open, which is not likely to lead to significant monetary benefit sharing, and the Andean example the most restrictive promoting a situation where multiple individuals or entities have the right to exclude access by others, potentially leading to a 'tragedy of the anticommons' (Heller & Eisenberg, 1998, see chapter 6). This analysis thus shows that the CBD itself does not necessarily lead to such access restrictions, but it is the national (or regional) legislation which is likely to have impact on seed systems.

4.5 Impact of biodiversity policies on seed systems

4.5.1 Introduction

Genetic resources are a key element in both farmers' and formal seed systems (see Chapter 2) since the genetic composition of seed determines the potential of agricultural production in terms of yield, yield stability and the quality characteristics that ultimately determine use and market price. Access to genetic resources determines the capacity of farmers' seed systems to effectively develop and adapt to changing conditions. Farmers' seed systems generally value materials that can be tested for local adaptation as ready varieties or for inclusion in genetically diverse landraces. Programmes to strengthen farmers' seed systems tend to use a wide range of genetic resources for variety selection and participatory plant breeding.

The formal seed system values access to genetic resources in order to maintain an effective seed chain. The availability of new varieties is one of the main prerequisites for an effective seed market. There is, however, a difference between the interest that farmers have in genetic resources and those of the formal system. The formal sector generally does not look for new varieties, but for new traits or single genes that can be included in their breeding programmes. Public and commercial breeding programmes, therefore, need access to very specific genetic resources. In farmer seed systems, however, quantitative access is more important.

The impact of genetic resource policies - and in particular the effect of access regulations on seed systems - is most obvious in the formal seed system where opportunities for genebanks to collect 'new' genetic resources and include them in their collections is an important issue. Breeders can also be affected by restrictive impacts when seeking to access materials either directly from '*in situ*' conditions or from genebanks for their inclusion in crop improvement programmes. Finally, their impact on farmers and agricultural output must also be considered. However, the length of the chain and the assumptions that have to be made about foregone benefits stemming from access restrictions are such that they make it impossible to analyse these effects in quantitative terms.

4.5.2 Direct contributions by policies to seed systems that conserve diversity

The objectives of both the Convention on Biological Diversity and the International Treaty on Plant Genetic Resources for Food and Agriculture (IT PGRFA) are to conserve and ensure the sustainably use of genetic resources, while equitably sharing the benefits from their use. The IT PGRFA directly links the benefits with actual conservation since it stipulates that benefit sharing should flow primarily - whether directly or indirectly - to the farmers who conserve and sustainably utilize plant genetic resources (Art. 13.3 and 18.5). The CBD implicitly assumes that putting value to biological diversity will create an incentive to conserve. Access regulations are primarily a mechanism to support the sharing of benefits but the latter should not counteract the objectives of conservation and use. One would, therefore, expect that access laws should be able to support local seed systems in their efforts to maintain and sustainably use genetic resources.

Generated benefits have been very limited to date except for some established cases such as InBIO in Costa Rica where a significant capacity has been built up to study the rain forest biodiversity. Visser *et al.* (2004) conclude from a study of a wide range of access contracts that the level of benefits is very limited and virtually absent in the field of agricultural genetic resources, and that the participation of communities that developed and maintain genetic resources in significant benefits is virtually absent. Heineke and Wolff (2004) conclude that "on the whole it can be argued that the enormous efforts of developing instruments for access and benefit sharing have contributed rather little to the conservation and sustainable use of biodiversity."

One explanation for the limited benefits shared from the use of agricultural genetic resources is that most pedigrees of field crops are extremely complex and before the CBD came into force they already incorporated a very wide diversity (Gollin, 1998; Zhou *et al*., 2000; Smale *et al*., 2002; Srinivasan *et al*., 2003). Identifying the country of origin - which according to the CBD is the country in which the materials developed their distinctive characteristics - creates severe legal complexities (Fowler, 2001).

The spirit of the CBD may have contributed to the development of programmes for on-farm conservation of genetic resources and participatory plant breeding, but there are no documented cases of access and benefit sharing arrangements that have directly contributed to the maintenance and improvement of local seed systems.

4.5.3 Indirect impact of policies on seed systems: *ex situ* conservation and exchange

The use of genetic resources in breeding is facilitated through networks of national and international genebanks. These genebanks are a major resource for national breeding programmes in developing countries (Cassaday *et al*., 2001), but also for industrialised countries (Brennan *et al*., 1999). The impact of genetic resource regulations on access to genetic resources by these genebanks, exchanges between genebanks, and the provision of materials to breeding programmes and other users together form a proxy for the impact of the regulations on seed systems.

Several countries have made significant efforts to develop national genebanks for the long-term conservation of genetic resources. For most countries this is not feasible and they depend on genebanks in other countries and the international genebanks of the research centres of the Consultative Group on International Agricultural Research (CGIAR) in particular. These genebanks collect, conserve and exchange large numbers of genetic resources of most of the major food crops.

The impact of the international agreements on access and exchange by these genebanks is difficult to establish. Exchange data for the international genebanks are systematically collected by SINGER, the System-wide Information Network for Genetic Resources of the CGIAR. This system covers approximately 600,000 accessions distributed over 12 international genebanks, which is close to 10% of the total number of accessions stored in official genebanks worldwide and for which no central registry exists. Smale & Day-Rubinstein (2002) and Day-Rubinstein & Smale (2004) analysed the exchange data of the US National Plant Germplasm System. Both analyses confirm the concept that all countries are interdependent with regard to plant genetic resources (Kloppenburg & Kleinman, 1987) and that all are net importers of genetic resources (Flores - Palacios, 1997). These data formed the quantitative basis of the concept of interdependence on agricultural genetic resources.

A study on 15 countries reported that in the peak collection period 125,000 samples were provided by these countries and in the same period they received over 500,000 samples. (IFAR, 1994). Fowler *et al.* (2001, 2003) analysed the exchange patterns of the CGIAR system as a whole and the major genebanks over a period of 7 to 12 years for different collections. Their report confirms the public research programmes of developing countries make much more use of these collections than those in industrialized countries plus private users. Follow-up research indicates that in the second half of the 1990s genebank access to genetic resources had sharply declined. None of the numerous complaints about the way access laws (or the absence of clear responsibilities) were affecting access to new genetic resources have been scientifically analysed and published (Fowler, pers. comm.). A recent survey at the request of the Genetic Resources Policy Committee (http://www.cgiar.org/corecollection/docs/GRPC_20thmeeting_aug2006.pdf) provides some explanation for this decline. One trend is that genebank curators who had concentrated on collecting large numbers of new accessions in their early years had now started to look for specific genetic resources to complement their collections. However, many of these curators also mentioned that legal access restrictions imposed by countries following the CBD formed an important bottleneck to accessing genetic resources (Halewood pers. comm.). The number of requests that were turned down have decreased in recent years, but this may have been the result of fewer requests being made because earlier requests had been refused (Stannard, pers. comm.). The same survey also showed that some countries such as Laos for example have tried to avoid genetic resources collected in their territory being put under the auspices of FAO, guaranteeing free exchange, but to specify a different status (or in one recent case to repatriate the materials).

These trends point towards reduced access by genebanks to genetic resources. They also suggest that genebanks as a result of national policies based on the CBD have faced increased restrictions on the release of specific materials. Together this means that crop improvement programmes including those that link farmers’ seed systems with formal systems must have suffered from reduced access to genetic resources.

4.5.4 Summarising the impact of strict biodiversity regulations

In the screen illustrating farmers' and formal seed systems and their interactions (Fig 2.5) activities that are particularly affected by poorly adapted biodiversity laws - particularly those related to access - can be indicated. These are presented in Figure 4.2.

Firstly, the formal seed system is constrained in (a) its access to genetic resources from the farmers' seed system (b) by the complex procedures breeders have to follow to acquire such materials from genebanks, and (c) by accessing gene constructs derived from genetic resources acquired from their country of origin. Both benefit sharing and the procedures for negotiating access can add to the cost of seed, but this may be considered a minor bottleneck compared to access problems themselves and the resulting legal uncertainties.
The farmers' seed system can also be constrained by making the transfer of genetic resources among communities subject to prior informed consent and mutually agreed terms as well (d).
Difficulties in integrating seed systems occur mainly at the level of participatory plant breeding (e) and potentially when genetic resources have to be restocked because of of natural or other disasters (a). Also, the emergence of small seed enterprises based on farmers' varieties may face problems when access regulations are very tight (e). Approaches to participatory plant breeding (PPB) commonly require a broader genetic diversity than highly commercialised breeding strategies and therefore they are more heavily affected. Furthermore, PPB commonly involves a regular transfer of materials between farmers and research institutes, for example, for disease resistance screening in the laboratory and this can be complicated by access rules.

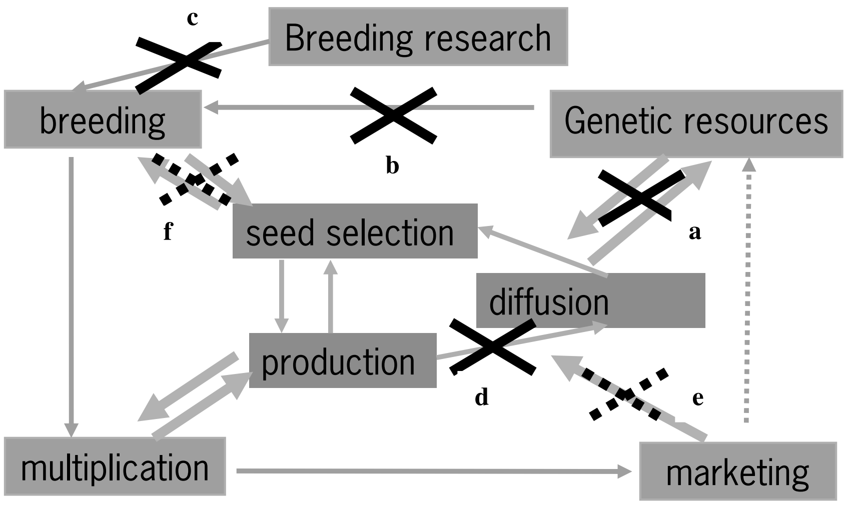

Figure 4.1** **Seed systems and the potential effects of poorly designed genetic resources (access) laws. Figure, derived from Fig. 2.5 with crosses through links that are blocked and dotted crosses at links that are affected by poorly designed seed laws (this thesis) - see further explanation in the text below

This summary shows that even though access regulations are designed to support conservation, sustainable use and benefit sharing very strict access laws may not live up to the expectations. Most of these bottlenecks will be overcome for the Annex 1 crops defined in the International Treaty when the standard MTA becomes widely used. Almost all major food crops and pasture species are included in this Annex.

4.5.5 Expected impact of the International Treaty

Developing and industrialised countries are all net importers of genetic resources for plant breeding in terms of diversity exchanged (countries can provide access to the same materials to many recipient countries). Therefore, restrictive access regimes for genetic resources will in the longer term affect farmers worldwide. Integrating farmers' and formal seed systems in participatory variety selection or breeding generally requires a wider set of genetic resources than is needed in specialised plant breeding. Restrictive access regimes therefore have a particularly detrimental effect on programmes to support local seed systems and through this on important aspects of conservation and the sustainable use of crop genetic resources.

The experiences under the CBD both in terms of restricted access to genetic resources and of the transaction costs associated with bilateral negotiations on access and benefit sharing (Visser *et al*., 2003) were among the reasons for negotiating the International Treaty and its Multilateral System (MLS). The MLS aims at facilitating both access and benefit sharing through multilateral arrangements. This should benefit both formal and farmers' seed systems.

The IT PGRFA came into force in June 2004. This legally important date did, however, not directly impact on the actual situation as far as access to genetic resources and their use in breeding were concerned. The first session of its Governing Body, which took place in June 2006, has adopted important documents to implement the Treaty and notably its MLS. Major achievements include reaching agreement on a Standard Material Transfer Agreement for genetic resources in the MLS and a range of administrative decisions. Many important decisions in the field of the Funding Strategy and Compliance are still pending. This means that the actual impact of facilitated access for strengthening seed systems cannot as yet be assessed.

It is expected that access will be facilitated through the Standard MTA and the further development of the anti-commons effects mentioned above will be avoided. Moreover, the direct linkage of benefit sharing and farmers who conserve genetic resources in the funding strategy should create room for support to local seed systems.

4.6 Conclusions

The CBD and the IT PGRFA have been developed to support the conservation and sustainable use of biodiversity, and a subset of that biodiversity – plant genetic resources for food and agriculture. Many regional organizations and individual countries have concentrated on the benefit sharing aspect in framing their implementation systems for the CBD through regulating access to genetic resources. The complexity of these laws in some countries combined with the lack of effective implementation has created impediments to widespread exchange of and access to genetic resources for plant breeding. A limited number of (mainly industrialized) countries have explicitly included facilitated access regimes in their conservation policies, which shows that it is not the CBD itself, but national and regional implementation that create such impediments.

It is not possible to quantitatively assess the impact of genetic resource regulations on the access to and use of genetic resources in farmers', formal and integrated seed systems, but the views of stakeholders in genebanks and breeding programmes all indicate that current regulations in several countries and regions obstruct the optimal use of genetic resources. Given the fact that developing countries are all net importers of genetic resources in terms of diversity received, and that integrating farmers' and formal seed systems in crop improvement generally requires the use of a wider set of genetic resources than specialised plant breeding, it is concluded that there is evidence that restrictive access laws have a detrimental effect on local seed systems.

Whether the Multilateral System of access and benefit sharing of the IT PGRFA will be able to improve this situation remains to be seen. This is one of the aims of the Multilateral System but its implementation depends on important decisions at the international level on the effectiveness of the Funding Strategy to generate and appropriately disburse funds, and at the national level for example on bringing collections under the MLS. It is therefore too early to assess impact at this time.

5. International agreements affecting seed systems: Intellectual Property Rights

Abstract

Intellectual Property Rights (IPRs) are a recent phenomenon in the seed sector in developing countries. Similar to conventional seed laws, these new regulatory systems have different impacts on formal seed systems than they do on farmers' seed systems. From a historical perspective, and using earlier work involving a large number of stakeholder interviews the potential impacts of different types of IPRs on the public and private breeding and seed sectors, and on farmers' seed systems are analysed in order to determine whether the introduction of such legal systems can be used to promote diversified seed systems. Options for developing countries to design their policies, regulatory frameworks and implementation systems in such a way as to avoid unwanted effects are subsequently analysed. This chapter is largely based on the results of a study on the impact of IPRs on the breeding industry in developing countries (Louwaars *et al.*, 2005; World Bank, 2006).

IPRs support ongoing trends towards commercialisation of the breeding and seed sectors and the commoditization of genetic resources in many countries. This trend may be detrimental to the interests of resource-poor farmers, especially when public research institutions are stimulated to create their own revenues through the use of IPRs. Strong IPRs like utility patents and plant breeder's rights consistent with the 1991 Act of Convention for the Protection of New Varieties of plants significantly restrict opportunities for farmers' seed systems and small local seed companies to use the best varieties.

The analysis in this chapter provides guidance for the development of IPRs in developing countries at the policy, legal, and institutional levels that minimise negative effects, through balanced exemptions for farmers and breeders in breeder's rights as well as patent systems, and differentiation of the strength of the rights among crops and farmer groups. In addition, initiatives can be strengthened within the current IPR systems in order to create access to technology for the poor. Countries that intend to develop their IPRs in breeding in support of diversified seed systems, therefore, have to primarily withstand bilateral pressures to limit the flexibility offered by the multilateral trade agreements of the WTO.

5.1 Introduction

Seed regulatory frameworks impact on the development of seed systems and need to be designed carefully in order to promote the parallel development of formal and local seed systems and to support the integration of knowledge and materials among these into a diverse seed system (Chapter 3). In industrialised countries additional regulations in the form of intellectual property rights (IPRs) have emerged to support commercial plant breeding. Developments in trade policies have resulted in the introduction of such intellectual property rights (IPRs) in developing countries. This chapter investigates the impact of implementing different types of intellectual property rights on formal and local seed systems and on initiatives towards their integration.

The following questions are relevant here: i) Are current IPRs beneficial to the development of diversified seed systems?; ii) Which managerial challenges for public research institutions can be foreseen and what options are open to these institutions to meet those challenges?; iii) Can IPR systems be designed in such a way that these support, or at least do not obstruct integration initiatives to link formal and local seed systems? The parallel with the analysis of conventional seed laws (Chapter 3) is that intellectual property rights have been designed to support formal seed systems and in particular commercial ones and that any impact on other seed systems may be conscious but should in most cases be considered a ‘side-effects’. The major difference is that the main initiative to develop IPR systems in developing countries comes from abroad. A methodological challenge to this research is that these systems are very recent in most developing countries and that it is, therefore, very hard to quantitatively assess the impacts.

In investigating such effects, first the rationale for intellectual property rights is analysed (5.2) and the historic development of their implementation in the field of agriculture and breeding assessed (5.3). The analysis of the impact on breeding and seed systems is largely derived from field studies in five countries: China, Colombia, India, Kenya and Uganda (Louwaars *et al.*, 2005; World Bank, 2006; Tripp *et al.*, 2007). These studies are used in the current analysis because it is impossible to quantitatively assess the impact of this recent phenomenon in developing countries, and these studies are the only ones assessing the perceptions of such impacts of such a wide stakeholder community. Section 5.4 discusses the methodology and the major results. Based on the analysis of intellectual property rights systems in relation to seed systems, regulatory and institutional options to circumvent undesired effects are discussed (5.5).

5.2 Rationale for intellectual property rights

Intellectual property Right (IPR) regulations provide a right to exclude others from commercializing an invention or other product of a creative mind. They are based on both moral and economic grounds.

IPRs are also considered a human right as Article 27 of the Universal Declaration of Human Rights states: “the right to the protection of the moral and material interests resulting from any scientific, literary or artistic production of which he is the author”. The moral grounds date back to the principle of natural law of John Locke that according to Jeremy Betham needed the specific protection by the state to ensure that the inventor received a fair share of the reward (Andersen, 2004). Current thinking, however, is that this moral right needs to be balanced against the rights “to take part in cultural life” and “to enjoy the benefits of scientific progress and its applications” laid down in the International Covenant on Economic, Social and Cultural Rights of 1976 (Chapman, 2000).

The economic approach is that IPRs are a way of increasing welfare in society. Legal rights should provide incentives for inventors and authors to invest in their work and produce useful products or insights. This aspect is reflected, for example, in the “industrial application” or “use” requirements for new inventions in the patent system. The US constitution states that: ”*Congress (will) ... promote the progress of science and useful arts by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries*”. This phrase illustrates that in order to increase welfare, society needs to put limitations on rights. In this sense, IPRs can be considered a contract between the inventor/author and society (Hardon, 2004) in which the rights are granted under particular conditions, for example, the obligation to publish the invention for the benefit of the further advancement of science, and for effective use in the public domain after the expiry of the right as well as the right of society to retaliate against misuse of the exclusive right in the market through compulsory licences.

Four distinct theories form the basis of the economic argument behind IPRs: (Nelson & Mazzoleni, 1997):

- the invention inducement theory providing a motivation for useful invention;
- disclosure theory facilitating access to information through the patent system;
- development and commercialisation theory promoting the development of useful products based on inventions;
- prospects development theory enabling the ‘orderly exploration of broad prospects for derivative inventions’.

An important practical argument behind Intellectual Property Rights is that creative products tend to be non-rivalrous and non-excludable (Commission on IPRs, 2002). “Non-rivalrous” means that consumption by one person does not prohibit another person also using the same product. “Non-excludable” means that others cannot easily be stopped from consuming the product. This is particularly true for biological products like genes and plant varieties that are self-replicating through seeds.

Sectors differ and call for different rights regimes. This has resulted in a family of intellectual property rights systems for different types of products of the mind. Copyright for literary, scientific and artistic works, including software and its components provide long term protection without formal scrutiny of such works (they are automatically protected once published). Industrial property rights relate to inventions (patents), industrial designs, trademarks, geographical indications and trade secrets, all with different regimes for registration, scope and duration of protection. Since these ‘standard’ industrial property rights were not considered sufficiently adapted to particular sectors, so called ‘*sui generis’* systems were developed for the protection of, for example, plant varieties (plant breeder’s rights) and integrated computer circuits and databases (Commission on IPRs, 2002).

The balance between the rights of society on the one hand and those of the person holding rights on the other is subjective and very difficult to determine. Davis (2004) questions whether the current IPRs contribute to a social optimum in research and development (R&D). Andersen (2004) critically discusses the different economic arguments from a costs and social benefits perspective: there are administration and enforcement costs, monopoly or anti-competition costs, opportunity costs in depriving others from using the most effective solutions, which is specifically aggravated by the broad scope of patents, social costs by increasing the cost price of products through royalties, and finally costs that are incurred when patents divert investment in socially less productive channels just because protection can more easily be obtained in certain fields. This latter argument may be particularly relevant in plant breeding in developing countries, where significant social benefits can be derived from access to good varieties by the poor.

5.3 IPRs in seed systems – historic perspective

5.3.1 Gradual inclusion of living matter

Current patent laws are based on the Paris Convention 1883 and its subsequent revisions. They provide protection to inventions that are new, that involve an innovative step and that are useful. Furthermore, the invention has to be described in such a way that someone 'skilled in the art' can reproduce it. Products or phenomena of nature have been exempted from patent laws for a very long time. There were moral, political and legal/technical reasons behind this. Moral arguments include the assumption that Life is sacrosanct and should not be privatised. Political reasons include the argument that something as important for mankind as food security should not fall under commercial monopolies. This argument is considered important for the exclusion of edible tubers in the Plant Patent Act of 1930 in the USA (Kloppenburg, 1988), and is the basis of the exclusion of 'methods of agriculture' in de Indian patent law.

Legal/technical arguments relate to problems with the application of the patent system to plants and varieties. The novelty criterion of the patent system is hard to maintain where natural diversity is insufficiently known to the examiner to assess whether a plant is absolutely new. Secondly, the inherent genetic diversity within a plant variety and the inevitable changes resulting from mutations create problems with the description of the protected subject matter. Whether the use of standard breeding methods would create an inventive step can also be debated and, finally, the requirement that the invention needs to be disclosed in the patent application in such a way to allow someone 'skilled in the art' to reproduce it, is impossible in plant breeding. Even if someone has access to the same parents and the same selection strategies it is impossible to breed the same variety. Other problems in the application of the patent system to living organisms is the possibility that the patented subject matter will replicate itself (also without human intervention), and the 'law of the land' that has allowed the free movement of plants within and among communities throughout the world (IDRC, 1994).

The emerging plant breeding and seed industry in the USA and Europe created a pressure to develop specially designed protection systems (van Wijk *et al*., 2004). The first so called *'sui generis'* system was the Plant Patent Act of 1930 in the USA which applied to vegetatively propagated fruit and ornamental species, thus avoiding the genetic diversity problem within varieties. In the years that followed more '*sui generis'* protection systems for plant varieties developed in Europe, which were subsequently harmonised through the Convention for the Protection of New Varieties of Plants (Paris, 1961). The Act of this Convention was revised in 1972, 1978 and 1991, gradually strengthening the rights of the breeder. By October 2007 63 countries (plus the EU) had ratified the Conventions under one of the four Acts (www.upov.int).

Membership of the Union for the Protection of New Varieties of Plants (UPOV) began to expand in the early 1990s and this expansion continued following the Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS) of the World Trade Organisation (WTO) that provides minimum requirements for national IPR laws in all WTO member countries. TRIPS has a specific clause in Article 27(3)b on the protection of plant varieties providing an option to exclude them from patent protection if the country provides for 'an effective *sui generis* system'. It is generally considered that UPOV provides a good and internationally harmonised '*sui generis*' system and the UPOV system was even mentioned in early drafts of the TRIPS Agreement (Dhar, 2000). Helfer (2004) contests - on legal grounds - the proposition that the UPOV Convention complies fully with TRIPS. Yet it is generally agreed that the UPOV systems provide for plant varieties with a type of protection that is better rooted in the agricultural tradition than industrial patents. The key differences with the patent systems, such as user exemptions for breeders and farmers, is that they take into account the biological nature of the protected subject matter and - to some extent - provide a way of recognising traditional ways of handling seed.

The emergence of biotechnology introduced the patent system into the domain of plant breeding. Court decisions in the USA caused a gradual expansion of patentability (Landes

& Posner, 2004). In the field of biotechnology this started with the Diamond vs. Chakrabarty case in 1980 which involved a genetically altered (micro-) organism (Eisenberg, 1996). In 1985, plants were considered patentable following the ruling in ex Parte Hibberd, followed in 1987 by the first animal (an oyster – Allen case) and in 1988 the first mammal (Harvard's 'onco-mouse'). The patentability of DNA-sequences has now been restricted following more rigorous novelty and industrial use requirements by the major patent offices.

Since IPRs are territorial, developments in the USA are not automatically followed by other states operating a patent system. There is currently a large diversity in the patentability of plants and varieties. Whereas very few countries allow patent protection on plant varieties, some exclude patents on (biological) products such as DNA (for example, most African countries and India until recently) and some have special provisions in the patent system to limit the scope of protection when patents are provided that affect living organisms. The European Directive that regulates the protection of biotechnological inventions (Directive 98/44/EC) includes a farmers' privilege when the protection (for example, on a gene) extends to a plant variety that is consistent with the rules of the plant variety protection system for that crop and that type of farmer.

5.3.2 Key legal provisions of current systems

The basic principle is that IPRs provide an exclusive right, i.e. that the right holder can exclude others from a number of specified acts done with the protected subject matter. These are normally acts that create commercial benefits or that compete with commercial interests of the right holder. In practice, this creates the right of the holder to negotiate a contract stipulating the conditions for allowing the use of the protected subject matter. Such conditions relate to the activities (for example, for research only), the geography (for which markets), the time period, and finally the payment of royalties or the provision of any other kind of benefit to the right holder. Public law copyrights or patents thus do not by themselves provide any benefits. These may accrue only after private law contracts have been agreed upon. This means that the right holder has to pursue his benefits, i.e. conclude contracts, find out infringements and take necessary actions. The Government just has to make sure that rights can be granted and that the judiciary is available for possible disputes.

IPRs can be considered an economic system to generate funds for inventors, but the rights go far beyond charging royalties, i.e. outright blockage of access to the inventions and their products. There are cases of public breeding research programmes being stopped because licenses could not be obtained. For example, research by the University of California on long shelf-life tomato through the introduction of the university's endoglucinase gene, was put on hold when the holder of the patent on the used promoter disallowed its use in downstream research that would lead to marketable varieties (Wright 1998). A similar fate overcame a strawberry research programme at the same university that failed to get clearance on the transformation method (National Research Council 1997, 8-9). Universities themselves can also have strong views on their rights. This was illustrated when the same university initially creating problems for the International Rice Research Institute who wanted to use a bacterial resistance gene Xa21 that was sequenced at UC-Davis, even though the materials and basic knowledge about the gene were generated by IRRI and its partners in India and Mali (Tu *et al.*, 1998). This dispute has, however, been settled amicably (Ronald, 1998).

In the seed sector, four types of intellectual property rights are important: trademarks, trade secrets, patents and breeder's rights. Trademarks are important for any commercial (and public) entity, protecting marks to avoid misrepresentation in the market. Trade secrets are important to avoid particularly valuable genetic resources being misused in the course of plant breeding or (hybrid) seed production. Breeder's rights and patents can protect (components of) the end product and are the focus of this section where the scope of protection and the exemptions provided by these two systems is emphasised. A more general comparison of UPOV-based protection of plant varieties, plant patents (USA) and utility patents, as analysed by Krattiger (2004) and Louwaars *et al.* (2005), indicates that the latter provides a much stronger right through wide claims, extended scope of protection and very limited exemptions. More detailed comparisons are presented below. As indicated earlier, plant variety protection (PVP) and patent rights are valid only in the countries where they have been granted and under the specific conditions of that country, but for the major differences being considered in this paper more general distinctions suffice.

- Scope of protection

The protectable subject matter and the scope of protection are fairly straightforward in Plant Variety Protection but much less so in the utility patent systems.

In PVP, only the plant variety as described by the breeder and/or a national authority can be protected. The UPOV systems also limits the scope of protection to commercial acts done with the seeds or other planting materials of such varieties: in the 1978 Act to the planting materials only; in the 1991 Act this is extended under certain conditions to include the harvested product as well. Only in the case of essential derivation can disputes arise among different right holders.

In the patent system it is up to the applicant to determine how widely he or she intends to exercise his or her rights. The patent office may limit the claims, but experience shows that patent claims can be very wide and even include applications that are unknown at the time of patenting and considerable discussion can arise about the exhaustion of the patent. The patent on a gene may extend to its use in laboratory R&D, in field trials of all varieties that contain the gene including the offspring of currently known varieties, and potentially to the processing of the harvested product if the gene has processing qualities. Different countries apply different levels of protection in such cases. Until the recent Schmeisser case (Louwaars & Minderhoud, 2002), Canada was fairly restrictive in the application of an extended scope of protection. The case ruled that the product patent on a biotechnology invention extends to the crop in the field containing the product irrespective on how it got there (through purchased seed, pollination or otherwise).

- Breeder's or research exemption

Another major difference between PVP and patents relates to the differences between the breeder's exemption in the former and the so-called research exemption in the latter. There is a lot of debate on the research exemption in the patent systems of several countries. Academic institutions have long been exempted from patent claims for research and education purposes based on the assumption that such research had no commercial intent (Moschini, 2004). In several countries such research exemptions are specifically included in the law, in others such as the USA it is an interpretation of clauses dealing with private and non-commercial use provisions. The situation has changed considerably in the USA as the result of a number of court rulings, notably Maley v. Duke (Ludwig & Chumney, 2003). The outcome of this case is that opportunities to use patented products or processes in research are strongly restricted and that scientists need a license to use them. The research exemption would only apply to research on (!) the invention, and not researching with the invention (Eisenberg, 1996) and this is widely considered to obstruct biotechnological research outside the big commercial companies (Nottenburg *et al.*, 2002).

Research licenses are commonly granted without the payment of royalties, but they specify the rights of the patent holder in case the research leads to something useful. Such interpretation would mean that a PVP-protected variety that is available for further breeding cannot be used when it contains a patented gene. In some countries in the European Union, this conflict between patents and PVP is not occurring because a breeder's exemption is explicitly included in the patent law (notably France and Germany). In other parts of the union, the breeders accept among themselves that the breeder's exemption as valid in PVP should also apply to materials with patented products in (Ghijsen, personal communication).

The Breeder's Exemption is also a matter of debate within the breeding industry itself. The introduction of the concept "essential derivation" in the UPOV Convention of 1991 does not restrict the exemption itself but it restricts possibilities for cosmetic breeding and recognises the rights of breeders who developed original varieties when small changes are later being incorporated by other breeders. The concept of 'minimum genetic distance' between varieties for calling them 'original' may lead to opportunities for strategic protection behaviour monopolising certain genepools, thus effectively restricting the breeder's exemption. A discussion on the exemption itself among seed company representatives arose in a seminar organised by the International Seed Federation in (ISF, 2004). A call for restricting the breeder's exemption in a future UPOV Convention (McConnell, CEO of Pioneer) was countered by a strong defence of the need to balance access to parental materials and the level of protection through PVP (Gouache, CEO of Limagrain).

- Farmers' privilege or farmers' rights

Within UPOV the farmers' privilege issue was specified in 1991. It was implicit in earlier Acts that farmers should be allowed to save and reuse seed, but some countries had a very wide interpretation of the clauses on non-commercial use (notably the USA) resulting in very limited opportunities for rights holders to exercise their rights. This wide interpretation allowed farmers to sell seed to the extent that the income of these sales was less than 50% of the total farm income. This allows for extensive 'brown-bagging' and reduced market control and revenues for the breeder.

The 1991 Convention made the farmers' privilege explicit by allowing member states to specify crops for which the re-using of farm-saved seed on the same farm would be allowed. This clause rules out any transfer of seed through sale, barter or gift among farmers, and thus any brown-bagging. This interpretation of the farmers' privilege leads to major discussions in many developing countries, several of which have chosen to introduce the provisions of the 1978 Convention when introducing breeder's rights. Making the transfer of seed from farmer to farmer illegal is widely considered incompatible with traditional ways of seed handling and sharing among farmers and thus opposing the 'law of the land'. Secondly, it was considered incompatible with ongoing discussions in the framework of the International Undertaking (and later the International Treaty on Plant Genetic Resources for Food and Agriculture – see Chapter 4) about the concept of Farmers' Rights which was to include provisions on the right to save, use, exchange and sell farm-saved seed/planting material. However, the IT PGRFA made this provision ". . . subject to national law and as appropriate". Some countries, notably India, explicitly include Farmers' Rights in their national law.

- General effect of these differences
These IPRs have three distinct functions in the market. They can be exercised
- to avoid customers free-riding on the protected variety by saving seed on-farm and possibly sharing some with neighbours,
- to avoid competing commercial seed producers free-riding on the protected variety by marketing of seed without a licence (brown bagging),
- to avoid competitive breeders using a protected gene or variety in the development of a new hybrid or variety.

The analysis of IPRs should thus include all three stakeholders.

In more general terms, Thumm (2001) identified three patenting strategies:
- patents to make money through direct commercialisation of a product or licensing
- negative patents to hinder competitors entering the market or to block competitors' technologies
- swap patents to improve the position in a certain technology field by having patents as bargaining chips to gain access to other inventor's patents.

Reitzig (2004) analysed these options based on the complexity of the technologies at hand.

The patent system is thus designed in such a way that it can be used strategically, whereas the exemptions in the breeder's rights systems (see below) reduce such options and turn the system into one that is more directed to immediate commercialisation and revenue creation.

5.3.3 International harmonisation

IPRs are territorial, i.e. they are based on national law. National legislators, therefore, have to balance the moral dimension of rights and the role of rights in increasing welfare in their country. Since sectors and countries differ, a maximum contribution to increased welfare is achieved at different levels of protection. This makes IPR a political issue at national and international levels. National policies on food security and public health have resulted in exemptions in several countries (at certain points in time) for what are considered essential fields such as agriculture, food, pharmaceuticals and chemicals. National interest has also been translated into provisions in national laws restricting or discouraging the application for rights by foreign nationals. Welfare is not only supported by promoting inventions within the country but also by promoting access to inventions made elsewhere. Since most inventions are non-rivalrous and non-excludable in nature (see 5.2), the cheapest option for countries depending on foreign technologies is not to have IPR protection at all. This allows their nationals to free-ride on foreign inventions that can easily be imported, as has been applied in Switzerland and The Netherlands in the early 20th century when these countries delayed the introduction of patent laws in order to support their emerging industries (van Wijk & Pistorius, 1999)

The second option for promoting access to foreign investments is the provision of internationally harmonised IPRs. Lesser (2002) shows a strong correlation between the strength of IPRs in developing countries and the level of foreign direct investment and makes a strong case in favour of stronger harmonisation (Lesser, 1997). Maskus (2000), however, while supporting the general positive impact on innovation and economic growth, states that the strengthening of IPRs shift the global terms of trade in favour of technology providers (OECD-countries mainly) and that the poorest nations have little benefit.

International harmonization of protection systems has been a key issue since 1883 when the Paris Convention streamlined the patent system in a growing number of countries who were signatories to the Convention. Since then, a number of international Conventions have emerged with different numbers of member countries. The Substantive Patent Law Treaty, which is currently being negotiated under the auspices of the World Intellectual Property Organisation, aims at harmonising the national patent laws (http://www.wipo.int/ipl/en/ipl-01.htm). The main thrust towards further harmonisation comes from the trade sector, notably the WTO and several Free-Trade Agreements. Smith *et al*. (2004), however, argue against harmonisation and support relaxation of the international IPR rules by pointing at the resulting changes in the distribution of costs and benefits among countries and quote G. Soros: "the market is not designed to ensure social justice". Correa and Musungu (2002) argue that IPRs should remain a tool of national policy, and that further substantive harmonisation of the patent law is not in the best interest of developing countries. 'Development related aspects in intellectual property rights (DRIPS) should be included in the national and international debate as complementary to the trade aspects of TRIPS (Louwaars, 2007). The development agenda of WIPO may form a step in that direction (Gerhardsen, 2007).

Next to the harmonisation efforts at the legal level, several institutions concentrate on harmonisation at the level of administrative or technical implementation. Within UPOV, countries may have quite different laws, based on different Acts and interpretations, but all members use the same technical guidelines for the testing of varieties for DUS: distinctiveness, uniformity and stability. This greatly facilitates the sharing of information among countries and reduces transaction costs. Some countries, such as Switzerland, fully rely on foreign DUS-reports, and thus do not need to build up their own specialised expertise and facilities. In utility patents, the Patent Convention Treaty (PCT) forms an important tool for facilitating application processes in member countries and the joint technical examination of applications (http://www.wipo.int/pct/en/). Applicants can apply in any member country through PCT and indicate the countries in which protection is sought and they do not need to apply for each of these countries separately. Similarly, regional patent offices such as ARIPO (Harare), OAPI (Yaoundé), and the EU Patent Office (Munich) take over much of the burden of processing patent applications from the offices of member countries. Such harmonisation at the implementation level leaves the territorial sovereignty aspects of IPR intact, because the final responsibility for granting or rejecting the application remains with the national patent offices that have to base their judgement on the specificities of national law. For example, a patent application through PCT for a particular gene construct that may be granted in China will be rejected in India (in 2004) because the latter provides patents for processes and not for products.

- Strengthening of the protection

Legal harmonisation processes commonly induce strengthening of rights since partners with stronger systems are unlikely to reduce the protection levels in the process. A major argument for expanding and strengthening IPR systems was provided in 1993 by the TRIPS Agreement. This agreement provides for the application of a range of minimum requirements for the protection of intellectual property by all member states of the World Trade Organisation.

While countries are implementing the TRIPS Agreement, new developments are restricting the freedom of countries to make their own choices in the development of IPRs. Bilateral trade negotiations between developing countries and their trading partners in the North (notably USA and EU) include provisions on IPRs that go beyond the minimum provisions under TRIPS. These so-called "TRIPS-plus" clauses favour a bilateral rather than a multilateral approach (El Said, 2005). In the field of agriculture, they require countries to introduce patent protection on plant varieties or genes, and/or force countries to become a member of UPOV. Such agreements have been concluded or are currently (early 2007) being negotiated with many countries or regional organisations. GRAIN collected and analysed 49 such agreements (GRAIN, 2004). Roffe (2004) provides a detailed account of the different TRIPS-Plus requirements in the US-Chile Free Trade Agreement.

There is controversy about the application of the TRIPS Agreement (1993) to developing country seed systems and the subsequent developments in IPR-policies. In this debate two issues emerge simultaneously: the reduction of the public domain due to private IPRs and the encroachment of the IPR systems into the domain of biology. These issues raise the question as to whether the application of the TRIPS agreement creates welfare for these countries, and whether there is enough flexibility in these minimum requirements to allow for a meaningful adaptation to the needs of developing countries.

5.4 Analysis: impact of IPRs on seed systems

5.4.1 Methodology of the study

A study on the impact of strengthened intellectual property right regimes on the plant breeding industry in developing countries was carried out in 2004 (Louwaars *et al.*, 2005; World Bank, 2006). It involved interviewing over 200 stakeholders in five case study countries plus some in international organisations. In China, Colombia, India, Kenya and Uganda key persons in the public, private and civil sectors were asked about their experiences and expectations with regard to the introduction or the strengthening of IPRs. The public sector interviewees were involved in policy making, IPR-implementation or members of agricultural research institutions. The private sector included local, national and internationally operating breeding (and sometimes biotechnology) and seed companies and civil society workers involved in seed systems, mainly at the local level. The countries selected were at different levels in research and IPR-implementation. Uganda, for example, was representative of those least developed countries who had no IPR regulation in the breeding sector. The discussions focused on major field and horticultural crops with flowers and cotton being the most affected and beans least affected by IPRs.

Further details of the methodology can be found in Louwaars *et al.* (2005). The analysis of the impact on the sector is as follows: the impact on public breeding and seed production (5.4.2), on private breeding and seed production (5.4.3) and on farmers (5.4.4). A summary of the impact on seed systems is provided in (5.4.5). Together with the other literature this research is used as a basis for the analysis of the impact on different seed systems.

5.4.2 Impact of IPRs on public breeding and seed production

The public sector consists, in principle, of not-for-profit organisations and it would be expected that the introduction or the strengthening of IPRs should not have an immediate impact on public plant breeding and seed production. However, a study involving different national agricultural research institutes (NARIs) in developing countries by Louwaars *et al.* (2005, 2006) indicated that IPRs do have an effect on the organisation and management of NARIs, often in conjunction with other developments in the countries reviewed. The establishment of PVP regimes comes at a time when the funding of public agricultural research is under severe pressure. Research administrators see the possibilities for earning income by licensing their varieties and other innovations as an important opportunity for achieving greater financial self-sufficiency. The degree to which such royalties can fulfil that promise depends on farmer demand for public varieties, the efficiency of the domestic seed delivery system, and the ability of public breeders to compete with their private sector counterparts. The opportunities to protect varieties in these countries, however, are still too young to actually determine whether the NARIs will be able to earn sufficient revenue and whether they will be able to effectively compete with the emerging private sector.

- Implications of PVP for research priorities
A major problem with revenue generation from IPRs is that they depend on commercial opportunities in the seed market. There is a danger that this is translated into inequitable and questionable public research resource allocation. Where NARIs become dependent on royalty income for their operations, they are likely to invest less in programmes that generate less revenue, such as in soil sciences and plant pathology and shift their research towards crops that have a commercial seed market and to breeding objectives that serve the regular buyers of seed rather than smallholders. In 2005, the management of the National Agricultural Research Organisation in Uganda intended to take this route making breeding for less commercial crops and smallholder objectives subject to external (donor) support. Counterparts in Kenya intended to redistribute possible revenue towards meeting national priorities, thus confirming their public tasks, but at the same time they accepted that some pressures towards commercialisation would arise. The emergence of IPRs in India is leading to strategies to invest in public breeding in order to cope with potential monopolistic tendencies due to IPRs. Also this strategy could potentially lead to a shift in priorities towards the clients in the private sector, and thus potentially away from smallholder needs (Louwaars *et al.*, 2005).

In China public research institutions have become quite commercial and the introduction of IPRs is welcomed. This can be seen in hybrid rice breeding in Hunan and Guangdong provinces, as well as with the longer running approaches to vegetable breeding. Also, the CGIAR centres for international agricultural research had to develop policies that bring IPRs in line with their task to work towards poverty alleviation and food security. They can protect inventions and materials under the condition that licenses will be given out royalty-free and used for the poor. Resources are limited to pursuing effective monitoring and to enforcing rights. Additional strategies are under way, for example, to jointly develop varieties with the private sector (e.g. ICRISAT), but some centres, such as CIAT with its *Brachchiaria* grass varieties, focus on obtaining income from IPRs (Louwaars *et al.*, 2005:114-117).

- NARI administration of IPRs
The advent of PVP and the increased use of patented technology in agricultural research put significant pressure on NARI administrations to establish IP policies and procedures. Legal skills are needed for securing freedom to operate on third party IP and for enforcement of own IP in the market, and commercial skills are required for the design and implementation of licensing strategies for patents and PVP produced by the institute. The larger organisations (in India, Brazil and China) have a marked advantage over their smaller counterparts, but even they will not easily match the legal resources and negotiation skills of the larger private technology owners. This is illustrated by the large Land Grant Universities in the USA that are pooling some of their IP-resources in a joint institution (PIPRA – see below).

Another administrative challenge is the distribution of royalties received by the NARIs. Decisions must be made about sharing such income between the institution, the research programme and the individual researchers. Scientists are considered by NARI-management in several countries a necessary recipients of a share in order to prevent them being hired away by the emerging private sector or that they leave the institute (with the materials under development) to start their own business.

5.4.3 Impact on private breeding and seed production

There is limited literature on the impact of IPRs in the seed industry. Most studies provide only limited evidence of the effect of PVP in industrialized countries (see Lesser, 1997; Srinivasan, 2001; Eaton 2002). Studies in the USA have shown that for most crops it would appear that PVP has played only a moderate role in stimulating commercial breeding (Butler, 1996; Kalton *et al.*, 1989). For wheat, Alston and Venner (2002) found that private sector investments have remained static while those of the public sector increased. UPOV (2005) concludes from a study in 5 countries that joining UPOV resulted in an increase of the number of available varieties (domestic and foreign), an increased number of breeding entities, increased breeding investments and an increase in the quality of new varieties, claims that were only scantily supported by the underlying data. The cause and effect rationalities in most examples in this study are not very convincing.

Other studies were less conclusive about the effects of PVP. Penna (1994) found an increase in the development of some horticultural varieties in the UK after the introduction of PVP but not for others. In Canada, a survey of breeders reported some increased breeding activity in horticultural crops, but less in grains or oilseeds, following the introduction of PVP (Canada Food Inspection Agency, 2001). In Spain, Diez (2002) found a correlation between the number of PVP certificates granted per crop species and the availability of protection, through either PVP or the potential to develop hybrid varieties. However, even when there are correlations, alternative explanations are possible. It is thus difficult, if not impossible, to attribute increased breeding investments to PVP alone because of the long-term changes involved and the role played by a number of other factors, such as developments in markets and other policies.

Based on evidence and experience of stakeholders in developing countries with PVP Louwaars *et al*. (2005) conclude that it is too early to allow any kind of statistical analysis of impact and that the impact of PVP is confounded with many other developments that affect the evolution of the breeding and seed sectors in these countries. The private sector in the mean time puts much emphasis on 'staying ahead of the competition', on branding and on policy measures other than IPRs when making investment decisions in developing countries. In many sub-sectors, breeders have additional tools to protect their interests:

- Hybrids and GURTs. Biological protection mechanisms, and particularly hybrid technology is important for almost all medium - and larger-size seed companies. Hybrids quite effectively protect against farm seed saving, thus securing a market for the commercial providers, but the technology does not necessarily protect against competing seed companies when there is no legal or physical protection for the parents. Larger companies can protect their interest in this field more easily by producing at least one parent in another region or even country, unknown to the competitors and contract growers. Local companies do not have that advantage and have to guard there production fields against theft. Hybrids have been developed in most cross-fertilising field crops and high-value vegetable crop for which labour-intensive hand pollination pays. More recently, hybrid technologies have been developed for rice (China) and pearl millet (India). The development of Genetic Use Restriction Technologies (GURTs) will open up a potentially widely applicable form of biological protection that may also provide protection of the germplasm and not just the seed (Visser *et al.*, 2001).

- Seed laws and associated contracts. Seed laws can also be very instrumental in protecting the interests of breeders in the absence of IPRs. When seed certification is compulsory, the breeder can control the market through managing breeder's seed. Release of breeder's seed to particular seed producers only and not to their competitors can provide these producers with a valuable assured market. This value can be shared with the breeder through a high seed price for the breeder's seed or through a contract with more specific conditions concerning royalties and market segmentation. This type of contract is effectively used in Uganda between the public research organisation and a number of maize seed producers, involving the exclusive production of varieties and hybrids in the absence of intellectual property rights.

- ***Contracts*** can generally be very effective as a legally enforceable agreement on any type of cooperation and they have hardly any limits. There is a wide variety of contracts among breeders, including Material Transfer Agreements and license contracts that can or cannot be based on IP. For example, flower producers in Uganda have to sign contracts with the breeder for the supply rose planting materials including the payment of a royalty and accepting the prohibition that they must not further multiply the variety. Growers accept such contracts because (most of) the varieties are protected in the country to which the product is exported (the Netherlands), but not in Uganda. The farmers have insufficient information about the protection status of these varieties abroad. In Kenya, KARI entered into a contract with a major biotechnology company for the use of Bt genes for maize. The contract stipulates how the genes can be used, who has rights on inventions made on the basis of the technology, etc. The institute is now bound to these conditions, although the patents on the genes concerned are not valid in most of Africa, including in Kenya.

- Biosafety regulations are not meant to protect property, but to protect the environment and to promote the safe use of biotechnologies. Some aspects of the biosafety system can create property-like rights. The biosafety system requires extensive testing data to prove product safety and this requires specialised testing facilities and significant investments. When a biosafety system requires access to biosafety data for every new variety carrying a transgene, this commonly confidential information can be used by the inventor to effectively manage rights on the technology by restricting access to the data needed to fulfil the biosafety requirements. Monsanto can thus enter into license agreements with Indian breeders for the use of its cotton Bt-technology.

- Secrecy is an alternative and often effective way to protect markets. Cohen *et al*. (2000) investigated the behaviour of a wide range of industries in the USA. They concluded that in most industries companies do not favour patents as a protection measure. Lead time advantages and specific marketing and manufacturing capabilities are considered more important. Secrecy becomes more and more difficult to secure with the advancements in molecular biology. The genetic unravelling of new inventions becomes easier and the copying into new genetic backgrounds quicker through the application of marker-assisted selection methods. Lead time thus becomes shorter for breeding companies with high-tech capabilities.

5.4.4 Impact on farmers

- Diversity of Seed Firms
One of the principal arguments in favour of PVP legislation is that it is intended to provide incentives for the generation of a wider array of seed sources and varieties from which farmers can choose (UPOV, 2005). Since the stimulus on the investments in breeding and seed production are based on a financial return in the market, the positive effect is likely to be limited to those farmers who can purchase seed on a regular basis. It is less likely to extend to resource-poor farmers who depend on farmers' seed systems. Moreover, it appears that such diversification has taken place in several countries without IP protection. India harbours a large number of large and small seed companies operating at the national, state and local levels. Also in Uganda, the rise of a number of seed companies has occurred in recent years in the absence of national IPR legislation.

- Focus on markets
Perhaps a more relevant concern is the potential impact of IPRs on public plant breeding for smallholder farmers and marginal environments. IPRs, together with a pressure on the public sector institutes to generate revenue, are likely to marginalise participatory plant breeding and conventional breeding directed at smallholders, neither of which is geared to produce products that can be marketed on a large scale. One could well imagine that the additional regulatory costs would discourage the emergence of small private companies that may be needed to deliver the results of these participatory programmes to a wider array of farmers. When the delivery is through promoting farmer networks (seed fairs etc.) the varieties need not to be protected and ownership not exercised, therefore, not contributing to the revenue target of the breeders. The same applies to situations where the farmers engaged in collaborative initiatives reject the concept of ownership, as illustrated by Salazar *et al.*, (2005)

- Farmer Priorities and seed saving
There are concerns about the extent to which IPRs shift plant breeding priorities away from smallholders in favour of commercial farmers (see 5.4.2). Secondly, there is no indication that the introduction of IPR legislation will reduce the focus of commercial breeders and seed producers on biological protection. Seed companies have open pollinated variety seeds in their portfolio mainly to provide a package to their customers, and not primarily so that they can make money. Investments in the breeding of such crops are minimal. Furthermore, the majority of farmers in developing countries rely on farm-saved or other non-formal sources of seed. Farmer-to-farmer seed exchange has been a key mechanism to transfer Green Revolution technologies to farmers who could not be reached by the formal seed systems. This 'lateral spread' system is the basis of the inclusion of modern varieties in the farmers' seed systems (Huda & Smolders, 2002). When varieties are protected, saving and especially the sharing of the seed of such varieties among farmers will become illegal and will depend on the consent of the breeder or his inability to control it rather than on the right of farmers. The Indian PVP-law does explicitly exclude non-branded seed in local seed systems from protection, but most other countries follow UPOV systems that make it much harder to promote lateral spread, and tend to strengthen their legal system (such as in Kenya and Colombia) towards compliance with the UPOV 1991 Convention. National pressures for such strengthening come primarily from the flower industry in these countries. Extending such rules to all crops may not immediately lead to the implementation of the rules for crops like beans and cassava that are important for the resource-poor farmers; it would be administratively impossible and politically unwise. There are, however, legitimate concerns about how farmers could be protected from the arbitrary use of such laws. Secondly, for many crops, non-compliance with the rules likely undermines the case for compliance in commercial

seed crops. Thus, having uniform protection levels for all crops is ultimately not in the interest of the commercial seed sector either.

- PVP as a first step

Several of the farmers' organizations spokespersons interviewed indicated that they do not see many advantages of IPRs for most of their members. They claim that IPRs will lead to monopolies that will increase seed prices and that will lead to a reduction in the amount of attention paid to the needs of farmers who will not be able to benefit from foreign bred materials. They do not expect such negative effects to take place in the coming years but only when monopolists have excluded any reasonable alternative (including the public sector). Local commercial seed companies will either be marginalized or purchased by the monopolists. The introduction of PVP (even the weak form in India) is seen as a first step in a process that will lead to strong patents. The capacity of governments to balance the interests of the industry and those of smallholder farmers in this process is considered very limited given existing international pressures. The TRIPS-plus negotiations in several countries can be cited as proof.

5.4.5 Summarising the impact of very strong intellectual property rights on seed systems

In the previous section, the impact of different types of IPR has been analysed. It can be concluded that 'light' types of IPR, for example, those with multiple exemptions are not likely to have a negative effect on farmers' handling of seed. Yet, such rights neither stimulate additional investments in research and breeding, nor in commercial seed production and marketing. Below, the activities that are particularly negatively affected by strong IPRs, such as patents and in some cases breeder's rights under the 1991 Act of UPOV, are summarised. (Fig 5.1)

Firstly, IPRs are primarily designed to support the formal sector and specifically the higher end of the chain (breeding research). The impact down the line (to breeders (a) and seed producers (c)) lies in the fact that users need to have a license and that IPR holders can refuse such a license or make it subject to strong conditions. Similarly, the use of genetic resources can be constrained when such materials (or components of those materials) are protected by IPRs (c).

The farmers' seed system can be constrained by making the sharing of seed of protected varieties illegal - as in UPOV '91 and patent systems (d) or even by disallowing the use of farm-saved seed (e).
Integration of seed systems is challenged when protected varieties or varieties with patented components are included in participatory plant breeding initiatives (f).

When communities will be able to protect traditional knowledge with measures similar to patents, the handling of genetic resources (g) will also be challenged.

The figure shows that even though IPRs may assist the organisation of the formal seed sector, if IPRs are too strong they can cause a number of obstacles both in the formal and the farmers' seed systems.

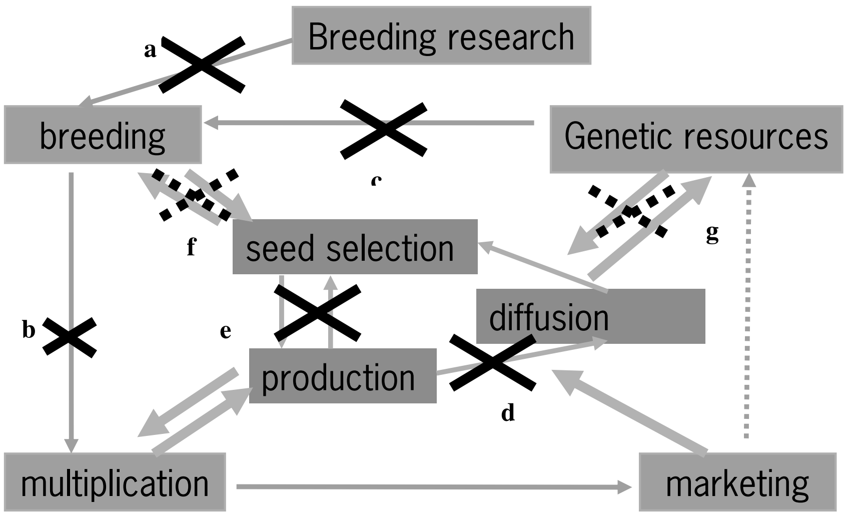

Figure 5.1 Seed systems and the potential effects of poorly designed intellectual property rights laws . Figure, derived from Fig. 2.5 with crosses through links that are blocked and dotted crosses at links that are affected by poorly designed IPR laws (this thesis) - see further explanation in the text below

5.5 Options

- Objectives

The TRIPS Agreement offers flexibility in the protection of plant varieties. Countries can exclude varieties from patentability and have some freedom in designing their 'effective *sui generis*' protection system. Secondly, TRIPS provides minimum standards for protection and also leaves room for some flexibility within the different systems. Many stakeholders are insufficiently aware of the fact that IPRs are territorial providing more opportunities to design systems and exclusions adapted to the national conditions and priorities.

This means that countries have to carefully determine their interests and objectives in seed provision. Promoting foreign investments in breeding and seed production does not necessarily require strong IP when companies find other ways to protect their interests. IP is essential though for certain sub-sectors, such as the flower industry (for the home market). Together with a conducive conventional seed law introduction of IPR legislation can contribute to the maturing of the sector, reducing the number and importance of fly-by-night seed providers selling seed of doubtful origin and quality. Well balanced IP can also reduce the improper use of regulations such as those of the biosafety system.

Promotion of the local seed industry can be assisted by intellectual property protection. Especially in the case of barely profitable seed crops such as self- fertilising crops, IPRs can provide a basis for market segmentation which may be useful to increase investments. Promoting the (near-) subsistence sector is nevertheless unlikely to be achieved through the introduction of IPRs. IPRs tend to block local arrangements such as the lateral spread of new varieties, and they tend to reduce interest in breeding programmes targeting resource-poor farmers in the public sector, unless clear policies and funding strategies for public research are provided concomitant with the introduction of IPRs.

Governments may wish to balance the above options, creating opportunities for commercial farmers to get access to the best varieties while safeguarding the interest of large numbers of resource-poor farmers.

Another challenge at the policy level is to balance the interests of different Ministries (see also Chapter 6). Recent developments in what are called TRIPS-plus negotiations indicate that the introduction of IPR in agriculture could be used by Ministries of Commerce as a bargaining chip in bilateral trade talks, possibly with insufficient consultation with the Ministry of Agriculture. Moreover, the need to implement provisions of national sovereignty over genetic resources under the Convention on Biological Diversity in national law commonly managed by the ministry responsible for the environment, further increases the challenge. Demands in this respect include the introduction of a certificate of origin in the application process of IPRs, and benefit sharing arrangements that may be linked to the level of protection. Both these aspects are alien to the current IPR system and meet with resistance from private sector holders of IPRs.

- Legal options
In most cases the analysis of the requirements for supporting the different seed sectors and the role of IPRs therein will result in different protection requirements for each agricultural sector. For example, in Colombia and Kenya the development of the flower industry will benefit from strong protection, whilst it may be necessary to support lateral spread systems for reaching resource poor farmers with new varieties of crops that are important for local food security such as cassava. In other cases, the interests of different types of farmers using the same crop such as maize may differ within the same country. In the latter case, a distinction between user groups needs to be included in the law. The Indian example of allowing the non-commercial movement of non-labelled seed from farmer to farmer could be an interesting solution. Such exemption may have to be combined with strict restrictions on quantities and based on a definition of ‘smallholder farmer’, as is done in the EU.

Countries can accommodate such challenges in developing a *sui generis* system. India has chosen to do this by combining Breeder’s Rights and Farmers’ Rights, and allowing the sale of non-labelled seed. Thailand has chosen to create different protection levels for different types of varieties. Others can use the example of the Netherlands before it acceded to UPOV 1991, when the UPOV 1978 consistent law which included the normal exemptions for farm-saved seed, had clauses that provided additional protection to named sectors such as flowers and fruits. Producing planting materials of protected varieties on-farm was not permitted for these crops despite general farmers’ privilege. Countries that choose to implement these options have to make sure that public services are maintained or developed to provide better varieties to sectors that are less attractive to the private sector due to the exemptions granted.

Even though the debate on *sui generis* options has been ongoing for a number of years, there has been little exploration of the opportunities to adapt the patent system in such a way that unwanted interference in the seed sector is avoided, in particular in farmers' seed systems. Taylor and Crayford (2003) propose mechanisms to improve access to patented technologies and flexibility for developing countries in the implementation of international agreements on IPRs. Follow-up discussions in the WTO in Doha tabled such questions with special reference to the patenting of pharmaceutical products which was triggered by the limited availability of cheap HIV drugs in developing countries (McCalman, 2002). In the seed sector, the pressure on industrialised countries and patent holders to prevent undesirable effects is less pronounced, and few countries have sought to adapt the patent system in an attempt to avoid undue influence on seed sector development. The European Union is the main exception. It introduced a farmers' privilege in the patent system for cases where the scope of a biotechnology patent extends to varieties. Some countries also included a breeder's exemption on such varieties which makes the genetic background of the variety available for further breeding. When the patented invention (for example, a gene) is part of the new variety, the breeder has to seek consent from the patent holder. Such arrangements provide a model for developing countries as well.

A very different approach is proposed by Lanjouw (2003) who advocates changes in patent law to encourage patent holders who have their main market in industrialised countries to grant freedom to operate in a list of least developed countries. Barry & Louwaars (2005) propose to investigate possibilities for a general 'humanitarian license' for the use of any technology for the poor, built on the licenses negotiated by Syngenta with a range of patent holders for the application of technologies in 'Golden Rice' and on the consortium agreement of the consortium of research institutions implementing the "Generation Challenge Program' (see: www.generationcp.org). This proposal would avoid the case-by-case scenario currently applied.

- Options at the implementation level

Countries have to develop implementation mechanisms to administer IPRs. This involves an office that administers applications and grants rights, the capacity to examine the applications, and effective enforcement mechanisms, a structure that requires a substantial investment in human and other resources. The distribution of costs will depend on how the tasks are shared between the government and the applicant. Countries may want to use the opportunities offered by international cooperation to bring down transaction costs. International cooperation in technical implementation does not automatically mean complete harmonisation at the legal level or membership of an organisation like UPOV. It can be beneficial to harmonise application procedures and technical examination while retaining specific legal arrangements based on national priorities. Rules on access to foreign examination reports, which currently often restricted to UPOV-members, will have to be changed if the provisions of TRIPS are applied. These provisions require WTO member countries treat all other members equally.

A proposal of more fundamental difference was tabled by Masters (2003), who suggests the creation of prizes to encourage innovations that offer social value to rural Africans. He puts emphasis on the social rather than the commercial value. Kremer and Zwane (2005) built on this concept.

- options for the commercial sector

Applicants need to develop their capacity to apply for and use their rights. Since IPRs are private rights and their use depends on contracts, the extent to which IPRs can deliver their policy objectives depend largely on the level of enforcement. Investments are only promoted by IPRs when companies are confident that their rights are protected by the court system and that there is sufficient legal support to enable them to defend their case. Whether this is possible will depend on the general status of legal infrastructure in a country, including the time required to come to a decision. Generating confidence in IPR depends on the extent to which the legislature can deal with new legal systems like IPR.

One result of the dependence on contracts is that, although the legislator attempts to create equity in the legal documents, differences in negotiating power between parties can have a significant effect on the way that IPRs are used to balance rights and obligations. IP-holders can easily misuse lack of information or the ignorance of the parties seeking access to protected technologies. Individual farmers have little defence against representatives of companies who claim royalties. Small companies and public institutes are at a disadvantage when negotiating access to a patented technology with large companies with extensive experience in this field.

- options at the science level
Recently, some institutions have been developed to counter the negative impact of IPRs on the use of technologies for development purposes.

The Public Intellectual Property Resource for Agriculture (PIPRA) initiative is based on the observation that several publicly developed enabling technologies cannot be used freely because universities have licensed them exclusively to commercial companies. It will help universities and research institutes – primarily but not exclusively in the USA – to take humanitarian uses into their patenting strategies and reduce cost. PIPRA furthermore develops information services to facilitate the scoping of problems in freedom to operate along a research trajectory, and supports the development of key enabling technologies to bypass tightly-controlled proprietary technologies (Atkinson *et al*. 2003).

The Biological Information for Open Society (BIOS) initiative (Nature, 2004) intends to develop open-source biotechnologies, similar to methods used in software such as Linux that provide an alternative to proprietary products. The scientific basis will be provided by new transformation technologies developed by CAMBIA (Broothaerts, 2005; Constans, 2005) based on microbial processes other than those mediated by *Agrobacterium tumefaciens* upon which hundreds of patents rest. The open-source concept uses patents to make sure that the information can be licensed freely to all, with only one major condition, i.e. that all users of the patent will provide the same liberal access to all subsequent inventions that are derived from it. It remains to be seen how this concept may work in biotechnology where many scientists will use additional proprietary technologies in trying to expand upon the open source and in doing so potentially create barriers to the grant-back obligation. BIOS also operates a database with information from over 70 patent offices that facilitate an initial analysis of IP by researchers (see www.cambia.org).

Some additional initiatives aim at mediating between patent holders in the North and potential users in the South in order to facilitate technology transfer, for example, the International Service for the Acquisition of Agri-biotech Applications (www.ISAAA.org) and the recently established African Agricultural Technology Foundation (www.AATF.africa.org). These public/private initiatives have had some notable successes in assisting the use of biotechnology in the South (e.g. virus-resistant papaya). However, such initiatives can easily be criticized for opening up developing countries to commercial transgenics and thus creating more benefit for the multinationals than for the poor (Kuyek, 2000).

5.6 Conclusions

IPRs are likely to have a marked impact on diversified seed systems. The impact is difficult to quantify in industrialized countries because the effect of IPRs is confounded with the effects of other policies and developments in the seed industry. There are strong indications that IPRs are not crucial for the development of a commercial seed industry in developing countries, but they can favour the maturation of a seed sector by reducing the role of 'fly-by night' companies.

Strong IPRs are likely to have a direct, negative effect on the on-farm saving of seed and especially in the traditional exchange of seeds among farmers. Many developing countries are aware of this but still there is a tendency in several countries towards agreeing to greater restrictions. Farmers' organizations are wary of monopolistic trends that may result in, for example, future increases in seed prices. The impact of IPRs on biotechnological inventions in the concentration of the seed industry in industrialized countries since the 1980s may serve as a case in point.
IPRs, and especially strong IPRs like utility patents and PVP based on the 1991 Convention of UPOV support neither the development of technologies for the resource-poor nor the transfer of new varieties from the commercial sectors to (near) subsistence farmers through lateral spread. They can be an important driver in shifting the focus of public resources away from the needs of the resource-poor towards those of commercial agriculture. IPRs also create significant additional costs to public research because the terms of freedom to operate must be established and access to proprietary technologies have to be acquired. Both these legal aspects must be implemented (for example, costs of application and maintenance) and enforced (effective and efficient mechanisms to fight infringements in and outside courts).

There are important differences between the potential impacts on seed systems among different IP systems. Patents provide stronger rights than Plant Variety Protection and can be used by right holders in more strategic ways leading to more opportunities to influence the market. Since IPRs are territorial, the strength of IPR systems lies in the fact that they provide countries with a mechanism that can be used to influence the development of seed system. If all countries had the same combination of public and private agricultural research, the same types of seed and agricultural markets, and equivalent institutions, perhaps it would make sense to consider a globally uniform IPR regime for plant breeding. Or even if national seed systems followed a simple, linear development path, then the progressive application of a single IPR strategy could be defended. Such uniformity can be found neither among countries nor among crops within countries. This means that a more individualized approach is necessary. At the same time, harmonization in implementation measures, such as through UPOV and PCT, can significantly reduce transaction costs.

The TRIPS Agreement provides developing countries with a fair level of flexibility in designing appropriate systems both by designing *sui generis* protection for plant varieties and creating exemptions in the patent system. Various types of pressures are exerted to provide protection beyond the minimum compliance of TRIPS. The result is that the options available to developing countries are rarely fully considered. The implementation of IPRs in the market is based on governmental negotiations. There is no sign of equity in current negotiations for access to technologies between the providers and the users. This aspect is hardly ever taken into account in the design of IPR regulations.

Concerted strategies for access to technology for the resource-poor need serious consideration, but are too recent to be evaluated.

6. Revisiting the observations: disconnections and lack of coherence among policies affecting seed systems

Abstract

The policy and regulatory frameworks affecting seed systems show disconnections between policy processes and practices in day to day agriculture, as well as between policies themselves. Seed laws commonly cater for the needs of a relatively small component of seed supply. Moreover, tensions exist between international agreements in the trade, environment and agricultural sectors. Here I will discuss disconnected and conflicting policies and regulations, and provide a range of explanations and solutions.

Disconnections are identified in three directions: among stakeholders within a dossier, between relevant dossiers (agriculture, trade, and environment) and between different levels of aggregation (local, national, and international). These disconnections explain a major part of the inconsistencies in observed policy outcomes.

Disconnections among dossiers may be due to parallel negotiations concomitant with insufficient direction over the relevant departments within a national government, a strong influence of stakeholders in any individual dossier, and power relations among departments and countries. Disconnections between the farmers and national and international levels within a dossier may be due to insufficient knowledge about the reality in agriculture, the prevalence of 'higher' policy goals or to an intentional attempt to modernize agriculture through legislation.

The analysis shows that inconsistencies are inevitable in policy making processes with complex influences from and power relations among individuals and organizations. Legislation based on disconnected and inconsistent policies are likely lead to problems with implementation, confusion and in the field of genetic resources and seeds to 'hyperownership' when proponents of national, communal or individual rights systems are caught in the spiral of an ever increasing thicket of rights.

The obvious solution lies in the development of mechanisms to increase policy coherence and break the spiral leading to hyperownership through institutional means. Doubts may however be cast on the idea that coherence is really possible in policies affecting seeds all of which reflect different objectives and value systems. Feasible options for real improvement include avoiding generic wordings in legislation that would otherwise have unintended effects beyond their primary focus, as shown in seed laws and IPRs, and to make provision for flexibility and change in legislation to respond to changing situations. Alternative options for improvement can also be found in strategies that increase the public space without changing the rules: through targeted public investments; the development of open source knowledge and materials; standardized text for humanitarian use licenses for both IP and genetic resource rights as well as patent pools.

Seed is an essential element in crop production, representing a valuable resource that is important in sustaining the supply of food, feed, flowers, fuel and many functional compounds for industry. Seed is also essential for rural development and poverty reduction. It is, therefore, important to continually search for solutions to the inconsistencies that threaten the availability, access and quality of the seed that farmers need. All these solutions can only develop when the inconsistencies are clearly formulated. This study intends to have contributed to that goal.

6.1 Analysis: comparing different policies and regulations affecting seed systems

The previous chapters have analysed three policy fields and associated regulatory frameworks that each have a marked effect on seed systems: i) Seed policies and national seed laws (Chapter 3); ii) Biodiversity policies, in particular the most relevant international agreements CBD and IT PGRFA, and national biodiversity laws (Chapter 4); and iii) Intellectual property rights systems, WTO-TRIPS and bilateral trade agreements, UPOV and WIPO-agreements, and national patent, trademark and plant breeder's rights laws (Chapter 5).

These policy fields have rather divergent effects on the formal and local seed systems, and on the options for integrating these seed systems at different points in the seed chain. These diverging effects are based on the rather different objectives of these policies. Two observations have been leading in analysing these frameworks:

i) Policies and regulations are based on a very limited concept of seed systems and ways to advance them, and
ii) Policies appear to be mutually inconsistent making it very hard to design regulations that include the objectives of different policies.

Evidence for the first observation is most obvious from the seed laws in many countries. These are designed primarily to regulate the formal seed system, but can also have a marked and likely unintended impact on farmers' seed systems that are much more important in terms of seed volumes. The same applies to intellectual property rights that intend to stimulate the commercial (formal) seed sector, but that can have a marked impact on both the public formal sector and farmers' seed systems. This observation leads to the conclusion that in such cases there is a disconnection between policy makers and reality in agriculture and a disregard for the actual organisation of seed systems.

The second observation has been illustrated in a number of cases in previous chapters. Chapter Four showed that biodiversity policies appear to hamper the exchange and use of the genetic resources that provide the building blocks for new crop varieties. These policies run counter to agricultural policies that aim to strengthen and integrate seed systems, and in some cases they even contradict their own objectives. The same applies to the introduction of strong intellectual property rights on plants or plant varieties (Chapter Five), which is particularly disruptive to the freedom to operate for plant breeders and to dissemination new varieties amongst farmers.
Moreover, current intellectual property rights are difficult to reconcile with biodiversity policies, including Farmers' Rights. Secondly, the Act on Breeder's Rights and Farmers' Rights in India has been shown to contradict the country's Seed Act. In India the freedom of farmers to save, exchange and sell seeds under the former act contradicts the strict requirements in the seed law which stipulates that all seed in the market has to be certified and should thus belong to officially released varieties. In other countries, the introduction or implementation of intellectual property rights systems are difficult to combine with trends in seed laws that aim to reduce the control tasks of certification agencies and include tasks that assist improving the quality of seed in farmers' seed system.

Opinions differ when it comes to the inconsistencies between the CBD and TRIPS (see, for example, Leskien & Flitner, 1997; Drahos & Blakeny, 2001; Sampath & Tarasovsky 2002). Where the CBD grants national sovereignty over genetic resources and promotes the rights of local and indigenous communities over their genetic resources and associated knowledge, TRIPS ensures that individual IP-holders can obtain control over particular genetic resources, notably new varieties and plants with patented components. One of the major debates that could lead to the two discussions being brought into line is the stipulation that origin should be disclosed when genetic resources are involved in IP-applications. This would make it possible for countries of origin to check whether genetic resources had been obtained with “Prior Informed Consent” and on “Mutually Agreed Terms”. Such proposals are discussed both at the CBD (see UNEP/CBD/GTE-ABS/1/2 of January 2007[3]) and the World Intellectual Property Organisation (see WIPO/GRTKF/IC/8/11 of June 2005[4]), but these discussions have not led to a conclusion and friction between the two systems continues. Similarly, there is conceptual tension between the national sovereignty principle in the CBD and the multilateral approach of the International Treaty, even though the latter’s objectives are “in harmony with the CBD” (Art 1), and between the promotion and the ‘taxation’ of intellectual property rights in the TRIPS agreement and the International Treaty respectively.

This leads to the observation that inconsistencies in regulations arise from a lack of policy coherence both at the national and the international level. Formally there is no discrepancy between these international agreements in legal terms (which would be resolved by the Vienna Convention on the Law of Treaties). For example:

i) the disclosure of origin would be a mechanism to facilitate the implementation of some of the provisions of the CBD, while not necessarily reducing the rights of the IPR-holder;
ii) the multilateral system in the IT PGRFA is agreed upon by states within their sovereign right to decide on access and benefit sharing;
iii) the rule in the Treaty that mandatory payment is due when IP-protected products derived from the multilateral system are not available for further breeding does not counter the rights to obtain IP-protection.

Linkages between the agreements have often been forged in the final stages of negotiations by the legal specialists of the negotiating parties charged with avoiding legal conflict between agreements. One example is the addition of the phrase “subject to national law and as appropriate” in Article 9.3 of the IT PGRFA which avoids a legal conflict between the Farmers’ Rights on the one hand and the existing national seed laws and intellectual property rights systems on the other. This type of text is needed to avoid problems arising during the ratification processes in member countries and are thus essential for an agreement to get the support of many members – an important indicator for success of a treaty.

The absence of legal conflict does not, however, signal the absence of policy conflict (CEAS *et al.*, 2003). Basic tensions exist between the principle of national sovereignty over genetic resources in the CBD, the multilateralism in the IT PGRFA and the rights of communities over genetic resources and traditional knowledge as discussed in the IGC and as included in some national laws under Farmers’ Rights or based on article 8j of the CBD and private rights over intellectual property in TRIPS. These tensions become apparent, and even counterproductive, particularly when national policy makers design national legislation to comply with the different obligations under these international agreements.

[3] http://www.cbd.int/doc/meetings/abs/absgte-01/official/absgte-01-02-en.pdf
[4] http://www.wipo.int/edocs/mdocs/tk/en/wipo_grtkf_ic_8/wipo_grtkf_ic_8_11.pdf

This chapter further analyses the two observations described in this section. It highlights a number of developments that explain the actual situation described in the previous chapters, notably through the observed disconnections in and inconsistencies between policies that impact upon seed systems. The key questions are: i) How consistent are the different policy fields investigated in the previous chapters in their impacts on seed systems? ii) What are the likely origins of inconsistencies observed?, and iii) What kind of ways forward can be suggested?

6.2 Analysing disconnections in policy processes

6.2.1 A framework: three domains of interaction in policy development

International policies are formed as a result of the interplay between a varied mix of stakeholders. In analysing the apparent weaknesses in policies that affect seed systems, different entries into the policy making process can be taken. The basis is that almost all decisions in this field are made by national governments, and that problems will relate to these processes. Scott (1998, referred to by Hajer, 2003) studied failures of large-scale rationalized planning and the limits of centralized hierarchical regulation. Pierre (2000) analysed the roles of different institutional layers of government in policy making. Hajer and Wagenaar (2003) concentrate on the interplay between government and societal organizations. Andersen (2007) recently applied this latter concept to the policy debate on genetic resources. Here these views are applied to the interplay of the various policy regimes that affect seed systems.

Healy *et al.* (2003) suggested a framework for analysing complex policy processes that involve different stakeholders at different levels of policy making. Their scheme emphasises the identification of different stakeholders and the analysis of their relations. In our situation these stakeholders operate in three domains. These can be classified as policy sectors, policy level and interest group.

In the policy arena that affects seed systems, each domain has three major classes. Three major policy sectors are involved: agriculture, environment and trade. In all these sectors, Government, Business Organizations (BO) and Civil Society Organizations (CSO) may have a stake. These stakeholders operate at local, national and international levels.

Interactions among these stakeholders operate along these three domains. Lack of interaction, which may give rise to inconsistencies will be discussed in the following sections:

- between stakeholders within a sector – Section 6.2.3
- among sectors – Section 6.2.4
- from local to global and back – Section 6.2.5

In all these interactions there are aspects of inclusion (or representation) of different stakeholders, and aspects that focus more on process, content and goals. Whereas literature has dealt with such issues at the conceptual level, and in fields other than agriculture and seeds, the following sections intend to contribute to a further understanding of the impacts of policy on seed systems. Examples are drawn from debates relating to seed systems already introduced in earlier chapters.

6.2.2 Interaction between stakeholders within a sector – a diverse picture

Interaction between stakeholders within a sector can be varied in nature and include formal and informal arrangements (Hajer and Wagenaar, 2003).

The formal involvement of stakeholders is commonly based on a choice of selected officials who are supposed to represent the interests of their constituencies (Hajer, 2003). An example in the seed sector is the representation of stakeholders in national variety release committees in countries where such institutions exists. At the international level, it is CBD that has the most specific provisions for allowing indigenous communities to be involved in the decision making process. Special meetings are devoted to the implementation of Art. 8j, which give these communities a voice. In formal arrangements the level of actual representation should give rise to concern as the discussion surrounding farmer-representation in the variety release committees (Chapter 3) illustrated. Formal representation requires some level of stakeholder organisation and mechanisms that ensure effective communication among members. This becomes more complicated where local, national and international negotiations are concerned.

Secondly, all international agreements include the option of organizing ad hoc (often technical) consultations in which a variety of stakeholders may be allowed to voice their views. Membership of such consultations can be open or be dependent on invitation alone. In both cases the issue of representation raises valid concerns.
Thirdly, the preparation of background study papers for the official conferences of parties can create a platform for the voices of stakeholders. This opportunity to exert influence is limited to stakeholders who have been invited by the secretariat of the international agreement to develop such documents. The boundaries of the space for the secretariat to influence the policy processes are set by the by-laws of the agreement.

Apart from the formal involvement of stakeholders in the debate, there are influential informal links between institutions and persons that must be considered. The environmental sector is renowned for the broad involvement of civil society groups in policy development at all levels: local, national and international (Tatenhove & Leroy, 2003). At the international level this is seen as one of the major reasons for the growth in the number of international institutions. These often have overlapping mandates and power struggles are a common result (Andresen, 2002). Hajer (2003:92) illustrated the positive role of informal arrangements in political participation in situations where “centrally organized policy deliberations no longer guarantee a reliable representation of the feelings of the various constituencies”, but he also realized that this challenges the idea of representative democracy (ibid: 93).

Civil society groups are influential in the environmental sector (in our case notably the CBD). The seed industry organisations (International Seed Federation and CropLife; national or sub-regional seed associations) and individual companies have a particular influence on commerce and agricultural ministries. Farmers are often able to influence agricultural policy makers.

6.2.3 Interaction between sectors: parallel and disconnected negotiations

A most obvious explanation for this lack of coherence is the fact that the different international agreements have distinct objectives and are negotiated by different ministries in national governments (Petit *et al.*, 2001). The TRIPS Agreement of the WTO was negotiated by the ministries of trade in most countries, the CBD by the ministries of environment and the IT PGRFA by the ministries of agriculture.

The different objectives of the international agreements clearly indicate the different perspectives underlying the negotiations and it should not be surprising that the overlap in influences and particularly the impact on agriculture (and seed systems in particular) have not been the primary concern of negotiators. Agriculture is not a primary concern of trade and environment representatives in national delegations to the WTO and CBD. Yet, agriculture appears in the form of commodity markets in the former, and in debates on the encroachment of agriculture in forests and other nature areas in the latter. It can be argued that Article 27(3)b of the TRIPS Agreement is a clear indication that 'agriculture' has featured on the WTO agenda in terms of intellectual property rights, but views on genetic resources do not appear to have had a marked impact on the framing of the CBD. The CBD now recognizes the special nature of agricultural biodiversity, but this should be regarded as the result of a 'repair mechanism' during the second Conference of Parties rather than a sign of coherent policy making at the onset of the negotiations for the Convention.

The fact that different ministries are responsible for international negotiations creates a great challenge for reaching policy coherence at the national level. In many countries, contacts between ministries can be established only through the hierarchy, i.e. via the responsible ministers. Lack of knowledge of each other's field of expertise is already a barrier to contact, and even if policy makers realize that some information from another ministry may be useful, hierarchical issues could make contact between colleagues difficult.

Even within a ministry, conflicts between different approaches can arise. In the field of the environment this is particularly apparent between strategies that focus on conservationism (fencing in biodiversity to conserve it), and preservation, i.e. finding an optimum between use and conserve of biodiversity (Wittmer & Birner, 2005). It appears that good coordination and direction – possibly by an 'independent' ministry such as foreign affairs, and the inclusion of the same persons in delegations to different negotiations, might improve policy coherence at the international level.

6.2.4 Interactions between policy levels in seed related policies: from local to global and the reverse

6.2.4.1 Disconnections between local and national policy levels

The history of seed laws in many countries typically illustrates that a very limited group of stakeholders within the government is able to push for regulations. As described in Chapter 3, the first seed laws were designed in a period of formal seed system development, when the quality control functions of the public seed production system needed legal backing for their operations. This need emerged because of pressures from the seed production operation within the organisation and because of the emergence of private enterprise in the seed sector was considered to need independent seed quality control institutions. The first situation concerns a conflict of interest within the unit responsible for seed supply, e.g. when the quality control section needs to reject a seed production field or a seed lot while the financial consequences for the unit would be grave. The need for independent quality control in view of private enterprise involvement is based on the assumption when quality control capabilities are connected to the public seed production operation there might be some bias in the approach towards other seed producers.

Seed laws were thus developed to regulate the formal seed system and were - in most cases - designed according to the examples European and North American law (Bombin, 1980), where a much larger share of the seed is produced in the formal system. Such seed laws in developed countries are commonly based on national seed policies that aim at providing certified seed to all farmers at all times. This orientation in developing countries is one of the reasons why public seed production planning and many investment projects in the seed sector fail to live up to expectations. Providing seed to all farmers is physically, logistically and economically impossible in both developing and (for many crops) industrialized countries. Very few countries have a seed purchasing rate of over 80% and even in many European countries this is less than 20% (Klein *et al*., 1992). Chapter 3 indicates that it is unrealistic to attempt to supply all seed in a country in the form of certified seed in large-scale commercial horticulture in some industrialised countries. Such seed laws are counterproductive in countries that want to support Farmers' Rights in terms of the right to save, use, exchange and sell farm-produced seed (Bala Ravi, 2005), and where agricultural development is to be stimulated by reaching remote and resource-poor farmers through the 'lateral spread' of new varieties.

The same holds true for the introduction of intellectual property rights systems in developing countries. Again, such rights are based primarily on models developed abroad and introduced mainly because of outside pressures - notably TRIPS and the trade agreements. They also specifically focus on the commercial sector within the formal seed system. The main difference with conventional seed laws is that seed laws are easily framed to regulate the formal sector only, but IPR laws almost by definition deal with the intellectual property, i.e. a variety is protected irrespective of whether the seed is reproduced in formal or in small-scale farmers' systems. Very explicit exemptions are needed to correct this, but such exemptions are often considered to be detrimental to the commercial interests of the rights holder.

Chapter 5 discusses the fact that a number of least developed countries have adopted a system of plant breeder's rights that was designed to support a highly commercialised breeding and seed production system in industrialised countries (the 1991 Act of UPOV). Again, this development indicates that in this case too national policy makers have not fully taken local reality into account when designing (or adopting) protection systems.

Finally, the same disconnections and inconsistencies play a role in biodiversity policies and particularly the policies towards access to genetic resources (Chapter 4). Even though such regulations are mainly a tool for implementing benefit sharing objectives, they have become a major policy issue in national policy frameworks. Strict and complex access regulations based on bilateral negotiations as designed in the Andean region, may be feasible for industrial uses of biodiversity based on a one-time extraction from the natural ecosystems; they are definitely not geared to regulate the continuous flow of agricultural genetic resources among farming communities and breeders. Andersen (2007) – on the basis of a detailed analysis of the Philippine law – states that such laws lead to reduced access to genetic resources and thus block the main benefit for farmers directly stemming from access. The policy makers responsible for processes leading to the seed regulations, IPR protection systems and biodiversity laws appear to have been poorly informed about seed management practices.

Possible origins of the disconnections

- Representation
Policies are commonly developed by an elite of educated government officials and parliamentarians residing in the cities who may be insufficiently connected to the changes that take place in agriculture. When their views are not challenged by strong voices from the stakeholders themselves, policies can be disconnected from reality. This tendency may be enhanced when advisory bodies such as national seed boards or variety release committees are formed where stakeholders have very limited or no representation at all (see also 3.3.1).

To strive for representation in formal institutions is again a formal approach. Decentralization and the development of local institutions (Uphoff, 1986) would be a more radical approach. Wusch (1991) proposes a framework for analyzing the benefits stemming from the decentralization of public administration to improve coordination, reduce managerial costs and design programmes that better fit local practices, needs and conditions. Ostrom (1990) goes further in proposing that collective action should play a stronger role in (decentralized) decision making. However, the current trend to increasingly resolve issues at the international level moves in the opposite direction. Participation in decision making on matters relating to the conservation and sustainable use of plant genetic resources for food and agriculture is formally defined as a Farmer's Right (Article 9.2 (c) of the IT PGRFA). This right has to be protected at the national level ("as appropriate and subject to national law" – Art 9.1), and it remains to be seen how countries deal with this.

- Developmentalism
Next to poor knowledge about the reality at farmers' level in policy circles, the disconnection is also due to intentional decisions based on a developmentalist attitude (Escobar, 1995). Developmentalism in this context stands for a technocratic and often externally driven perspective on the problems of developing countries with little eye for (farmers') reality and the role of the stakeholders in the countries concerned. It focuses on what these countries are not instead of what they already are (Jones, 2003), and - as a result - on external solutions without building on the strengths of the country itself. Such views are common in development assistance organizations, and also amongst the elite in developing countries themselves. When applied to agricultural development this approach translates into a primary focus on technology to improve rural livelihood (Evenson *et al.*, 1979; Kline & Rosenberg, 1986) as opposed to strategies that aim at endogenous development and local innovation capacities (Röling & Wagemakers, 1998; Rogers, 2003; Röling *et al.*, 2004). The approach for seed system development by Douglas (Chapter 2) fits into this attitude very well; it is not based on the situation in the developing countries themselves, and instead focused fully on what the ideal situation should be based on foreign experiences.

Education is a powerful factor in promoting such developmentalist approaches – almost all leading seed specialists in developing countries in the 1980s and 1990s had been trained at or by universities in the USA one or two decades earlier. The technological components of these courses were excellent, but its focus on developing the formal seed system bypassed the importance of the farmers' seed systems that it intended to replace. It is only logical that when these students rose to responsible jobs in their ministries, they drafted seed policies and laws based on western examples.

The seed laws and especially provisions that all seed (or all seed in the market) should be certified may be framed as a mechanism to stimulate the modern attitude of using purchased seed. This is based on the assumption that regulations can be an effective tool for quickly reaching a desired change, in this case a western style seed industry. The same view led in the Netherlands to focusing official variety trials on advanced farmers rather than farmers with an average crop management level with the aim of stimulating 'good farming' with higher productivity. Tripp (1998), however, states that regulations in the seed sector that are insufficiently linked to reality are not likely to be effectively implemented and may be a strong incentive for haphazard application and rent-seeking. In their theoretical study on the role of regulations in development, Davis and Trebilcock (2001) conclude that "developing countries should not focus exclusively on enacting . . . bodies of law and regulation. . . . Rather, the empirical evidence suggests that it is appropriate to emphasize reforms that enhance the quality of institutions charged with the subsequent administration and/or enforcement of those laws or regulations."

6.2.4.2 Disconnections between national to international levels

Policies, and particularly those developed at the international level, have to be based on generic principles that allow for a wide application. There are two risks when these principles are translated at higher policy levels into detailed rules.
The first is the risk that the perceptions of reality that dictate the formulation of such bread principles and goals are not well founded. This is particularly so when the debate at the international level is limited to professional diplomats and legal specialists or who are at a great distance from the agricultural reality in their countries. Only in a few countries - notably in Latin America, the Philippines and India - have local groups emerged that involved themselves in the debates on seeds and genetic resources. In many other regions non-governmental organizations that originate in North America (RAFI, now Etcetera Group) or Europe (GRAIN) have tried to fill the gap, mainly at the international level. Here too, aspects of representation are critical, but there is also a role for 'higher political goals'.
The second risk is that when generic principles are translated into detailed rules these rules do not take sufficient account of the specificity of problems on the ground in different countries and situations.

- Representation
The lack of effective contact among sectors, notably in government organisations is aggravated by another disconnection expressed to the author by several permanent representatives of developing country governments in Rome (FAO), and Geneva (WTO, WIPO) in 2005 and 2006. When their relation with their home government was discussed, several had direct contact only to their home ministry (often Ministry of Foreign Affairs, Trade (Geneva) or Agriculture (Rome). Several permanent representatives of developing countries indicated that the communications with their government were very weak, and that they often did not get answers to queries relating to topical issues on the agendas of the international organizations. As a result (they said) they were often actually forced to make national policy 'on the spot' rather than being in a position to represent their national government with clear instructions and appropriate feedback to their questions. Petit *et al.* (2001) further emphasized the turnover of staff in policy departments of ministries and amongst international negotiators. This does not help the development of coherent policies

in complex and rather specialized dossiers such as the one on genetic resources with its multiple links to seed, biodiversity, rural development, property rights and trade issues.

In defence of the international organisations, Andresen (2001) observed that power in the international system is in the hands of the states and the UN-system cannot be expected to coordinate international agreements. Finally, Stannard *et al.* (2004) argue that the different rules of procedure of different international bodies influence the process, which adds to the inconsistent outcomes of the negotiations in FAO, CBD and WTO respectively. This applies, for example, to the role of indigenous communities in the CBD negotiations, and to the differences in compliance mechanisms between WTO on the one hand (with its own conflict resolution system) and the environmental agreements on the other without or with very weak sanctions on non-compliance.

- Overriding political considerations

Accepting examples of regulations from other countries for political rather than practical reasons appears to be a common phenomenon. The Kyrgyz Republic adopted plant variety protection and became a member of UPOV in 1998 not to promote plant breeding in the country or to gain easier access to foreign-bred varieties, but primarily because it wanted to show the countries in the region that it wanted to be a modern, free market economy (Rudenko, ministry of agriculture, Bishkek, pers. comm., 2001). Similarly, the Ministry of Agriculture in the Yemen asked me as a World Bank consultant in 1996 to develop a modern seed law that should be 'like the ones in Europe' instead of asking itself what the key issues in the specific seed situation in the country were (A.H. Karhash, Ministry of Agriculture Sana'a, pers. comm., 1998). Any call for policy decisions from the most directly involved stakeholders may be futile when such wider political considerations and engrained attitudes exist.

Also, the frequently heard statements from developing country stakeholders in the seed industry (notably from Africa) that government officials participating in international meetings 'sign anything', leaving the implications to lower level policy makers (quoted in Louwaars *et al*., 2005) adds to the weaknesses of policy making and regulation.

- Influence and power

International law is developed by sovereign nations that negotiate international agreements and that ratify them through their national (democratic) processes taking into consideration potential contradictions with existing law. This should mean that agreements always take into account the concerns of various stakeholders and at various levels and that such agreements form the rational outcome of consistent policies. This is - in most cases - not true or, as a senior politician once put it, "when such outcomes would be possible, it would be science; politics deal with situations where interests have to be weighed against each other" (Terlouw, pers. comm.). This implies that there are always winners and losers in any significant agreement, and in developing implementation mechanisms that involve different agreements (such as TRIPS, CBD, IT PGRFA). The result is that differences in influence and power shape the debate and the outcomes.

Power, the capacity to achieve outcomes (Giddens, 1984) shapes the debate at many different levels (Brand & Gorg, 2003): among agents and organizations influencing a particular department of government, within a particular dossier (for example. biodiversity), among departments within any given country (for example. between biodiversity and trade dossiers) and among countries (for example, between OECD and G77 countries in international negotiations). These relations shape an individual international agreement. Such compromise may not be beneficial to all parties, thus reflecting a power relationship, or be framed in such a way that as many countries a possible can consider it a victory. In the latter outcome this commonly implies that language is imprecise and subject to multiple interpretation (for example, “equitable sharing of benefits” in the CBD or the use of “unreasonably” in Article 30 of TRIPS when dealing with exceptions), or that difficult aspects are left to be regulated at a later stage (for example, the Standard Material Transfer Agreements and the Funding Strategy of the IT PGRFA). This kind of outcome is reached when there is a perceived need to include as many countries as possible from the very start.

An example of the more confrontational strategy is to ‘sell’ an agreement that was designed by only a few states to others. This strategy is followed in free trade agreements with regard to plant breeder’s rights. The Act of 1991 of UPOV was debated among its industrialised country members in the late 1980s. In the WTO, where any effective ‘*sui generis*’ system was allowed by the TRIPS Agreement, the UPOV systems were not mentioned. Inclusion of the rules of the 1991 Act is being negotiated in many more countries as part of bilateral trade agreements, even though this Act is adapted to the agricultural systems of the UPOV members at the time the Act was drafted rather than those in the countries that it is now ‘sold’ to.

The different types of power (Arts, 2004; Andersen, 2007) exercised among states also influence internal relations within a government, where departments that are involved in an international negotiation have to weigh different interests and either negotiate with other departments or just decide for themselves (depending on power relations). This is the case in various countries where ministries of trade, involved in negotiations give in to a clause on breeder’s rights (with or without consulting the ministry of agriculture) in order to get trade benefits (pers. comm. FTA-negotiators Andean Community countries, 2006). Complex power relations among individuals, institutions and structures (Arts & van Tatenhove, 2005) shape the outcome of policy processes, which leads to the conclusion that contradictions are inevitable in seed related policies.

6.3 Effects of the challenges in policy processes

6.3.1 Confusion at the national level

The fact that there is no conflict in legal terms between the international agreements that impact on seed systems, whilst tensions between policies are apparent creates problems for national policy makers. They get quite hard (WTO) and quite compelling (CBD) prescriptions on the national obligations to implement the agreement at the national level. They are then charged with unravelling the confusion or even policy conflicts that arise at the national level in order to come up with regulatory solutions that satisfy the different international organizations, and (!) the national interest and align these with national legislation (Louwaars & Visser, 2004). It is exactly this problem that motivated the African Union to develop its model law with its complex balance of the rights of breeders and the rights of farmers. Indian legislation on this matter is also extremely lengthy and can lead to a wide range of interpretations. Other countries created separate laws for breeder’s rights and biodiversity management, leaving it largely to the users to sort out any conflicting provisions in court. The clearest proof of the complexity is that in many countries there is considerable delay in enacting national legislation. Biodiversity laws that aim to implement the basic principles of the CBD are still in the process of being enacted in many countries, 15 years after the Convention was agreed upon.

A common argument from civil society organizations, but also from developing country policy makers when explaining policy conflicts at the national level is that international rules are forced upon developing countries by politically and economically stronger powers. A legalistic response to these problems is that such problems cannot arise, because these countries have agreed with the details of the international arrangements. The question, therefore, arises whether international law is forged by governments or whether it is forced upon governments (Jan Anne Vos, Asscher Institute, pers. comm.). The example of plant breeder's rights is an interesting case in that the system evolved over a period of 30 years and with a membership that primarily consisted of industrialized countries. Plant variety protection are now being promoted for adoption by developing countries as the only tested '*sui generis*' system. When UPOV membership is included in free trade agreements – as is often the case (Choudry, 2005) - this can be considered as forcing regulations upon developing countries. In many other cases countries are indeed present in negotiations, but despite the one-country – one-vote rule (in UN-organizations), some countries have less influence in the outcome than others for the reasons mentioned in Section 6.2 above.

6.3.2 Juridification and Hyperownership

Another outcome of the negotiation processes is that although the different parallel discussions are not linked, they still lead jointly to a juridification of seed-related issues, and they appear to influence each other. These trends unfortunately do not to reach an agreed optimum of rights over genetic resources and associated knowledge for individuals, communities and nations.

Juridification as 'the proliferation of law' and the tendency towards an increase of formal law (Blichner & Molander, 2005) is obvious in the field of seed systems where international law creates new rules which in many cases replace or conflict with the 'law of the land'. The term juridification is also used to refer to the increased role of legal professionals (Brooker, 1999) and the global expansion of judicial power (Tate & Vallinder, 1995). These meanings of the word apply also in access to genetic resources and technologies and the distribution of the results of research. These lawyers in turn increase the body of formal law by creating jurisprudence and even though the laws that regulate intellectual property and other rights on genetic resources are territorial, such jurisprudence is increasingly used across borders to claim or to oppose rights.

Butler *et al*. (2002) claimed that strong breeder's rights have resulted in claims for Farmers' Rights. Safrin (2004) in turn called the outcome of this process 'hyperownership' - a term that describes the reduction of the public domain or, as she describes it, 'the legal enclosure' of genetic resources through increasing levels of both intellectual property and other genetic resource rights. Her analysis is that claims from developing countries and local communities are the result of the strengthening of intellectual property rights, creating a spiral of ever increasing rights-levels. Gepts (2004) in turn confirmed that the commoditization of biodiversity has led to the active pursuit of IP protection on genetic resources (both in agriculture and pharmacology). When appropriation is achieved without authorization of the holders of the basic resource, the claim of 'biopiracy' may in turn result in tighter rules. He added that uncertainties about rights are leading to restrictions on the flow of genetic diversity to the detriment of scientific research and plant breeding both in developed and developing countries. Similarly, 'thickets' of intellectual property rights create barriers to accessing technologies and genetic resources (Bobrow & Thomas, 2001). They complicate access and increase costs (Barton, 2000). Such thickets can arise when different rights act on a single resource (for example, genetic resource rights, various process patents, and plant breeder's rights), and when they all impact on options for access to and use of that resource, for example, the use of a variety for further breeding.

When both the intellectual property and the sovereignty based rights have been overstretched in permitting or asserting ownership rights over genetic material, this creates an “anti-commons”, and leads to socially suboptimal access to the resource and – in this case – inhibits innovation and development (Runge & Defrancesci, 2006). Claims have been made that access to information is delayed after policies were introduced at universities in the USA to seek protection (David, 2004); access to technology was also considered reduced (Hanson *et al.,* 2005; Zheng *et al.*, 2006); secrecy and the use of patents as blocking tools disturbed public research (Cohen *et al.*, 2000), and start-up companies were hindered (Wright *et al.*, 2006). An anti-commons is a situation in which multiple individuals or entities have rights of exclusion to a given resource (Heller & Eisenberg, 1998), significantly increasing the role of lawyers in research. This concept has sidelined the ‘tragedy of the commons’ (Hardin, 1968) which explains the over-use of shared resources for which nobody claims responsibility, which has dominated the privatization theories in natural resource management for decades.

In analyzing the parallel development of stronger rights over intellectual property and genetic resources, an almost perverse development in thinking can be observed in civil society about genetic resource policies. Louwaars (2006) described how the development of the debate in civil society in the 1980s as they opposed the control of genetic resources by the corporate world has now resulted in a spiral of increasing enclosure by both the corporations and civil society. This development fits in the trends in environmental politics (van Tatenhove & Leroy, 2003), which started with the ‘societalisation’ of major environmental issues. This is now followed by the marketisation of the environment whereby economic instruments are developed to regulate over-exploitation (tradable emission rights) or to obtain funds for (public) counteractive measures, such as taxes. The parallel in the genetic resources debate is the concept that benefit sharing should pay for the conservation of genetic resources. The perversity of this outcome is that the wealthiest users may gain preferential access to the resources, a situation which does not solve the initial problem of corporate control over genetic resources (through research and market power assisted by rather weak breeder’s rights) identified in the 1980s – it may even provide a much stronger legal control over genetic resources through patents plus access and benefit sharing contracts based on biodiversity laws. The most profitable ‘mutually agreed terms’ for providers of genetic resources can be agreed on by the industries that can offer the highest profits through their market power and patent positions.

6.4 Opportunities to reduce undesirable effects

6.4.1 Increasing coherence at the national level

The literature on policy coherence focuses to a large extent on the need to make economic and development policies more consistent (Matthews & Giblin, 2006). Problems with inconsistency have even led to the UN Secretary General establishing a High-Level panel on Coherence in 2006 (www.un.org/events/panel) to study policy coherence issues in the fields of development, the environment and humanitarian assistance. Various donors have supported the promotion of policy coherence in developing countries, e.g. through stimulating the preparation of Poverty Reduction Strategy Papers (see: www.imf.org/external/np/prsp/prsp.asp). This provides opportunities to include important fields, such as environmental issues in the development agenda in a more consistent manner (Duraiappah A.K., & P. Roddy, 2005).

The Organisation for Economic Development and Cooperation surveyed measures to increase coherence in its member states and involved the DAC peer review mechanism to monitor the consistency of member countries economic and development policies (OECD, 2005b). Various institutional measures are used in different OECD countries including the involvement of different ministries and in some cases other stakeholders in the preparation of important international conferences, the establishment of a range of high-level interdepartmental standing committees and working groups and the formal establishment of a coherence unit within the Netherlands Ministry of Foreign Affairs. Finally, the Commission of the European Communities intends to improve its screening mechanisms for policy coherence (CEC, 2005). These institutional solutions commonly do not have agenda setting powers, and could compete with other coordination mechanisms, thus weakening their ability to develop and implement cross sectoral policies. Aside from institutional solutions, Addor (pers. comm. 2006) claimed that it is very difficult to institutionalize policy coherence and that personal stature and commitment is needed to bridge the different government departments.

However, in line with the more practical views of Hajer & Wagenaar (2003) that coherence is hardly possible given the different networks that provide government departments with information and points of views, Fresco (2004) wonders whether policy coherence is possible at all. Governments have contradictory objectives leading to inconsistent policies, and secondly, priorities may change over time leading to incoherence as values and conditions change. This would mean that coherence is not best served by complex policy monitoring (and repair) processes, but by improved priority setting of policy objectives. The effects of power relations both among departments and stakeholders within the country and among countries cannot be nullified by good intentions to increase policy coherence. If it is thus assumed that full policy coherence at the national level is not feasible, and that this is aggravated when policy making is 'lifted' to the international level it can even be concluded that there should be much less emphasis on binding (!) international agreements, since these are bound to lead to implementation problems at the national and local levels.

Another approach is to embrace policy-incoherence at the international level as a way to increase opportunities at the national level for local interpretation (Trond Selnes, LEI-DLO, pers. comm.). However, the implementation of this concept is likely to be limited by power relations among stakeholders and agreements (Andersen, 2006).

In our practical case of policies that affect seed system development, two basic approaches can be proposed to reduce inconsistencies: adapting the rules or developing new mechanisms within the existing rules.

6.4.2 Adapting the rules

- Inherent flexibility of the rules

Regulatory frameworks should not be seen as a fixed 'given externality'. Many countries have changed their national seed laws to cater for the development of their private seed sector. Intellectual property rights systems have also shown to adapt to changing situations. Even though the general trend during the last decades has been to gradually strengthen the rights of the inventor, also clear indications can be observed that there is a way back – or 'a better way forward'. Examples are the reduction of the scope of patent

protection in Germany and France by explicitly providing for a farmers' privilege and a breeder's exemption in patent law. Another example is the decision that put a halt on the patenting of expression sequence tags (ESTs), strands of DNA that do not have an apparent function (Kintisch, 2005). This decision followed an unprecedented run on patents as a result of the first sequencing work in the early 1990s. The Development agenda of WIPO which has been given a significant push in June 2007[5] may provide additional grounds for opening up the patent systems in many developing (and industrialized) countries.
Finally, the adoption of the International Treaty can also be considered a 'better way forward' within the general framework of the CBD, for example, by improving access and reducing transaction costs for many major food and feed crops.

The examples show that different situations warrant different routes towards regulatory change. Stakeholder groups, such as the (inter-) national seed industry have been instrumental in many countries in framing changes in seed laws, which then had to pass through many democratic filters. In a number of countries, changes in intellectual property rights have not required any parliamentary approval. Most changes in the patenting of life forms since the Chakrabarty case in 1980 are the result of new interpretations of existing law. This development follows from the fact that these changes occurred under a common law regime (in the USA). Indeed it is surprising that these decisions have had great impact globally, including in countries ruled by civil law systems. The high level of dependence of the IP-system on the judiciary rather than on democratic processes and the importance of case law is an excellent way of responding quickly to technological developments.

Challenging such far-reaching decisions on the basis of a lack of parliamentary approval (such as the Ex Parte Hibberd case providing patent protection to plants in the USA) are commonly not accepted. The challenge of Pioneer Hybrid by J.E.M Ag Supply (case 534 US 124 of 2001) on the grounds that the approval of a utility patent on plants (case Ex Parte Hibberd 227 USPQ 443, 1985) had not received Congressional approval, was not accepted by court.

In the field of rights over genetic resources, civil society has had a very significant influence in policy development. A remarkable development was the organization of a very constructive debate in the form of the Keystone Dialogue that started in 1989 (Keystone Centre, 1991). In this forum, individuals from different backgrounds (industry, NGO, science, government) got together in their personal capacity to deal with the outstanding issues that were discussed at the same time in more formal platforms (notably the Commission on (Plant) Genetic Resources for Food and Agriculture of the FAO). This initiative and the two rounds of the "Crucible Group" (IDRC, 1994; IDRC, 2000a,b) that followed, was very influential. National governments have used the outcome of these deliberations in their policies in international forums and in national regulation. The outcomes of the Keystone Dialogue and the Crucible Group have contributed to the call by Safrin (2004) to the government and the Patent Office in the USA to take into account the response of developing countries in genetic resource rights on the strengthening IPRs in the USA.

- International harmonisation
Very important in this respect is the balance between national sovereignty on the one hand and the trend towards international harmonization on the other. Harmonization of rights has been an important trend during the last decade. Harmonization aims to ensure transparent rights across borders and to reduce transaction costs, thus facilitating

[5] http://www.ip-watch.org/weblog/index.php?p=656&res=1024&print=0 (last visited 19 June 2007)

international trade in innovations and derived goods. However, the trade-related aspects referred to in the TRIPS Agreement are only one group of aspects relevant where rights over genetic resources are concerned. In the implementation of TRIPS and in negotiating the Free Trade Agreements it is insufficiently realized that the primary reasons for introducing intellectual property rights are related to stimulating investments in innovation. If developing countries were allowed to make the development-related rather than the trade-related aspects of intellectual property rights (DRIPS) leading, they would come to very different approaches, as indeed Chapter 4 has shown. There would be less emphasis on harmonization and more space for specific rules to deal with specific objectives. “The key question is not whether to enforce a global IP regime; rather, policymaking needs to be informed by a more detailed approach” (Shen, 2005).

It may be claimed that the call for harmonization does not only stem from a desire to stimulate international seed trade, but also from a lack of detailed knowledge by policy makers and negotiators on the impact of harmonisation and the options for alternative solutions. This appears from the limited knowledge of agriculture amongst the economists and lawyers who participate in my international courses on Genetic Resources and Intellectual Property.

6.4.3 Working within the rules

Reducing the effects of regulations can be partially realized without changing the rules themselves. Special actions and actors who stay within the rules in order to reach more desirable development goals can have a considerable effect. Delmer *et al*. (2003) list three major institutions that attempt to reduce the impact of hyperownership on development:
i) The open source movement, championed – in biology - by CAMBIA,
ii) Joint IP policies and management of public institutions to reduce the thickets, such as PIPRA, and
iii) Assistance in the transfer of proprietary technology such as AATF (African Agricultural Technology Foundation – Nairobi) that aims to broker between technology owners and African users, and PIIPA (Public Interest Intellectual Property Advisors – Washington DC) who provide free expert legal advice on IP issues.
These initiatives have not been developed primarily to reduce the hyperownership aspects derived from biodiversity policies, but to facilitate processes and to mitigate negative effects (Louwaars, 2006).

- Open source
Open source strategies are licensing strategies that keep technologies available for the public. This is realized by making protected innovations (patented in most cases) available to everyone under a license contract that specifies that any improvements or further innovations are licensed to all under the same conditions. BIOS[6] is the pioneer in applying this strategy to biotechnology following the success of open source software (Herrera, 2005). The idea is very compelling from a public cause point of view and the concept received a boost by the patenting of an alternative to the *Agrobacterium*-mediated transformation system, which is protected commercially (Broothaerts *et al*., 2005). When such open source (or public domain) alternatives exist for all enabling biotechnologies for plant biotechnology, there is scope for end products that have no strings attached to them. Yet there are significant differences between software and biotechnology, such as the lab facilities needed and higher investment requirements in the latter field. It furthermore

[6] Biological Innovation for Open Society: www.bios.net

appears difficult to successfully apply the BIOS license because scientists commonly use many different tools and technologies (in improving on an open source technology) and may not be able to grant back his or her own invention to the BIOS pool of enabling technologies when some of those technologies carry obligations based on “normal” licences. (PIPRA, 2005)

- Humanitarian use licenses
The development of humanitarian use licenses forms a common approach in accessing technologies for non-commercial uses such as in developing countries. The approach basically means that a patentee allows a user free access to the protected technologies for particular uses, for example, to use a patented gene in an African crop. This approach intends to solve the thicket of rights problem for a particular purpose. The approach can be applied for technologies, products or data, and the provider can also include some free capacity building into the contract so that the user can optimally apply the technologies. The best known example is the “Golden Rice” case where approval needed to be obtained from 70 patents held by 32 universities and companies in order to work with high-provitamin A rice strains (Kryder *et al.*, 2000). Even though there are many examples of effective humanitarian use licenses, the big disadvantage of this approach which prevents more general use is formed by the high transaction costs - the user must first find out who the right-holders for the different products or processes are, and then approach them and negotiate his or her freedom-to-operate individually. In addition, each contract may have different restrictions, which makes it difficult to oversee the complex of licenses necessary for one research project. Finally, whereas major companies may have experience (and a policy) in granting humanitarian use licenses on their patented inventions, there are no documented examples where governments have concluded such preferential access to their genetic resources for developing country research (Louwaars *et al.*, 2006). The development of agreed standard language for humanitarian use licenses is particularly attractive, and specifically language that binds a number of parties for a wide array of technologies instead of bilateral agreements that are common in this field. An example is the consortium agreement of the Generation Challenge Program which binds various national and international research institutions in their efforts to develop efficient ways to identify useful traits such as drought tolerance in large genetic resource collections using genomic techniques (Barry & Louwaars, 2005).

- Patent pools
A patent pool was first developed by the US Government in airplane technology during the First World War, when it was realized that the ownership situation of aeronautic patents was so complicated that it stifled innovation (Anon, 2005). A patent pool was created to avoid complex licensing processes and blocking strategies. Such pools basically put all relevant patents in one (multilateral) pool with agreed values, which can then be licensed as one joint technology, or in different combinations. Such facilitated licensing could be managed by a government initiative, by the industry itself, such as in the case of the DVD and MPEG industry standards, or by an independent, non-profit corporation that could manage patents and have the authority to grant licenses as suggested for biotechnology (Anon, 2005). In order for the pool to work, it should include patents on a variety of materials and methods that play an important role in biotechnology. The creation of a pool might significantly improve the competition levels in the biotechnology industry by improving access to enabling technologies, a good reason for governments to promote it (Ebersole *et al.*, 1995), but little has been heard in the past decade, possibly because the main players are not very interested in such increased competition. Biotechnology companies appear to prefer to follow an alternative business strategy, i.e. to buy companies that have important patents.

6.5 Concluding

As previous chapters have shown, different legal frameworks can have marked effects on seed systems and particularly on the opportunities available to support systems that can serve the diverse needs of farmers. This chapter shows that the joint outcomes of the three relevant international policy arenas - agriculture, environment and trade - create confusion at the national and local levels that have far-reaching impacts on seed systems. Even though the three relevant international agreements are legally in line with each other, the conflicting policy views that underlie the parallel debates lead to inconsistencies when implemented at the national level and have stimulated the tendency towards juridification and hyperownership.

Explanations are found in disconnections in three domains: lack of effective debate among stakeholders within a policy sector, insufficient communication and understanding among sectors and poor linkages between local, national and international policy levels. Apart from the inherent weaknesses in policy processes that lie at the basis of this disconnection in which representation plays an important role, conscious decisions contribute to the observed inconsistencies as well. These may have their basis in the idea that regulations themselves can support development and the exercise of various types of power in this multi-dimensional field of complex interactions. The broad scope of this study has made it possible to identify a number of explanations to the regulatory problems observed in seed systems.

Creating a more coherent policy framework for seed system development is essential if diversified seed systems that serve the diverse needs of farmers are to be supported. This should result from improved interactions in the three domains identified. But full coherence must be considered a dream since the three policy fields operate with very different starting points and objectives. Yet, when the inconsistencies are recognised, options exist within the framework of current rules that can make these prescriptions more conducive to development goals. Both the fine-tuning of international agreements in bilateral negotiations, and national and local pressures to increase the levels of community and national rights over genetic resources reduce policy space. The resulting hyperownership is damaging to the functioning of effective seed systems.

Important openings exist and new ones have been developed (notably in India and the European Union) that show that when undesirable effects are clearly formulated, new legal solutions can be found. In addition, it is not the law and its interpretation alone, but the way stakeholders use the rights that determines actual impact. Initiatives that use the rights to enhance public access to innovations (for example, open source) and genetic resources (for example, the Nordic approach) instead of restricting it deserves attention and support.

Seed is an essential element in crop production, representing a valuable resource that is important in sustaining the supply of food, feed, flowers, fuel and many functional compounds for industry. Seed is also essential for rural development and poverty reduction. It is, therefore, important to continually search for solutions to the inconsistencies that threaten the availability, access and quality of the seed that farmers need. These solutions can only develop when the inconsistencies are clearly formulated. This study has contributed to that goal, and has analysed options and in some cases proposed regulatory change in order to increase coherency in the effects these have on diversified seed systems and make them more consistent with development goals. Contrary to the main trends was particularly influential criticised in this study, such as linear approaches to seed system development and globally harmonised IPRs does not provide blueprint solutions. Rather, improved analysis allows for targeted interventions at various policy levels and productive solutions to actual problems that farmers face.

References

Allard, R.W., 1961. Relationship between genetic diversity and consistency of performance in different environments. Crop Sci., 1: 127-133.
Almekinders, C.J.M., N.P. Louwaars & G.H. de Bruijn, 1994. Local seed systems and their importance for an improved seed supply in developing countries. Euphytica 78: 207-216.
Almekinders, C.J.M. & N.P. Louwaars, 1999. Farmers' seed production: New approaches and practices. London, Intermediate Technology Publications. 291 pp.
Almekinders, C. & W. de Boef, 2000. Discouraging or encouraging diversity. In: Conny Almekinders & Walter de Boef (Eds.). Encouraging diversity. The conservation and development of plant genetic resources. London, Intermediate Technology Publications, pp. 323-326.
Almekinders, C.J.M., and A. Elings, 2001. Collaboration of farmers and breeders: participatory crop improvement in perspective. In: A. Elings, C.J.M. Almekinders & P. Stam (eds), Euphytica Special Issue 122: 425-438.
Almekinders, C.J.M. & J.J. Hardon (Eds), 2007. Bringing farmers back into breeding. experiences with participatory plant breeding and challenges for institutionalisation. Wageningen, Agromisa, AgroSpecial 5, 135 p.
Alston, J.M. & R.J. Venner, 2002. The effects of the U.S. Plant Variety Protection Act on wheat genetic improvement. Research Policy 31(4): 527-542.
Amstel, H.van, J.W.T. Bottema, M. Sidik & C. van Santen, 1996. Integrating seed systems for annual food crops. Proceedings of a workshop, held in Malang, Indonesia, 24-27 October 1995. Bogor, ESCAP.
Andersen, R., 2003. 'FAO and the management of plant genetic resources'. In: O. Schram Stokke and Ø. B. Thommessen (Eds.), Yearbook of international co-operation on environment and development 2003/2004. London, Earthscan Publications, pp. 43–53.
Andersen, B., 2004. If intellectual property rights' is the answer, what is the question? Revisiting the patent controversies. Econ. Innov. New Techn. 13(5): 417-442.
Andersen, R., 2006. Explaining compliance with intellectual property commitments: the case of agrobiodiversity. 47th Annual Convention of the International Studies Association, San Diego, March 22-25, 2006, 27 p.
Andersen, R., 2007. Governing agrobiodiversity: International regimes, plant genetics and developing countries. PhD thesis Department of Political Science at the Faculty of Social Sciences, Oslo, University of Oslo.
Andresen, Steinar, 2001. Global environmental governance: UN fragmentation and coordination. In. Olav Schram Stokke & B. Oystein (eds.) Yearbook of international co-operation on environment and development 2001/2002. London, Earthscan Publ. pp. 19-26
Anon, 2003. SADC Seed Update 4, April 2003. http://www.sadc-fanr.org.zw/ssn/news/SADCSEEDUpdateN42003.pdf
Anon, 2005. Essential Patent Pool for Aids (EPPA). Background Information January 31, 2005. Washington DC, Essential Innovations, 7p. http://www.essentialinventions.org/docs/eppa/eppa-backgroundinfo.doc
Arts, B., 2004. Non-state actors in global governance; three faces of power. Bonn, Max Planck projectgruppe Recht und Gemeinschaftsgüter. 2003/4, 53 p.
Arts, B. & J. van Tatenhove, 2005. Policy and power. A conceptual framework between the 'old' and 'new' policy idioms. Policy Sciences 37 (3/4): 339 – 356.
Astley, D., N.L. Innes & Q.P van der Meer, 1982. Genetic resources of Allium species. Rome, IBPGR Secretariat, 38 p.
Atkinson, R., R. Beachy, G. Conway, F. Cordova, M.A. Fox, K. Holbrook, D. Klessig, R. McCormick, P. McPherson, H. Rawlings, R. Rapson, L. Vanderhoef, J. Wiley & C. Young, 2003. Public sector collaborations for agricultural IP management. Science. 301: 174-175.
Ayres, I & J. Braithwaite, 1992. Responsive regulation. Transcending the deregulation debate. New York, Oxford University Press.
Bala Ravi, 2005. Seeds of trouble. The Hindu, March 8, 2005.
Bänziger, M. & M. Cooper, 2001. Breeding for low-input conditions and consequences for participatory plant breeding: examples from tropical maize and wheat. Euphytica 122(3): 503-519.
Barrett, C.B & D.G. Maxwell, 2005. Towards a global food aid compact. Food Policy 31 (2): 105 – 118.

Barry, G. & N. Louwaars, 2005. Humanitarian licenses: making proprietary technology work for the poor. In: N. Louwaars (Ed). Genetic Resource Policies and the Generation Challenge Programme. Mexico D.F. Generation Challenge Programme pp 23-34.
Barton, J.H., 2000. Intellectual property rights: reforming the patent system. Science 287:1933-1934.
Bay, A.P.M., 1999. The seed sector in Sub-Saharan Africa: alternative strategies. In: FAO, 1999. Seed policy and programmes for sub-Saharan Africa. Rome, FAO Plant production and Protecton Paper No. 151
Bellon, M.R., 1996. The dynamics of crop infraspecific diversity: a conceptual framework at the farmer level. Economic Botany 50: 26-39
Bertuso, A.R., R. van Treuren, F.A. van Eeuwijk and L. Visser, 2005. Characterisation of red rice (Oryza sativa) varieties developed under on-farm dynamic management on Bohol, Philippines. Plant Genetic Resources Newsletter 142: 68-72.
Birol, E., 2002. Applying environmental valuation methods to support the conservation of agricultural biodiversity. In: M. Smale, I. Már & D.I. Jarvis. The economics of conserving agricultural biodiversity on-farm. Rome, IPGRI, pp. 19-29.
Bishaw, Z., 2004. Wheat and barley seed systems in Ethiopia and Syria. Wageningen, PhD thesis Wageningen University, 383 p.
Blichner, L.C. & A. Molander, 2005. What is juridification? University of Oslo, Centre for European Studies, Arena Working Paper 14/2005, 41 p.
Bobrow, M. & S. Thomas, 2000. Patents in a genetic age. Nature 409: 763-764.
Boef, W.de, K. Amanor, K. Wellard & A. Bebbington (Eds), 1993. Cultivating Knowledge. Genetic diversity, farmer experimentation and crop research. Intermediate Technology Publ.206 p.
Bombin-Bombin, L.M., 1980. Seed legislation. Rome, FAO.
Bommer, D.F.R. 1991. The historical development of international collaboration in plant genetic resources. In: Th.J.L. van Hintum, L. Frese and P.M. Perret (eds.). Crop networks: searching for new concepts for collaborative genetic resources management. Papers of the EUCARPIA/IBPGR symposium held in Wageningen, The Netherlands, 3-6 December 1990. Rome, IBPGR, International Crop Network Series No. 4, pp. 3-12.
Borlaug, N.E., 1968. Wheat breeding and its impact on world hunger. In: K.W. Finlay & K.W. Shepherd (Eds): Proc. 3rd Int. Wheat Genetics Symposium. Canberra, Australian Academy of Science, pp. 1-36.
Brand, U. & C. Gorg, 2003. The state and the regulation of biodiversity: international biopolitics and the case of Mexico. Geoforum, 34(2): 221-233.
Braun, J. von, 2005. The world food situation – an overview. Washington DC,IFPRI. www.ifpri.org/pbs/agmo5/jvb/jvbagm2005.pdf
Brennan, J.P., D. Godden, M. Smale & E. Meng, 1999. Breeder demand for and utilization of genetic resources in Australia. Plant Varieties and Seeds 12(2): 113-127
Brooker, P., 1999. The juridification of alternative dispute resolution. Anglo American Law Review 20: 1-36.
Broothaerts, W., H.J. Mitchell, B. Weir, S. Kaines, L. M. A. Smith, Wei Yang, J.E. Mayer, C. Roa-Rodríguez & R.A. Jefferson, 2005. Gene transfer to plants by diverse species of bacteria. Nature 433: 629-633.
Brown, Lester R., 1970. Seeds of change: the green revolution and development in the 1970s. New York, Praeger.
Brush, 1992. Ethnoecology, biodiversity, and modernization in Andean potato agriculture. Journal of Ethnobiology 12: 161-185.
Brush, S.B., 1996. Valuing genetic resources. J. Environ.Dev. 5: 416-433.
Brush, S.B., 2000. The issues of in situ conservation of crop genetic resources. In: Stephen B. Brush (Ed.), Genes in the field. On-farm conservation of crop diversity. Ottawa, IDRC and Rome, IPGRI. pp 3-28.
leBuanec, B, 2002. The rules for international seed trade. In: Niels P. Louwaars (Ed). Seed Policy, Legislation and Law; widening a narrow focus. Binghamtom NY, Food Products Press, The Haworth Press, pp.143-154.
Buruchara, R.A., L. Sperling, P. Ewell & R.Kirkby, 2002. The role of research institutions in seed-related disaster relief: Seeds of Hope experiences in Rwanda". Disasters 26(4): 288-301.
Butler, L.J., 1996. Plant breeders' rights in the US: Update of a 1983 study. In: J. van Wijk and W. Jaffe (eds), Proceedings of a seminar on the impact of plant breeders' rights in developing countries, held at Santa Fe de Bogota, Colombia, March 7-8. Amsterdam: University of Amsterdam.

Butler, L.J., R.E. Evenson, V. Santaniello & D. Zilberman, 2002. Conflicts in intellectual property rights of genetic resources: implications for agricultural biotechnology. In: R.E. Evenson & V. Santaniello (Eds). Economic and social issues in agricultural biotechnology. Wallingford, CABI Publ., pp. 17-29.
Byerlee, 1996. Modern varieties, productivity and sustainability: Recent experience and emerging challenges. World Development 24: 697-718.
Cabrera Medaglia, J., 2003. A Comparative analysis on the legislation and practices on access to genetic resources and benefit-sharing (ABS): critical aspects for implementation and interpretation. Bonn, IUCN ABS Project. http://www.iucn.org/themes/law/absdocuments/eng_critical_aspects.pdf
Camargo, C.P., C. Bragantini & A Monares,1989. Seed production systems for small farmers : a non-conventional perspective. Cali, CIAT – International Centre for Tropical Agriculture.
de Candolle, A., 1882. Origin of cultivated plants. Reprinted in 1967, Ney York and London: Hafner Publishing Co., 468 p.
Canadian Food Inspection Agency, 2001. 10-Year review of Canada's plant breeders' rights act. Ottawa: Canadian Food Inspection Agency (CFIA).
Carrisoza, S., 2004. Diversity of policies in place and in progress. In: Santiago Carrisoza Santiago Carrizosa, Stephen B. Brush, Brian D. Wright, Patrick E. McGuire (Eds). Accessing Biodiversity and Sharing the Benefits; lessons from implementing the Convention on biological Diversity. Gland & Cambridge, IUCN Environmental Policy and Law Paper No.54. http://www.iucn.org/themes/law/pdfdocuments/EPLP54EN.pdf
Cassaday, K., M. Smale, C. Fowler & P.W. Heisey, 2001. Benefits from giving and receiving genetic resources: the case of wheat. Plant Genetic Resources Newsletter 127: 1-10.
CBD, 1996. Decision II.15 FAO Global System for the Conservation and Utilization of Plant genetic Resources for Food and Agriculture. Montreal, CBD, document UNEP/CBD/COP/2/19 p. 26
Ceccarelli, S, 1989. Wide adaptation: how wide? Euphytica 40: 197-205.
Ceccarelli, S, 1994. Specific adaptation and breeding for marginal conditions. Euphytica 77: 205-219.
Ceccarelli, S, S. Grando & J. Hamblin, 1992. Relationship between barley grain yield measured in low- and high yielding environments. Euphytica 64: 49-58.
Ceccarelli, S., S. Grando, E. Bailey, A. Amri, M. El-Felah, F. Nassif, S. Rezgui & A Yahyaoui, 2001. Farmer participation in barley breeding in Syria, Morocco and Tunisia. Euphytica 122(3): 521-536.
Ceccarelli, S., S. Grando, M. Singh, M. Michael, A. Shikho, M. Al Issa, A. Al Saleh, G. Kaleonjy, S.M. Al Ghanem, A.L. Al Hasan, H. Dalla, S. Basha & T. Basha, 2003. A methodological study on participatory barley breeding II. Response to selection. Euphytica 133(2): 185-200.
CEAS Consultants, with Geoff Tansey and Queen Mary Intellectual Property Research Institute, 2000. Study on the relationship between the Agreement on TRIPS and biodiversity related issues. Final report to DG1 of the European Commission. Wye, Ceas Consultants Ltd.:135p.
CEC, 2005. Policy coherence for development. Communication from the Commission to the Council, the European parliament and the European Economic and Social Committee. Brussels, SEC, 455 p.
Chapman, A.R., 2000. Approaching intellectual property as a human right: Obligations related to Article 15(1)c. UN Economic & Social Council document E/C 12/2000/12.
Chaudhry, M, P. Heisey & M. Ahmad, 1990. Wheat seed production and marketing in the Punjab and NWFP. In: P.Heisey (Ed). Accelerating the transfer of wheat breeding gains to farmers: a study of the dynamics of varietal replacement in Pakistan. Mexico DF, CIMMYT.
Choudry, Aziz, 2005. Corporate conquest global geopolitics. Intellectual property rights and bilateral investment agreements. Seedling, January 2005: 7 -13.
Clawson, D.L., 1985. Harvest security and intraspecific diversity in traditional tropical agriculture. Economic Botany 39: 56-67.
Cohen, W.M., R.R. Nelson & J.P. Walsh, 2000. Protecting their intellectual assets; Appropriability conditions and why US manufacturing firms patent (or not). Cambridge MA, National Bureau of Economic Affairs, Working Paper 7552. www.nber.org/papers/w7552
Commission on Intellectual Property Rights, 2002. Integrating intellectual property rights and development policy. London, DFID, 195p.
Constans, A., 2005. Open source initiative circumvents biotech patents. Researchers develop workaround for Agrobacterium-mediated gene transfer. The Scientist 19(8): 32.
Cooper,H.D., C. Spillane & T. Hodgkin, 2001. Broadening the genetic base of crop production. Wallingford, UK. CABI and Rome, FAO/IPGRI. 452 p.

Correa, C., in press. Do national access regimes promote the use of genetic resources and benefit sharing? Int. J. Environment and Sustainable Development.
Correa, C.M. & S.F. Musungu, 2002. The WIPO patent agenda: the risks for developing countries. South Centre, T.R.A.D.E. Working Paper 12, 30 p.
Cromwell, 1996. Governments, farmers and seeds. Wallingford, CAB International.
Cromwell, E., S. Wiggins & S. Wentzel, 1993. Sowing beyond the state: NGOs and seed supply in developing countries. London, ODI.
David, P.A., 2004. Can 'open science' be protected from the evolving regime of IPR protections? Journal of Institutional and Theoretical Economics 160(1): 9-34.
David, S., L.Mukandala & J. Mafure, 2002. Seed availability,an ignored factor in crop varietal adoption studies: a case study of beans in Tanzania. J.of Sustainable Agric. 21(2): 5-20
Davis, K.E. & M.J. Trebilcock, 2001. Legal reforms and development. Third World Quarterly 22(1): 21 -36
Davis, L. 2004. Intellectual property rights, strategy and policy. Econ. Innov. New Technol. 13(5): 399 – 415.
Day-Rubinstein, K. & M. Smale, 2004. International exchange of genetic resources, the roleof information and implications for ownership: the case of the U.S. National Plant germplasm System. EPTD Discussion paper no. 119. Washington DC, IFPRI.
Day-Rubinstein K., P. Heisey, R. Shoemaker, J. Sullivan & G. Frisvold, 2005. Crop genetic resources: an economic appraisal. Washington DC. Economic Research Service, USDA. Economic Information Bulletin No.2, 41 p.
Delmer, D.P., C.Nottenburg, G.D.Graff & A.B. Bennett, 2003. Intellectual property resources for international development in agriulture. Plant Physiol. 133: 1666-1670.
DFID, 2005. Growth and poverty reduction: the role of agriculture. A DFID policy paper. London, Department for International Development. 53 p.
Dickson, M. H., 1980. Genetic aspects of seed quality. Hortic Sci 15: 771-774.
Diez, M.C.F., 2002. The impact of plant breeders' rights on research. The case of Spain. Food Policy 27: 399-415.
Dhar, B., 2000. Options under TRIPS, a discussion paper. Geneva, Quaker United Nations Office, p 9.
Dhillon, B.S., Pratibha Brahmi & S. Saxena, 2006. Crop improvement programmes in India – emerging scenarios. Current Science 90(6) : 780 – 783.
Diekmann, M., 1993. Seed-borne diseases in seed production. Aleppo, Syria, International Center for Agricultural Research in the Dry Areas, 81 p.
Douglas, J., 1980.Successful seed programs: a planning and management guide. Boulder, Co., Westview Press, 302 p.
Dominguez, C., D. Rohrback, K. Longley, S. Momade & R. Jones, 2001. Organising seed fairs in emergency situations; improving the efficiency in seed distribution. Patancheru, India, ICRISAT, 60p.
Drahos, P. & M. Blakeney, 2001. IP in biodiversity and agriculture. London, Sweet & Maxwell
Drucker, A., M. Smale & P. Zambrano, 2005. Valuation and sustainable management of crop and livestock biodiversity: a review of applied economics literature. Rome, Systemwide Genetic Resources Programme with IFPRI and IPGRI, 70 p.
Duraiappah A.K., & P. Roddy, 2005. Integrating the environment into the poverty reduction strategy papers. Winnipeg, IISD, 19 p.
Dutfield, G., 2003. Intellectual property rights and the life science industries: a 20th century history. Aldershot, Ashgate Publ. 247 p.
Dyer, G., 2006. Crop valuation and farmer response to change: implications for in situ conservation of maize in Mexico. In: M. Smale (Ed.), Valuing crop biodiversity; on-farm genetic resources and economic change. Wallingford. CABI, pp. 17-31.
Eaton, D.J.F., 2002. TRIPS and plant varietal protection: economic analysis and policy choices. Report no. 7.02.01. The Hague: Agricultural Economics Research Institute (LEI).
Ebersole, Ted.J., M. C. Guthrie & J.A. Goldstein, 2005. Patent pools and standard setting in diagnostic genetic. Nature Biotechnology 23: 937 – 938.
Echeverría, R., 1990. Public and private investments in maize research in Mexico and Guatemala. Mexico DF, CIMMYT, 39p.
Eeuwijk, F.A.van, M. Cooper, I.H. DeLacey, S. Ceccarelli & S. Grando, 2001. Some vocabulary and grammar for the analysis of multi-environment trials, as applied to the analysis of FPB and PPB trials. Euphytica 122(3): 477-490.

Eisenberg, R. 1996. Patenting research tools in the law. National Research Council. Intellectual property rights and research tools in molecular biology; Summary of a workshop held at the National Academy of Sciences, February 15-16, 1996. Chapter 2. http://books.nap.edu/html/property/2.html
El-Said, M., 2005. The road from TRIPS-Minus to TRIPS, to TRIPS-Plus; implications of IPRs for the Arab world. The Journal of World Intellectual Property 8(1): 53-56.
Engels, J. & B. Visser, 2000. Strategies and methodologies in genetic diversity conservation. In: Conny Almekinders & Walter de Boef (Eds), Encouraging Diversity – the conservation and development of plant genetic resources. IT Publications pp 26-31.
Engels, J.M.M. & L. Visser, 2003. A guide to effective management of germplasm collections. IPGRI Handbooks for Genebanks No. 6. Rome, IPGRI, 165 p.
Escobar, A, 1995. Encountering development: the making and unmaking of the third world. Princeton, Princeton Univ. Press, 320 p.
Esquinas-Alcazar, J.T. & P.J. Gulick, 1983. Genetic resources of cucurbitaceae. Rome, IBPGR Secretariat, 101 p.
Esquinas-Alcázar, J., 2005. Protecting crop genetic diversity for food security: political, ethical and technical challenges. Nature Reviews Genetics 6: 945-953.
Evenson, R.E., P.E. Waggoner and V.W. Ruttan (1979). Economic benefits from research: An example from agriculture. *Science* 205:1101-1107.
Evjen, G., 2003. A Nordic approach to access and rights to genetic resources. Report to the Nordic Genetic Resources Council, 95 p. http://www.norden.org/jord_skog/sk/Nordic-approach.pdf
Farrell, A.E., R. J. Plevin, B. T. Turner, A. D. Jones, M. O'Hare & D. M. Kammen, 2006. Ethanol can contribute to energy and environmental goals. Science 311: 506 – 508.
FAO, 1993) Quality Declared Seed. Technical guidelines for standards and procedures. Rome, FAO.
FAO, 1995. The international network of ex situ collections, and the centres of the CGIAR. Joint report by FAO and the International Plant genetic Resources Institute (on behalf of the CGIAR) on the implementation of the agreement between the FAO and the CGIAR-Centres on 26 October 1994. Rome, Commission on Genetic Resources document CPGR/6/95/12 ADD.1, 7p.
FAO, 1996. The Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture, and the Leipzig Declaration. Rome, FAO, 63 p.
FAO, 1998. International workshop on developing institutional agreements and capacity to assist farmers in disaster situations to restore agricultural systems and seed security activities. Rome (Italy). 3-5 Nov 1998.Rome, FAO. Plant Production and Protection Paper (FAO). no. 150.
FAO, 1999. Seed policy and programmes for sub-Saharan Africa. Rome, FAO Plant production and Protecton Paper No. 151.
FAO, 2000a. Seed policy and programmes in the Near East and North Africa. Rome, FAO Plant production and Protecton Paper No 159.
FAO, 2000b. Seed policy and programmes for asia and the pacific. Rome, FAO Plant production and Protection Paper No. 160.
FAO, 2001a. Seed policy and programmes in Latin America and the Caribbean. Rome, FAO Plant production and Protection Paper No 164.
FAO, 2001b. Seed policy and programmes for the Central and Eastern European countries, Commonwealth of Independent States and other countries in transition. Rome, FAO Plant production and Protection Paper No. 168.
Feistritzer, W.P., 1975. FAO's Seed Industry Development Programme (SIDP). In: W.P. Feistritzer & H. Redl (Eds.), The role of seed science and technology in agricultural development. Proceedings of an International Seed Symposium (Vienna, 1-6 October, 1973). Rome, FAO, pp. 353-357.
Feistritzer, W.P., 1984. The FAO Seed Improvement and Development Programme (SIDP). Seed Science and Technology 12 (1): 31-34.
Fenwick-Kelly, R. 1989. Seed planning and policy foragricultural production. London, Belhaven Press.
Flores Palacios, Ximena, 1997. Contribution to the estimation of countries' interdependence in the area of plant genetic resources. FAO Commission on Genetic Resources for Food and Agriculture, Background Study Paper No. 7.
Fowler, C. 2001. Protecting farmer innovation: the Convention on Biological Diversity and the question of origin. Jurimetrics: The Journal of Law, Science and Technology 41: 477-488.

Fowler, C. & P. Mooney, 1990. Shattering: Food policies and the loss of genetic diversity. Tucson, Univ.Arizona Press. 278 p.
Fowler, C., M. Smale & S. Gaiji, 2001. Unequal exchange? Recent transfers of agricultural resources. Development Policy Review 19(2): 181-204.
Fowler, C., M. Smale & S. Gaiji, 2003. What is a genebank worth? The demand for crop genetic resources from international collections. Washington DC. IFPRI (with IPGRI & SGRP) Research at a Glance, brief 12.
Fowler, C. & T. Hodgekin, 2004. Plant genetic resources for food and agriculture: assessing global availability. Annu.Rev.Environ.Resource 29: 143-179
Freeman, H.A., P.J.A. van der Merwe, P. Subrahmanyam, A.J. Chiyembekaza & W. Kagunongo, 2002. Assessing adoption potential of new groundnut varieties in Malawi. Exp. Agric. 38: 211-221.
Fresco, L.O., 2004. Policy coherence for agriculture and development. Rome, FAO, Agenda 21 spotlight http://www.fao.org/AG/magazine/0406sp.htm.
Gaasbeek, A. F. van, Heijbroek, A. M.A, Vaandrager, P., Broers, G.J (1994), The world seed markets: development and strategy. LEI-DLO, Rabobank Nederland, Ministry of Agriculture, Nature and Fisheries, The Hague, 53 p.
Gastel, A.J.G. van, B.R. Gregg & E.A. Asiedu, 2002. Seed quality control in developing countries. Journal of New Seeds. 4(1/2): 117-130.
Garforth, K., I López Noriega, J. Cabrera Medaglia, K. Nnadozie & G. Nemogá, 2005. Regional implementation of access to genetic resources and benefit sharing measures. Montreal, Centre for International Sustainable Development Law, 100 p.
Gastel, Tony J.G., Bill R. Gregg & E.A. Asiedu, 2002. Seed quality control in developing countries. J.of New Seeds 4(1/2):117-130.
George, R.A.T., 1995. Vegetable seed production, London, Longman.
Gepts, P., 2004. Who owns biodiversity and how should owners be compensated. Plant Physiol. 134: 1295-1307.
Gerhardsen, T., 2007. WIPO Development Agenda meeting snags on norm-setting. Intellectual Property Watch, 14 June 2007. www.ip-watch.org/
Giddens, A., 1984. The constitution of society. Outline of the theory of structuralism. Cambridge, Polity Press.
Gisselquist, D. & C. van der Meer, 2001. Regulations for seed and fertilizer markets, a good practices guide for policy makers. Washington DC., World Bank, Rural Development Working Paper, 55 p.
Gollin, M., 1998. Valuing farmers'rights. In: R.E. Evenson, D. Gollin & V. Santaniello (Eds.). Agricultural values of plant genetic resources. Wallingford, CABI, pp 133-145.
Gonzales, Tirso, 1996. Political Ecology of Peasantry, the Seed,a nd non-Governmnetal Organisations in Latin America. Doctoral dissertation, Department of Sociology, University of Wisconsin, Madison, 517 p.
Gonzales, T.A., 1999. The Cultures of the seed in the peruvian andes. In: S.B. Brush (Ed). Genes in the field; on-farm conservation of crop diversity. Rome, IPGRI, Boca Raton, Lewis Publishers, and Ottawa, IDRC, pp 193-216.
Graham, R. D., R. M. Welch & H.E. Bouis, 2001. Addressing micronutrient malnutrition through enhancing the nutritional quality of staple foods: principles, perspectives and knowledge gaps. Adv Agron 70: 77-142.
GRAIN, 2000. AU Model Law on Rights of Local Communities, Farmers, Breeders and Access. http://www.grain.org/brl/?docid=798&lawid=2132
GRAIN, 2004. Bilateral agreements imposing TRIPS-plus intellectual property rights on biodiversity in developing countries. http://www.grain.org/rights/TRIPSplus.cfm?id=68
GRAIN, 2005. Africa's seed laws: red carpet for the corposations. Seedling, July 2005: 28-35.
Green, T., 1987. Farmer-to-farmer seed exchange in the eastern hills of Nepal: the case of Pokhreli Masino Rice. Working Paper No. 5/87. Dhankuta, Nepal: Pakhribas Agricultural Centre.
Gregg, B.R. & A.J.G. van Gastel, 1997. Managing seed marketing. Ibadan, IITA / GTZ / CRI – WASDU Publication no.128 p.
Gwinner, J., R.Harnisch & O.Mueck, 1991. Manuel sur la manutention et la conservation des graines après récolte. Eschborn, GTZ.
Hajer, M., 2003. A frame in the fields: policy making and the reinvention of politics. In: M.Hajer & H. Wagenaar, (Eds). Deliberate Policy Analysis; understanding governance in the network society. Cambridge, Cambridge Univ. Press, pp 88-207.

Hajer, M. & H. Wagenaar, (Eds). Deliberate policy analysis; understanding governance in the network society. Cambridge, Cambridge Univ. Press. 296 p.
Hanson, S., A. Brewster & J. Asher, 2005. Intellectual property and the AAAS scientific community: a descriptive analysis of the results of a pilot survey on the effects of patenting on science. , Washington DC. AAAS, Directorate for Science and Policy Programs.
Hardin, G., 1968. The tragedy of the commons. Science 162:1243-1248.
Hardon, J, 1995. Participatory plant breeding. The outcome of a workshop sponsored by IDRC, IPGRI, FAO and CGN at Wageningen, the Netherlands on 26-29 July, 1995. Rome, IPGRI , Issues in genetic Resources 3, 15p.
Hardon, J., 2004. Patents beyond control; biotechnology, farmer seed systems and intellectual property rights. AgroSpecial 2, Wageningen, Agromisa, 80 p.
Hardon, J.J. & W.S. de Boef, 1993. Linking farmers and plant breeders in local crop development. In: Walter de Boef, Kojo Amanor, Kate Wellard and Anthony Bebbington, 1993. Cultivating knowledge. London, IT Publications, pp: 64-71.
Harlan, J.R., 1992. Crops and man, 2nd ed. Madison, American Soc. Of Agronomy, 284 p.
Harlan, H.V. & M.L. Martini, 1936. Problems and results in barley breeding. In. Washington, DC, USDA, Yearbook of Agriculture, 1936.
Harlan, J.R. & J.M.J. de Wet, 1971. Towards a rational classification of cultivated plants. Taxon 20: 509-801.
Harris, D.R. & G.C Hillman (eds.), 1989. Foraging and farming: the evolution of plant exploration. London,Unwin-Hyman.
Hawkes, J.G., N. Maxted & B.V. Ford-Lloyd, 2000. The ex situ conservation of plant genetic resources. Dordrecht, Kluwer, 250 p.
Healey, P., C. de Magalhaes, A Madanipour & J. Pendlebury, 2003. Place, identity and local politics: analysing partnership initiatives. In: Hajer, M. & H. Wagenaar, (Eds). Deliberate policy analysis; understanding governance in the network society. Cambridge, Cambridge Univ. Press.
Heineke, C. & F. Wolff, 2004. Access to genetic resources and sharing of benefits. ELNI Reviews 2/2004, 26 p.
Heisey, P.W. & J.P. Brennan, 1991. An analytical model of farmers' demand for replacement seed. Amer.J. of Agric. Econ. 73(4): 1044-1052.
Heller, M., & R. Eisenberg, 1998. Can patents deter innovation? The anticommons in biomedical research. Science 280: 698-701.
Helfer, L., 2004. Intellectual property rights in plant varieties; International legal regimes and policy options for national governments. Rome FAO, FAO Legislative Study 85.
Hermann, M., G. Moore & M. Halewood, 2006. International policies dealing with biodiversity and their impact on achieving the millennium development goals. In: S. Bala Ravi, I. Hoeschle-Zeledon, M.S. Swaminathan & E. Frison (Eds). Hunger and poverty: the role of biodiversity. Report of an international consultation on the role of biodiversity in achieving the UN-Millennium Development Goal of freedom from hunger and poverty. Chennai, M.S.Swaminathan Research Foundation and Rome, IPGRI and GFU, pp. 163-178.
Herrera, S. 2005. Profile: Richard Jefferson. Nature Biotechnology 23, 643.
Hesser, Leon, 2006. The man who fed the world: Nobel prize laureate Norman Borlaug and his battle to end hunger. Dallas, Durban House.
Hildebrand, P., 1984. Modified stability analysis of farmer managed, on-farm trials. Agronomy Journal 76: 271-274.
Howard, P., 2003a. The major importance of 'minor' resources; women and plant biodiversity. Gatekeeper Series no. 112 London, IIED, 22 p.
Howard, P., 2003b. Women and the plant world – an exploration: In. P. Howard (ed.) Women and plants; gender relations in biodiversity management and conservation. London & New York, Zed Press & Pelgrave-Macmillan, pp 1-48.
Huamán, Z. & P. Schmiedliche, 1991. The importance of ex situ conservation of germplasm: a case study. Diversity 7: 68-69
Huda, Md.Nazmul & Hans W.J. Smolders, 2002. Seed regulatory frameworks in a small farmer environment: the case of Bangladesh. In: Niels P. Louwaars (Ed.). Seed policy, legislation and law – widening a narrow focus. Binghamton, Food Products Press, pp. 165-176.
IAASTD (in press). International Assessment of Agricultural Science and Technology for Development. Washington DC, World Bank. www.agassessment.org
IDRC, 1994. People, plants and patents – the impact of intellectual property on trade, plant biodiversity and rural society. Ottawa, The Crucible Group, 140 p.

IDRC, 2000a. Seeding solutions vol 1 Policy options for genetic resources – The Crucible II Group. Ottawa, IDRC, Rome, IPRGI, and Oslo, DHF, 120 p.
IDRC, 2000b. Seeding solutions vol 2 Options for national laws covering access to and control over genetic resources – The Crucible II Group. Ottawa, IDRC; Rome, IPRGI, and Oslo, DHF, 300 p.
InterAcademy Council, 2004. Realizing the promise and potential of African agriculture; Science and technology strategies for improving agricultural productivity and food security in Africa. Amsterdam, InterAcademy Council, 266 p.
Ishizawa, J., 2004. Cosmovisions and environmental governance: the case of in situ conservation of native cultivated plants and their wild relatives in Peru. In: Bridging Scales and Epistemiologies; linking local knowledge with global science in multi-scale assessments. Conference at the Bibliotheca Alexandrina, March 17-20, 2004.
ISF, 2004. Protection of intellectual property and access to plant genetic resources. Proceedings of an international seminar, Berlin, 27-28 May, 2004, Nyon, International Seed Federation.
ISTA, 2005. International rules for seed testing. Zurich, Switzerland, International Seed Testing Association. http://www.seedtest.org/en/content---1--1083.html
Jaffé, W. & J. Srivastava, 1994. The roles of the private and public sectors in enhancing the performance of seed systems. The World Bank Research Observer 9: 97-117.
Janssen, W., C.A.Luno & M.C. Duque, 1992. Small-farmer behaviour towards bean seed; evidence from Colombia. J.Appl.Seed Prod. 10:43-51.
Jiggins, J. & H. de Zeeuw, 1992. Participatory technology development in practice: process and methods. In: Coen Reijntjes, Ann Waters-Beyer & Bertus Haverkort (Eds.) Farming for the future. London, MacMillan, pp. 135-162.
Jones, P.S., 2003. When “development” devastates: donor discourses, access to HIV/AIDS treatment in Africa and rethinking the landscape of development. Oslo, Norwegian Centre for Human Rights, Research Note 01/2003.
Justice, O.L. & L.N. Bass, 1979. Principles and practices of seed storage. Castle House Publ. 289 p.
Kalton, R.R., P.A. Richardson and N.M. Frey (1989). Inputs in private sector plant breeding and biotechnology research programs in the United States. Diversity 5(4): 22-25.
Keystone Centre. 1991. Final consensus report: Global initiative for the security and sustainable use of plant genetic resources. Third Plenary Session, 31 May to 4 June 1991. Oslo, Norway: Keystone International Dialogue Series on Plant Genetic Resources.
Kiewiet, B., 2001. Modern plant breeding and intellectual property rights. Colloquium in Einbeck, Germany, January 26th, 2001.
Kintisch, E., 2005. Intellectual property: court tightens patent rules on gene tags. Science 309: 1797-1799.
Klein, E.H.J.M. de, G.J. Boers & A.M.A. Heybroek, 1992. Visie op de internationale concurrentiekracht in het uitgangsmateriaal. Utrecht: Rabobank.
Kline, S. and N. Rosenberg (1986). An overview of innovation. In: R. Landau and N. Rosenberg (Eds.). The positive sum strategy; harnessing technology for economic growth. Washington DC, National Academic Press, pp 275-306.
Kloppenburg, J.R., 1988. First the seed: the political economy of plant biotechnology, 1492 – 2000. Cambridge, Cambridge University Press.
Kloppenburg, J. Jr. & D.L. Kleinman, 1987. Analyzing empirically the distribution of the world’s plant genetic resources: the plant germplasm controversy. Bioscience 37(3): 190-198.
Kone, S., 1993. Traditional storage of farm products. ILEIA Newsletter 9(3): 12-13.
Koornneef, M. & J.H. van der Veen, 1980. Industion and analysis of Gibberellin sensitive mutants in Arabidopsis thaliana (L.) heynh. TAG 58(6): 257-263.
Kozlowski, T.T.(Ed), 1972. Seed Biology (3 volumes). New York, Academic Press.
Krattiger, A., 2004. Editor’s introduction: PVP and agricultural productivity. IP-Strategy Today no.9
Kremer, M. & A. P. Zwane 2005. Encouraging private sector research for a tropical agriculture. World Development 33(1): 87-105.
Kryder, R., Kowalski, S. & Krattinger, A., 2000. The intellectual and technical property components of pro-vitamin A rice (Golden Rice): A preliminary freedom-to-operate review. Ithaca, NY, International Service for the Acquisition of Agri-biotech Application. ISAAA Briefs No. 20, 56 p.
Kugbei, S., & Z. Bishaw, 2002. Policy measures for stimulating indigenous seed enterprises. In: N.P. Louwaars (Ed). Seed policy, legislation and law. Binghamtom NY, Food Products Press, The Haworth Press. pp. 47 – 64.

Kugbei, S., M. Turner & P. Witthaut, 2000. Finance and management of small scale seed enterprises. Aleppo, ICARDA, 191 p.
Kugbei, S., M. Turner & Z. Bishaw, 2001. African seed sector challenges: building seed systems for greater food security through partnerships. ICARDA-Caravan. 15: 18-20.
Kuyek, D., 2000. ISAAA in Asia, promoting corporate profits in the name of the poor. GRAIN Briefing www.grain.org/briefings/?id=137
Landes, W.M. & R.A. Posner, 2004. The political economy of intellectual property law. Washington DC, AEI Press, 35 p.
Lanjouw, J.O., 2003. Intellectual property and the availability of pharmaceuticals in poor countries. In :A.B. Jaffe, J. Lerner & S. Stern (Eds.), Innovation Policy and the Economy: Volume 3 (NBER Innovation Policy and the Economy series). Cambridge, MIT Press. Chapter 4.
Latorre, F., 2005 Review of the experience of implementation by UK of access and benefit sharing arrangements under the Convention on Biological Diversity. London, Department for Environment, Food and Rural Affairs – National Focal Point for Access to Genetic Resources and Benefit Sharing. 80p. http://www.defra.gov.uk/science/geneticresources
Lapeña, I. & M. Ruiz Müller, 2004. Accesso a recursos genéticos, propuestas e instrumentos jurídicos. San Isidoro, Peru, SPDA. (in Garforth *et al.*, 2005).
Lemonius, M., 2003. Proceedings SADC Technical Meeting to formulate a regional crop variety release system. SADC Seed Security Network, Gaborone, Botswana, April 7-9, 2003, p.5.
Leskien, D. & M. Flitner, 1997. Intellectual property rights and plant genetic resources. Options for shaping a sui generis system. Rome, IPGRI, Issues in Genetic resources No. 6.
Lesser, W.H., 1997a. The Role of Intellectual property rights in biotechnology transfer under the Convention on Biological Diversity. ISAAA Briefs No.3, ISAAA, Ithaca NY.
Lesser, W.H., 1997b. Assessing the implications of intellectual property rights on plant and animal agriculture. American Journal of Agricultural Economics 79: 1584-1591.
Lesser, W., 2002. The effects of Intellectual property rights on foreign direct investments and imports into developing countries in the post TRIPS era. IP Strategy Today no.5-2002.
Lipton, M. & R. Longhurst, 1985.Modern varieties, international agricultural research, and the poor. CGIAR Study Paper No.2. Washington DC, Consultative Group on International Agricultural Research, 139 p.
Lipton, M. & R. Longhurst, 1989. New seeds and poor people. London, Unwin Hyman, 473 p.
Louette D., A. Charrier, J. Berthaud, 1997. In situ conservation of maize in Mexico: genetic diversity and maize seed management in a traditional community. Economic Bot 51: 20-38.
Louwaars, N.P. 1990. Commercial and developmental aspects of seed production. Kampala, proceedings, international conference on agricultural research, Kampala, December, 1990.
Louwaars, N.P. 1994a. Connecting formal and local seed systems in development: integrated seed supply systems. In: P. Stolp (Ed.), Organisation and Management of National Seed Programmes", ICARDA, Aleppo, Syria, DSE Feldafing, Germany. pp. 10-17.
Louwaars, N.P., 1994b. Integrated seed supply: institutional linkages in relation to system efficiency, biodiversity and gender. In: S. David (Ed.). Alternative approaches to bean seed production and distribution in Eastern and Southern Africa: Proceedings of a working group meeting, Kampala, Uganda, 10-13 October 1994. Network on Bean Research in Africa. Workshop Series No. 32, CIAT, Kampala, Uganda.
Louwaars, N.P., 1997. Regulatory aspects of breeding for field resistance in crops. Biotechnology and Development Monitor 33, 6-8.
Louwaars, N.P., 2001 Regulatory aspects of breeding for diversity. In: H.D. Cooper, C. Spillane & T. Hodgekin. Broadening the genetic base of crop production. Wallingford, CABI Publishing and Rome, FAO and IPGRI, pp 105 – 114.
Louwaars, N.P., 2002. Variety controls. Journal of New Seeds 4 (1/2): 131-142.
Louwaars, N., 2006. Controls over genetic resources – a double edged sword. Nature Reviews Genetics 7: 241 (April 2006).
Louwaars, N., 2007. Tailoring Rights Regimes in Biotechnology: Introducing DRIPS next to TRIPS. Tailoring Biotechnologies 3(2)
Louwaars, N.P. & G.A.M. van Marrewijk, 1996. Seed Supply Systems in Developing Countries. Wageningen, CTA, 135 p.
Louwaars, N. & M. Minderhoud, 2002. Quand une loi ne suffit plus: la réalité des brevets sur les biotechnologies. Inf'OGM No. 26.
Louwaars, N.P. & R. Tripp, 1999. Regulatory aspects of seed security. In: Restoring farmers' seed systems in disaster situations. Proceedings of a workshop in Rome, Italy, 3-5 November 1998. Rome, FAO, FAO Plant Production and Protection Paper 150:157-170.

Louwaars, N. & B. Visser, 2004. Inter-regional conference on international agreements. Rome, IPGRI Newsletter for Europe. http://www.ipgri.cgiar.org/cmd/Europereadnews.asp?IDNews=347
Louwaars, N.P. & B. Visser, 2006. Marketing biodiversity and benefit-sharing; a product development perspective. In: S. Bala Ravi, I. Hoeschle-Zeledon, M.S. Swaminathan & E. Frison (Eds.). Hunger and poverty: the role of biodiversity. Report of an international consultation on the role of biodiversity in achieving the UN-Millennium Development Goal of freedom from hunger and poverty. Chennai, M.S.Swaminathan Research Foundation and Rome, IPGRI and GFU, pp. 163-178.
Louwaars, N.P., R. Tripp, D. Eaton, V. Henson-Apollonio, R. Hu, M. Mendoza, F. Muhhuku, S. Pal & J. Wekundah, 2005. Impacts of strengthened intellectual property rights regimes on the plant breeding industry in developing countries. A synthesis of five case studies. Wageningen, Centre for Genetic Resources The Netherlands, 176 p. http://documents.plant.wur.nl/cgn/literature/reports/IPR%20in%20breeding%20industry.pdf
Louwaars, N., R. Tripp & D. Eaton, 2006. Public research in plant breeding and intellectual property rights: a call for new institutional policies. Washington, The World Bank. Agricultural & Rural Development Notes issue 13, June 2006, 4 p. http://siteresources.worldbank.org/INTARD/Resources/Note13_IPR_PublicResrch.pdf
Louwaars, Niels P., Eva Thörn, José Esquinas-Alcazar, Shumin Wang, Abebe Demissie & Clive Stannard, 2006. Access to plant genetic resources for genomic research for the poor: from global policies to target-oriented rules. Plant Genetic Resources 4(1): 54 – 63.
Ludwig, S.P. & J.C.Chumney, 2003. No room for experiment; the federal circuit's narrow construction of the experimental use defence. Nature Biotechnology 21: 453.
Maredia, M., J. Howard & D. Boughton, with A. Naseem, M. Manzala & K. Kajisa, 1999. Increasing seed system efficiency in Africa: concepts, strategies and issues. MSU International Development Working Paper No. 77. East Lansing, Michigan State University, Department of Agricultural Economics, 46 p.
Maskus, K. E., 2000. Intellectual property right in the global economy. Washington DC. Institute for International Economics. 286 p.
Masters, W.A., 2003. "Research prizes: A mechanism to reward agricultural innovation in low-income regions" AgBioForum 6(1&2): 71-74.
Mathur S.B. & Johs. Jorgensen (Eds.), 1988. Seed pathology. Wageningen, CTA, 412 p.
Matthews, A. & T. Giblin, 2006. Policy coherence, agriculture and development. IIIS Discussion Paper no. 112. Dublin, IIIS, 17 p.
Mauriya, D.M., 1989. The innovative approach of Indian farmers. In: R. Chambers, A Pacey & L.A. Thrupp (Eds). Farmer first: farmer innovation and agricultural research. London, IT Publications, pp. 9-13.
Maxted, N., B.V. Ford-Lloyd & J.G. Hawkes (Eds.) 1997. Plant genetic conservation: the in situ approach. London - NY. Chapman & Hall. 446 p.
McAdam, D., J.D. McCarthy & M.N. Zald, 1996. Comparative perspectives on social movements: political opportunities, mobilizing structures and cultural framings. Cambridge, Cambridge University Press.
McCalman, P., 2002. The Doha Agenda and intellectual property rights. ADB, Manilla. 35 p.
McGuire, S., G. Manicad & L. Sperling, 2003. Technical and institutional issues in participatory plant breeding – done from a perspective of a farmer plant breeding. PPB Monograph no.2. Cali, Colombia, CIAT PRGA Program. 109 p.
Mc.Mullen, N., 1987. Seeds and world agricultural progress. Washington DC, National Planning Association, 263 p.
Meer, C. van der, 2002. Challenges and limitations of the market. In: Niels P. Louwaars (Ed). Seed policy, legislation and law; widening a narrow focus. Binghamtom NY, Food Products Press, The Haworth Press, pp. 65-75.
Merrick, L. 1989. Crop genetic diversity and its conservation in traditional agroecosystems. In: M.A. Altieri & S.B. Hecht (Eds), Agroecology and small farm development, pp. 3-11. Boca Raton, CRC Press.
Mooney, P.R., 1979. Seeds of the earth; a public or private resource? Ottawa, Mutual Press.
Moschini, G.C., 2004. Research exemption and the economic incentive to Innovate. http://www.ipagcon.uiuc.edu/moschini.html
Mueller Warrant, G.W., L.R. Schweitzer & R.L. Cook, 2003. Monitoring trends in weeds of grass seed crops using GIS tools. MAP #736. ESRI users conference. July 25-30, 2003.
Murray, D.R. (Ed),1984a,b. Seed physiology (Vols 1 and 2). Sydney, Academic Press..

Murray, D.R., 2003. Seeds of concern: the genetic manipulation of plants. Wallingford, CABI, 156 p.
National Academy of Sciences, 1993. Managing global genetic resources. Agricultural crop issues and policies. Washington DC, National Academy Press.
National Research Council, 1997. Intellectual property rights and plant biotechnology. proceedings of a forum held at the National Academy of Sciences. Washington, DC.
Nature, 2004. "Open-source biology." Nature 431(September 30): 491.
Neergaard, P., 1977. Seed pathology (Vols 1 and 2). London, MacMillan.
Nelson, R.D & R. Mazzoleni, 1997. Economic theories about the costs and benefits of patents. In: commission on life sciences, 1997. Intellectual property rights and research tools in molecular biology: Summary of a Workshop Held at the National Academy of Sciences, February 15-16, 1996, p. 17-27.
Nottenburg, C., P.G. Pardey & B.D. Wright, 2002. Accessing other people's technology for non-profit research. Australian Journal of Agricultural and Resource Economics 48(3): 389-416.
OECD, 2000. OECD seed schemes for the varietal certification or the control of seed moving in the international trade. Paris, OECD.
OECD, 2005a. The OECD seed schemes for the varietal certification or the control of seed moving in international trade. Paris, OECD. http://www.oecd.org/dataoecd/40/50/15284225.PDF
OECD, 2005b. Making poverty reduction work: OECDs role in development partmership. Paris, OECD SG(2005)/Rev3.
Opole, M. 1993. Revalidating women's knowledge and indigenous vegetables: implications for policy. In: W. de Boef, K. Amanor, K. Wellard & A. Bebbington (Eds), 1993. Cultivating knowledge. Genetic diversity, farmer experimentation and crop research. Intermediate Technology Publ.: 157-164.
Osman, Aad & Edith Lammerts and Bueren, 2003. A participatory approach to design and implementing 'Value for Cultivation and Use' research. In: E.T. Lammerts van Bueren & K-P. Wilbois. Organic seed Production and Plant Breeding – strategies, problems and perspectives. Driebergen & Frankfurt, European Consortium of Organic Plant Breeding pp 46-49.
Ostergard, R.L.Jr., 1999. Intellectual property: A universal human right? Human Rights Quarterly 21: 157.
Ostrom, E., 1990. Governing the commons: the evolution of institutions for collective action. New York, Cambridge Univ. Press.
Penna, A.L.D.R., 1994. An Analysis of the impact of plant breeders' rights legislation on the introduction of new varieties in UK horticulture. PhD dissertation. Wye College, U.K.
Perales, H.R., B.F. Benz & S.B. Brush, 2005. Maize diversity and ethnolinguistic diversity in Chiapas, Mexico. Proceedings of the Nat. Acad. of Sciences of the USA 102, #3, p. 949-954.
Petit, M., C. Fowler, W.Collins, C.Correa,& C-G. Thornström, 2001. Why governments can't make policy; the case of plant genetic resources in the international arena. International Potato Centre (CIP), Lima, Peru. 80p.
Pierre, J., 2000 (Ed). Debating vovernance. Oxford. Oxford Univ. press.
PIPRA, 2005. PIPRA's evaluation of the BIOS license. PIPRA (Newsletter) summer 2006. p3.
Pistorius, R., & J. van Wijk, 1999. The exploitation of plant genetic information. Political strategies in crop development. Amsterdam, Print Partners Ipskamp.
Ploeg, J.D. van der, 1990. Labor, markets and agricultural production. Boulder, Westview Press.
Plucknett, D.L., N.J.H. Smith, J.T. Williams & N.M. Anishetty, 1987. Genebanks and the worlds food. Princeton, Princeton Univ.Press 147 pp.
Pray, C. & B. Ramaswami, 1991. A framework for seed policy analysis in developing countries. Washington, IFPRI.
Quiros, C.F., R. Ortega, L. van Raamsdonk, M. Herrera-Montoya, P. Cisneros, E. Schmidt & S.B. Brush, 1992. Increase of potato genetic resources in their centre of diversity: the role of natural outcrossing and selection by the Andean farmer. Genetic Resources and Crop Evolution, 39: 107-113.
Ramamoorty, K., K. Sivasubramaniam & A. Kannan, 2006. Seed legislation in India. Jodhpur, Agrobios., 344 p.
Reijntjes, C., B. Haverkort & A. Waters-Bayer, 1992. Farming for the future. An introduction to low-external-input and sustainable agriculture. London, MacMillan Press.
Reitzig, M., 2004. The Private values of 'Thickets' and 'Fences': towards an updated picture of the use of patents across industries. Econ. Innov. New Techn. 13(5): 457 – 476.
Resnik, D.B., 2003. A biotechnology patent pool: an idea whose time has come? J. Philosophy, Science & Law. 3.

Reusché, G.A. & K.R. Chopra, 1993. Seed enterprise development and management; a resource manual. Bangkok, FAO Regional Office GCP/RAS/103/DEN.
Richards, P., 1998. Fighting for the rain forest: war, youth and resources in Sierra Leone. Oxford, James Curry.
Richards, P., G. Ruivenkamp, & R. van der Drift, 1997. Seeds and survival; crop genetic resources in war and reconstruction. Rome, IPGRI, 61 p.
Rheenen, H.A. van, W.M. Pere & J.K. Magoya, 1983. protection of stored bean seed against the bean bruchid. Rome, FAO Plant Protection Bulletin 31(3): 121-125.
Rhoades, R. 1987. Farmers and experimentation. London, ODI, Agr. Adm. Network Discussion Paper 21. London.
Rhoades, R.E. & A. Bebbington, 1991. Farmers who experiment: an untapped resource for agricultural resource and development? In: B. Haverkort , J. van der Kamp & A. Waters-Bayer (Eds). Joining farmers'experiments. Experiences in participatory technology development. London,Intermediate Technology Publ.
Richards, P. 1985. Indigenous agricultural revolution. Boulder, Westview Press.
Richards, P., G. Ruivenkamp & R. van der Drift, 1997. Seeds and survival: crop genetic resources in war and reconstruction in Africa. Rome, International Plant Genetic Resources Institute.
Roffe, P., 2004. Bilateral agreements and a TRIPS-plus world: the Chile-USA Free Trade Agreement. Ottawa, Quaker International Affairs Programme, 56 p.
Rogers, E.M., 2003. Duffusion of Innovations (5th Edition). New York, the Free Press.
Rohrbach, D.D., Z. Bishaw & A.J.G. van Gastel, 1997. Alternative strategies for smallholder seed supply. Proceedings of an International Conference on Options for Strengthening National and Regional Seed Systems in Africa and West Asia. Patancheru, India – ICRISAT.
Rohrbach, D.D., I.J. Minde & J Howard, 2003. Looking beyond national boundaries: regional harmonisation of seed policies, laws and regulations. Food policy 28: 317-333.
Röling, N. 2000. The agricultural treadmill and plant genetic resources. In: Conny Almekinders & Walter de Boef (Eds.). Encouraging diversity. The conservation and development of plant genetic resources. London, Intermediate Technology Publ.: 262-265.
Röling, N. and A. Wagemakers (Eds.) (1998). Facilitating sustainable agriculture. Participatory learning and adaptive management in times of environmental uncertainty. Cambridge: Cambridge University Press.
Röling, N., D. Hounkonnou, S. Kwame Offei, R. Tossou, and A. Van Huis. 2004. Diagnostic studies. Linking science to farmers' innovative capacity. case studies from Benin and Ghana. Introduction to Special Issue of the Netherlands Journal of Life Sciences (NJAS) Vol. 53(3/4): 211-235.
Ronald, P.C., 1998. Genetic resource recognition fund. CABI AgBiotech News 10:1 – 19N-21N.
Rouw, A. de, 1991. Rice, weeds and shifting cultivation in a tropical rain forest. A study of vegetation dynamics. Doctoral thesis. Agricultural University, Wageningen, the Netherlands
Runge, C.F. & E. Defrancesco, 2006. Exclusion, inclusion, and enclosure: historical commons and modern intellectual property. World Dev. 34(10): 1713-1727.
Runge, C.F. & B. Senauer, 2007. How biofuels could starve the poor. Foreign Affairs, May-June 2007.
Sachs, J.D., 2005. The end of poverty. How we can make it happen in our lifetime. Penguin, 416 p.
Safrin, S., 2004. Hyperownership in a time of biotechnological promise: the international conflict to control the building blocks of life. 98 American Journal of International Law 641.
Salazar, R. 1992. MASIPAG: alternative community rice-breeding in the Philippines. Appropriate Technology 18 (4): 20-21.
Salazar, R., N. Louwaars & B. Visser, 2005. Protecting farmers' new varieties: new approaches to rights on collective innovations in plant genetic resources. CAPRi Working Paper 45, Washington DC, IFPRI, 40p.
Sampath,P.G. & R.G. Tarasovsky, 2002. Study on the Inter-relation between Intellectual property rights regimes and the conservation of genetic resources. Report, prepared for the European Commission, DG Environment. Berlin. Eco-Logic, 148 p.
Shen, Xiaobai, 2005. A dilemma for developing countries in intellectual property strategy? Lessons from a case study of software piracy and Microsoft in China. Science and Public Policy June 2005.
Shepard, J.F. & L. E. Claftin, 1975. Critical analyses of the principles of seed potato certification. Ann. Rev. of Phytopathology 13: 271-293.
Simmonds, N.W., 1979. Princples of crop improvement. Harlow, Longman Group. 408 p.

Simmonds, N.W., 1991. Selection for local adaptation in a plant breeding programme. Theor.& Appl. Genetics 82: 363-367.
Smale, M., 2006. Concepts, metrics and plan of the book. In: M. Smale (Ed). Valuing Crop Biodiversity; on-farm genetic resources and economic change. Wallingford and Cambridge, MA, CABI Publishing. p.4.
Smale, M., M.R. Bellon, & P.L. Pingali, 1998. Farmers, genebanks and crop breeding: introduction and overview. Pp 3-18 in: M. Smale (Ed). Farmers, genebanks, and crop breeding: economic analyses of diversity in wheat, maize and rice. Boston MA, Kluwer.
Smale, M. & K.. Day-Rubinstein, 2002. The demand for crop genetic resources: international use of US National Plant Germplasm System. World Development 30(9): 1639-1655.
Smale, M., M.P. Reynolds, M. Warburton, B. Skovmand, R. Trethowan, R.P. Sing, I. Ortiz-Monasterio & J. Crossa, 2002. Dimensions of diversity in modern spring bread wheat in developing countries from 1965. Crop Sci. 42: 1766-1779.
Smale, M., L. Lipper & P. Koudouri, 2006. Scope, limitations and future directions. In: M. Smale (Ed). Valuing crop biodiversity; on-farm genetic resources and economic change. Wallingford and Cambridge, MA, CABI Publishing, pp 280-295.
Smith, R.D., H. Thorsteinsdottír, A.S. Daar, E.R. Gold & P.A. Singer, 2004. Genomics knowledge and equity: a global public goods perspective of the patent system. Bulletin of the World Health Organisation 82: 385 – 389.
Smolders, H., 2006. Enhancing farmers' role in crop development. Framework information for participatory plant breeding in farmer field schools. Wageningen, Centre for Genetic Researches, The Netherlands, Pedigrea Publication, 60 p.
Smolders, H. & E. Caballeda, 2006. Field guide for participatory plant breeding in farmer field schools. Wageningen, Centre for Genetic Researches, The Netherlands, Pedigrea Publication, 60 p.
Sperling, 1992., Farmer participation and the development of bean varieties in Rwanda. In: J. Lewinger Moock & R. Rhoades (Eds.), Diversity, farmer knowledge and sustainability. Ithaca, Cornell Univ. Press.
Sperling, L., 2001a. The effect of the civil war on Rwanda's bean seed systems and unusual bean diversity.Biodivers-conserv. 10 (6) p. 989-1009.
Sperling, L., 2001b. Emergency seed aid in Kenya. In: L. Sperling (Ed.) Targeted seed aid and seed system interventions: Strengthening small farmer seed systems in East and Central Africa. Proceedings of a workshop in Kampala, 21-24 June 2000. Cali, Colombia, CIAT. p. 27-32.
Sperling, L., M.E. Loevinsohn & B. Ntambovura, 1993a. Rethinking the farmer's role in plant breeding: local bean experts and on-station selection in Rwanda. Expl. Agr. 29: 509-519.
Sperling, L., J.A. Ashby, M.E.Smith, E. Weltzien & S. McGuire, 2001. A framework for analyzing participatory plant breeding approaches and results. Euphytica 122(3): 439-450.
Sperling, L., T.C. Osborn & H.D. Cooper, 2004. Towards effective and sustainable seed relief activities. Report of the workshop on effective and sustainable seed relief activities, Rome, Italy 26-28 May 2003. Rome, FAO, 94 p.
Srinivasan, C.S., 2001. International experience of plant variety protection: Lessons for India. PhD dissertation. University of Reading, U.K.
Srinivasan, C.S., C. Thirtle & P.Palladino, 2003. Winter wheat in England and Wales, 1923-1995: what do indices of genetic diversity reveal? Plant Genetic Resources: Characterisation and Utilization 1(1): 43-57.
Stannard, C., N. vander Graaff, A. Randell, P. Lallas & P. Kenmore, 2004. Agricultural biological diversity for food security: shaping International Initiatives to Help Agriculture and the Environment. Howard Law Journal 48 (1): 397-430.
Stoorvogel, J.J. & E.M.A. Smaling, 1998. Research on soil fertility decline in tropical environments: integration of spatial scales. Nutrient Cycling in Agroecosystems 50(1-3): 151- 158.
Strange, R.N., 2005. Plant disease: a threat to global food security. Ann.Rev.Phytopathology 43: 83-116.
Tanksley, S.D. & S. R. McCouch, 1997. Seed banks and molecular maps: Unlocking genetic potential from the wild. Science 277: 1063 – 1066.
Tate, C.N. & T. Vallinder, 1995. The global expansion of judicial power. New York Univ. Press.
Tatenhove, J., B. Arts & P. Leroy (eds.), 2000. Political modernization and the environment. The renewal of policy arrangements. Dordrecht, Kluwer Academic Publishers.
Tatenhove, J. P.M. van, & P. Leroy, 2003. Environment and participation in a context of political modernisation. Environmental Values 12: 155-174.

Taylor, M.R. & J. Crayford, 2003. American patent policy, Biotechnology and African agriculture: a case for policy change. Washington DC, Resources for the Future, 114 p.
Thrupp, L.A., 1989. Legitimizing local knowledge: from displacement to empowerment for third world people. Agric and Human Values 6(3): 13 – 24.
Thumm, N., 2001. Management of intellectual property rights in European biotechnology firms. Technology Forecasting and Social Change 64: 259-272.
Traynor, P.L. & J. Komen, 2002. Regulating genetically-modified seeds in emerging economies. In: N.P. Louwaars (Ed). Seed policy, legislation and law: Widening a narrow focus. Binghamton NY, Food Products Press pp.213-229.
Tripp, R., 1997. New seeds and old laws. London: Intermediate Technology Publications.
Tripp, R. (Ed), 1998. New seed and old laws; regulatory reform and the diversification of national seed systems. London, Intermediate Technology Publications, pp 88- 120.
Tripp, R., 2001. Seed provision and agricultural development. The Institutions of Rural Change. Oxford, James Currey.
Tripp, R. & W.J. van der Burg, 1997. The conduct and reform of seed quality control. In: R. Tripp (Ed). New seed and old laws: regulatory reform and the diversification of national seed systems. London, Intermediate Technology Publications pp 121-126.
Tripp, R. & N.P. Louwaars, 1997a. The conduct and reform of crop variety regulation. In: R. Tripp (Ed) New seed and old laws; regulatory reform and the diversification of national seed systems. London, Intermediate Technology Publications, pp 88- 120.
Tripp, R. & N. Louwaars, 1998. Seed regulation: choices on the road to reform. Food Policy Vol.22, (5): pp. 433-446.
Tripp, R. & S. Pal, 2000. Information and agricultural input markets. Pearl millet seed in Rajastan. Journal of International Development 12: 133-144.
Tripp, R., N. Louwaars & D. Eaton, 2007. Plant variety protection in developing countries. A report from the field. Food Policy 32 (3): 354-371.
Tu, J., I. Ona, Q. Zhang, T.W. Mew, G.S. Khush & S.K. Datta, 1998. Transgenic rice variety 'IR72"with Xa21 is resistant to bacterial blight. TAG 97(1-2): 31-36.
Uphoff, N., 1986. Local institutional development: an analytical sourcebook with cases. West Hartford, CT., Kumarian Press.
Uganda Seed Project, 1991. Seed production handbook for Uganda. Kampala, New Vision Printers, 175 p.
Ullstrup, A.J., 1972. The impacts of the southern corn leaf blight epidemics of 1970-1971. Ann.Rev. of Pathology 10: 37-50.
UPOV, 2005. Draft report of the ad hoc working group to study the impact of plant breeders' rights. Geneva, UPOV, March 24.
Vaughn, C.E., B.R. Gregg, J.C. DeLouche, 1968. Seed processing and handling. Starkville, Seed Technology Laboratory, Mississippi State University, 294 p.
Vavilov, N.I., 1926. The origin, variation, immunity and breeding of cultivated plants. Studies on the origin of cultivated plants. Bulletin of Applied Botany 16(2).
Vavilov, N.I., 1951. Selected writings of N.I. Vavilov, translated from Russian by K. Starr Chester. Chronica Botanica 13:1-366.
Venkatesan, V., 1994. Seed systems in Sub-Saharan Africa: issues and options. Washington DC, World Bank Discussion Paper 266.
Vernooy, R., 2003. Seeds that give. Ottawa, IDRC, 93 p.
Vervoorn, M., 1996. Seed sector development in Bangladesh with focus on secondary food crops. In: H. van Amstel, J.W.T. Bottema, M. Sidik & C.A. van Santen (Eds). Integrating seed systems for annual food crops; proceedings of a workshop held in Malang, Indonesia, October 24-27, 1995. Bogor, Indonesia. CGPRT, RILET & PERAGI, CGPRT Paper No. 32, pp. 239-255.
Virk, D.S, A.J. Packwood & J.R. Witcombe, 1996. Varietal testing and popularisation and research linkages. Centre for Arid Zone Studies, Bangor, Discussion papers series. 27 p.
Visser, B., 2002. An agrobiodiversity perspective on seed policies. In: N.P. Louwaars (Ed). Seed policy, legislation and law. Binghamtom NY, Food Products Press, The Haworth Press., pp. 231 – 246.
Visser, L., D. Eaton, N. Louwaars & I. van der Meer, 2001.Potential impacts of genetic use restriction technologies (GURTs) on agrobiodiversity and agricultural production systems, Rome, FAO.
Visser, B, D. Eaton, N. Louwaars, and J. Engels, 2003. Transaction costs of germplasm exchange under bilateral agreements. In: GFAR/IPGRI, eds. Strengthening Partnerships in Agricultural

Research for Development in the Context of Globalisation. Proceedings of the GFAR 2000 Conference, 21-23 May 2000, Dresden, Germany. GFAR, Rome, Italy and IPGRI, Rome, Italy pp.51-80.
Visser, B., R. Pistorius, R. van Raalte, D. Eaton & N. Louwaars, 2004. Options for non-monetary benefit sharing. An inventory. Rome, FAO, Commission for Genetic Resources for Food and Agriculture. Background study paper # 30, 27 p.
Visser, Bert & Niels Louwaars, 2006. Policy and criteria for the Funding Strategy for the implementation of the International Treaty on Plant Genetic Resources for Food and Agriculture. Rome, FAO Commission on Genetic Resources for Food and Agriculture. Background Study Paper # 31.
Voss, J., 1989. Integrating social science research into the development and testing of new agricultural technology: the case of CIAT's Great Lakes Bean Project. In: D. Groenfeldt & J.L.Moock (Eds), Social science perspectives in managing agricultural technology, pp.57-62. IIMI, Colombo, Sri Lanka.
Walker, D.J. & R. Tripp, 1997. Seed management by small-scale farmers in Ghana and Zambia. In: "International workshop on seed security for food security", Florence, Italy, 30 November - 1 December 1997. Rome, FAO. http://www.fao.org/ag/agp/agps/georgof/Georgo18.htm#Ghana
Wellving, A.H.A., I. Kiliangile, P.M. Jones & D.M. Naik 1984. Seed production handbook of Zambia. Department of Agriculture, Lusaka. 397 p.
Wennekes, W., 1996. Golden Trade, the history of an infamous maritime nation scouring the seas in search of trade and profit. Amsterdam/Antwerp, Atlas, 472 p.
Wiggins, S. & E. Cromwell, 1995. NGOs and seed provision to smallholdersin developing countries. World Development 23(3): 413-422.
Wijk, J. van & R. Pistorius, 1999. the exploitation of plant genetic information: political strategies in crop development. Wallingford, UK, CABI, 231 p.
Wijk, A.J.P. van, N.P. Louwaars & D.J.F. Eaton, 2004. Framework for the introduction of plant variety protection in developing countries. Wageningen, Centre for Genetic Resources, 48 p.
Witcombe, J. & A. Joshi, 1996. Farmer participatory approaches for varietal breeding and selection and linkages to the formal seed sector, *Participatory Plant Breeding,* P Eyzaguirre and M Iwanaga (Eds) Rome, Italy, IPGRI.
Wittmer, H. & R.Birner, 2005. Between conservationism, eco-populism and developmentalism – Discourse in biodiversity policy in Thailand and Indonesia. Washington DC,IFPRI, CAPRI Working Paper No.37. 29 p.
World Bank, 2006. Intellectual Property Rights. Designing regimes to support plant breeding in developing countries. Washington DC, World Bank Agriculture and Rural Development. Report # 35517, 77 p. http://siteresources.worldbank.org/INTARD/Resources/IPR_ESW.pdf
World Bank, 2007. World development report 2008. Washington DC, World Bank.
Wortmann, C.S., H.E. Gridley & S.M. Musaana, 1996. Seed yield and stability of bean multiline. Field Crops Research 46: 153-159.
Wright, B.D. 1998. "Public germplasm development at a crossroads: Biotechnology and Intellectual Property." California Agriculture 52(6): 8–13.
Wright, B.D., P.G. Pardey, C. Nottenburg & B. Koo, 2006. Agricultural innovation: incentives and institutions. In: R.E. Evenson, P. Pingali & T.P. Schultz (eds.) Handbook of Agricultural Economics Vol. 3. Amsterdam, Elsevier, p.32.
Wunsch, J.S., 1991. Institutional analysis and decentralization: developing an analytical framework for effective third world administrative reform. Public Admin. And Dev. 11 (5): 431 – 451.
Zeven, A.C. & J.M.J. de Wet, 1982. Dictionary of cultivated plants and their regions of diversity. Wageningen, PUDOC, 263 p.
Zimmerer, K.S., 1996. Changing fortunes: biodiversity and peasant livelihood in the Andes. Berkeley, University of Califormia Press.
Zheng, L., R. Juneja & B.D. Wright, 2006. Implications of intellectual property protection for academic agricultural biologists. University of California, Berkely, Department of Agricultural and Resource Economics, mimeo.
Zhou, X., T.E. Carter Jr., Z. Cui, S. Miyazaki & J.W. Burton, 2000. Genetic base of Japanese soybean cultivars released during 1950 to 1988. Crop Sci. 40: 1794-1802.
Zohrabian, A., G. Traxler, S. Caudill & M. Smale, 2003. Valuing pre-commercial genetic resources: a maximum entropy approach. Amer.J.Agr.Econ. 85(2): 429-436.

Glossary

Abiotic stress	Stress (on a crop) caused by non-biotic factors, such as moisture, temperature, light, etc.
Agro-biodiversity	The variability among living organisms in agro-ecosystems; this includes diversity within species, between species and of ecosystems. Synonyms: agricultural biodiversity***
Analytical seed quality	The quality of a seed lot in terms of the amount of good seed in a seed lot (as opposed to inert matter, weed seeds, etc.)
Apomixis	The production of an embryo in the absence of meiosis. Apomictic higher plants produce asexual seeds, derived only from maternal tissue*.
Barter	To exchange goods for other things rather than for money**
Biennial (species)	A plant which completes its life cycle within two years and then dies*
Biodiversity	The variability among living organisms from all sources, including, inter alia, terrestrial, marine and other ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems. Synonyms: biological diversity*.
Biotic stress	Stress factors (on a crop) caused by pests (animals, weeds, micro-organisms)
Confusion	Bewilderment, misunderstanding, disorientation, mystification, disorder, commotion (source: Microsoft thesaurus)
Cosmovision	The complex of views and creations that conform with the image and general concept of the world, on the basis of which nature and existence can be interpreted (source: Wikipedia).
Diversified seed system	Seed system that has both formal and farmers' components and components where these are integrated (for example, participatory crop improvement)
Ex situ (conservation)	The conservation of a plant outside its original or natural habitats, for example, in a genebank, botanical garden or field genebank, (…) ***
Farmers' privilege	Rights to hold germplasm, covered by plant variety protection, as a seed source for subsequent seasons.*
Farmers' Rights	Rights first recognized by Resolution 5 of the 1989 FAO Conference as "rights arising from the past, present and future contributions of farmers in the conservation, improvement and the making available of plant genetic resources" (…). The binding 'International Treaty of Plant Genetic Resources for Food and Agriculture' (…) makes provision for the Farmers' Rights in Article 9.*
Farmers' seed system	Seed system operated by farmers, which may include both land race and modern variety seed
Farming system	All the elements of a farm that interact as a system, including people, crops, livestock, other vegetation, wildlife, the environment and the social, economic and ecological interactions between them***
Formal seed system	Seed supply through an organised chain of events by specialised breeders, seed producers, marketing agents, etc., commonly including certification and quality control.****
Genebank	Facility where germplasm is stored or maintained in the form of seed, pollen, or in tissue culture, or in the case of a field genebank in the form of plants growing in the field.***
Genetic diversity	The heritable variation within and among populations which is created, enhanced or maintained by evolutionary or selective forces.*

Genetic drift	Change in allele frequency from one generation to another within a population, due to the sampling of finite numbers of genes. The smaller the population, the greater is the genetic drift, with the result that some alleles are lost, and genetic diversity is reduced.*
Genetic erosion	The loss over time of allelic diversity, particularly in farmed organisms, caused by either natural or man-made processes.*
Genetic resource	Genetic material of actual or potential value. *
Genetic seed quality	The quality of a seed lot in terms of the identity and genetic homogeneity of the seed.
Green Revolution	Name given to the dramatic increase in crop productivity during the third quarter of the 20th century, as a result of integrated advances in genetics and plant breeding, agronomy, and pest and disease control.*
Heterosis	The extent to which a hybrid individual outperforms both its parents with respect to one or many traits. *.
Hybrid	General: the first generation progeny of a cross between two different parents. In seed producton: a variety of which the seed is produced through controlled crossing of different parents. ****
In situ (conservation)	The conservation of a plants or animals in the areas where they developed their distinctive properties, i.e. in the wild or in farmers' fields***
Land race	a variety developed by farmers in particular agr-ecological and socio-economic conditions, usually a complex, heterogeneous population****
Modernism	constant innovation, utopian; associated with ideal visions of human life and society and a belief in progress.(Tate glossary)
Multilateral system	The system of facilitated access to genetic resources and multilateral benefit sharing applied to a number of important food and fodder crops by the IT PGRFA
Multiplication factor	General: the number of seeds produced from one parent seed. In seed production: net seed yield per hectare (i.e. after seed cleaning and quality control), divided by the seed rate****
Natural selection	The differential survival and reproduction of organisms because of differences in characteristics that affect their ability to utilize environmental resources.*
Non-excludablility	Others cannot easily be stopped from consuming a product (together with non-rivalrous the typical conditions that warrant intellectual property rights protection).
Non-rivalrous	The consumption of a product by one person does not prohibit another person also using the same product. (together with non-excludability the typical conditions that warrant intellectual property rights protection).
Open Pollinated Variety	Variety, multiplied trough random fertilization, i.e. opposite to hybrid (commonly used for cross-fertilizing species only)****
Participatory crop improvement	A participatory approach to crop improvement, which encompasses two contracting methodologies: participatory plant breeding and participatory variety selection ***
Participatory plant breeding	A breeding process in which farmers and plant breeders jointly select cultivars from segregating materials under a target environment, (…) and thus draw upon the comparative advantages of both the formal and informal systems.***
Participatory variety selection	The selection of fixed cultivars by farmers in their target environment using their own selection criteria. ***
Physiological seed quality	The quality of a seed lot in terms of germination capacity and the percentage of normal seedlings, and seedling vigour.
Plant breeder's rights	Legal protection of a new plant variety granted to the breeder or his successor in title. The effect of PBR is that prior authorization is required before the material can be used for commercial purposes.*

Plant variety protection	The protection granted under a plant breeder's rights law that is consistent with an UPOV Act.
Sanitary seed quality	The quality of a seed lot in terms of absence of seed transmitted diseases
Seed	Botanically, the matured ovule without accessory parts. * In this volume: any plant part that is intended or used for sowing or planting.
Seed certification	The assurance of varietal identity and purity in seed production through generation control, field inspection, and labelling.****
Seed chain	Expression for the formal seed system, which consists of interlinked components in a linear arrangement (from genetic resource management through breeding and seed production to seed marketing.
Seed quality control	The control of seed quality through field inspection and seed testing, commonly performed in combination with seed certification.
Seed system	All the elements of seed provision that interact as a system, including for example, genetic resource management and crop improvement, multiplication and diffusion/marketing.
Sui generis (legislation)	Literally: 'of its own kind'. This refers to any unique form of intellectual property legislation specifically designed to meet certain needs.*** (under TRIPS, a special law to protect plant varieties)
Triploid	A cell, tissue or organism containing three times the haploid number of chromosomes*
Variety	A plant grouping within a single botanical taxon of the lowest known rank, which grouping, irrespective of whether the conditions for the grant of a breeder's right are fully met, can be - defined by the expression of the characteristics resulting from a given genotype or combination of genotypes, - distinguished from any other plant grouping by the expression of at least one of the said characteristics and - considered as a unit with regard to its suitability for being propagated unchanged (source: UPOV)
Wide adaptation	The ability of a variety to perform well under a variety of agro-eclogical conditions. ****

* Glossary of Biotechnology in Food and Agriculture http://www.fao.org/biotech/index_glossary.asp

** Cambridge Dictionaries on line: http://dictionary.cambridge.org/

*** Friis-Hansen, E. & B. Shthapit (Eds), 2000. Participatory approaches to the conservation of plant genetic resources. Rome, International Plant Genetic Resources Institute, 216 p.

**** Almekinders, C. & N. Louwaars, 1999. Farmers' seed production. New approaches and practices. London. Intermediate Technology Publications pp 273-279

About the author

Niels Louwaars was born in Zwijndrecht, The Netherlands on January 27th 1958. He grew up in Breda and at age 17 moved to Wageningen where he studied Plant Breeding. A traineeship at the French research organization ORSTOM in Côte d' Ivoire confirmed his choice for a minor in Tropical Crop Husbandry. After his graduation he spent his social service period at the Institute for Horticultural Plant Breeding. He married José van de Ven and for nine years worked in Sri Lanka and Uganda in various seed related projects and during this period abroad Sjoerd, Bas and Janneke were born.

Experiences in Sri Lanka and Uganda triggered his interest in alternative arrangements to the formal seed systems being promoted by both donor agencies and developing country governments, and in the policies and laws that affect their implementation. After returning to The Netherlands he carried out several consultancies and teaching assignments before becoming manager of international markets and the corporate secretary of the Centre for Plant Breeding and Reproduction Research during a managerially turbulent period that led to the formation of Wageningen University and Research centre.

He maintained his interest in seed systems following the launching of the concept of integrated seed systems in regional meetings in Ethiopia, Indonesia, Syria and Uganda in 1994/95, and the invitation to participate in the drafting of seed- and breeders' rights laws in several countries. He included the development in intellectual property rights and biodiversity policies into his analysis of the impact of policies on seed systems. This resulted in invitations to participate in various debates all over the world, including CBD meetings representing the FAO, presentations on intellectual property rights at the World Trade Organisation and the African Union speaking on behalf of the World Bank, and publishing for non-governmental organizations such as the Genetic Resources Action International (GRAIN), the Community Biodiversity Development and Conservation programme and the SAWTEE network in South Asia.

During the last ten years he has been teaching in Germany, Sweden and The Netherlands and running international courses that aim to extend and refine seed systems concepts. Currently, he combines a research and teaching task on biopolicies at the Centre for Genetic Resources, The Netherlands, with efforts to strengthen collaboration between Wageningen UR and the international agricultural research centres of the CGIAR, and a research management task of the Policy Support Cluster International of the Ministry of Agriculture, Nature and Food Safety.

He has (co-) authored four books, two online-courses and a number of scientific and popular publications, mainly on seed system related issues.