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COMMISSION ON GENETIC RESOURCES FOR FOOD AND AGRICULTURE

Item 6 of the Provisional Agenda

INTERGOVERNMENTAL TECHNICAL WORKING GROUP ON ANIMAL GENETIC RESOURCES FOR FOOD AND AGRICULTURE

Eighth Session

Rome, 26 – 28 November 2014

EXPLANATORY NOTES TO THE DISTINCTIVE FEATURES OF GENETIC RESOURCES FOR FOOD AND AGRICULTURE

TABLE OF CONTENTS

I. INTRODUCTION

1. The Commission, at its Fourteenth Regular Session, considered a list of distinctive features of genetic resources for food and agriculture (GRFA), as identified by the Commission's Ad Hoc Technical Working Group on Access and Benefit-sharing for Genetic Resources for Food and Agriculture (ABS Working Group) and the Commission's working groups on plant, animal and forest genetic resources (Working Groups).[1] The Commission requested its Secretary to develop explanatory notes to the distinctive features, while acknowledging the need to further refine them and to focus on the utilization of GRFA.

2. The special nature of agricultural biodiversity, its distinctive features and problems needing distinctive solution is widely recognized, including by the Conference of the Parties to the Convention on Biological Diversity (CBD)[2] and the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity (Protocol).[3] As requested by the Commission, the ABS Working Group, at its session in September 2012, identified relevant distinctive features of GRFA requiring distinctive solutions for ABS.

3. The ABS Working Group agreed that it would be appropriate for the distinctive features of subsectors to be addressed by the Commission's Working Groups. The Working Groups welcomed the report of the ABS Working Group and, in reviewing the distinctive features identified by the ABS Working Group, revised some of the features and highlighted features particularly relevant or less relevant to their subsectors.[4] Table 1 presents the different features, as reviewed by the Working Groups.

4. In response to the Commission's request, this document provides explanatory notes to the distinctive features of GRFA to be taken into account in the process leading to *Draft Elements to Facilitate Domestic Implementation of Access and Benefit-Sharing for Different Subsectors of Genetic Resources for Food and Agriculture*.

II. EXPLANATORY NOTES

5. The identification of the distinctive features of GRFA benefited from previous work undertaken by the Commission, in particular from:

- the analysis of the use and exchange patterns of genetic resources in the various subsectors of food and agriculture contained in a series of background study papers prepared for the Commission in 2009[5];
- the outcomes of stakeholder consultations held to develop and review the above mentioned background study papers,
- and the conclusions of a Multi-stakeholder Expert Dialogue on ABS for GRFA held in 2011.[6]

6. The study papers and stakeholder consultations demonstrated that GRFA are exchanged in many different ways, by a broad range of stakeholders, for various purposes, and on the basis of widely varying conditions. The patterns of use and exchange vary not only between the different subsectors of food and agriculture, but also within the subsectors according to various factors such as the type of use, the type of genetic material, the taxonomic group and the geographical region concerned. At the same time, in

[1] CGRFA-14/13/Report, paragraph 40.xi; *Appendix E*.
[2] Decisions II/15 (*retired*); V/5.
[3] Protocol, Preambel.
[4] CGRFA-14/13/Report, paragraph 40.xi; *Appendix E*.
[5] Background Study Paper No. 43-47.
[6] Background Study Paper No. 59.

Table 1: Distinctive features of genetic resources for food and agriculture

The distinctive features of genetic resources for food and agriculture (GRFA) requiring distinctive solutions for access and benefit-sharing are presented below in seven clusters. They aim to reflect an equilibrium between all subsectors of food and agriculture. Not every feature is necessarily applicable to each and every genetic resource for food and agriculture and the various subsectors often have different features. Further detailing of subsector-specific features may still be developed.
The features are distinctive, but not necessarily unique to genetic resources for food and agriculture. While other genetic resources may share with genetic resources for food and agriculture some of the features listed below, the specific combination of these features distinguishes genetic resources for food and agriculture from most other genetic resources.

A. The role of GRFA for food security	A.1 GRFA are an integral part of agricultural and food production systems and play an essential role for achieving food security and the sustainable development of the food and agriculture sector.
	A.2 Plant, animal, invertebrate and micro-organism GRFA form an interdependent network of genetic diversity in agricultural ecosystems.
B. The role of human management	B.1 The existence of most GRFA is closely linked to human activity and many GRFA can be regarded as human-modified forms of genetic resources.
	B.2 The maintenance and evolution of many GRFA depend on continued human intervention, and their sustainable utilization in research, development and production is an important instrument to ensure conservation.
C. International exchange and interdependence	C.1 Historically, GRFA have been widely exchanged across communities, countries and regions over often long periods of time, and a relevant part of the genetic diversity used in food and agriculture today is of exotic origin.
	C.2 Countries are interdependent with regard to GRFA and act both as providers of some GRFA and as recipients of others.
	C.3 The international exchange of GRFA is essential to the functioning of the sector, and its importance is likely to increase in future.
D. The nature of the innovation process	D.1 The innovation process for GRFA is usually of incremental nature and the result of contributions made by many different people, including indigenous and local communities, farmers, researchers and breeders, in different places and at different points in time.
	D.2 Many GRFA products are not developed out of an individual genetic resource, but with the contributions of several GRFA at different stages in the innovation process.
	D.3 Most products developed with the use of GRFA can in turn be used as genetic resources for further research and development, which makes it difficult to draw a clear line between providers and recipients of GRFA.
	D.4 Many agricultural products reach the market place in a form in which they may be used both as biological resources and as genetic resources.
E. Holders and users of GRFA	E.1 GRFA are held and used by a broad range of very diverse stakeholders. There are distinct communities of providers and users with respect to the different subsectors of GRFA.
	E.2 The different stakeholders managing and using GRFA are interdependent.
	E.3 A significant amount of GRFA is privately held.
	E.4 An important part of GRFA is held and can be accessed *ex situ*.
	E.5 An important part of GRFA is conserved *in situ* and on farm under different financial, technical and legal conditions.
F. GRFA exchange practices	F.1 The exchange of GRFA takes place in the context of customary practices and existing communities of providers and users.
	F.2 An extensive transfer of genetic material between different stakeholders along the value chain occurs in research and development.
G. Benefits generated with the use of GRFA	G.1 While the overall benefits of GRFA are very high, it is difficult to estimate at the time of the transaction the expected benefits of an individual sample of GRFA.
	G.2 The use of GRFA may also generate important non-monetary benefits.
	G.3 The use of GRFA may lead to external effects going far beyond the individual provider and recipient.

all subsectors the international exchange of GRFA plays a fundamental role for achieving food security and sustainable agricultural development.

7. The identified features aim to reflect an equilibrium between all subsectors of food and agriculture. Not every feature is necessarily applicable to each and every GRFA, but of relevance to GRFA overall. The features are often more or less pronounced in the different subsectors of food and agriculture and may display subsector specificities. The features are distinctive, but not necessarily unique to GRFA. While other genetic resources may share with GRFA some of the listed features, the specific combination of these features distinguishes GRFA from most other genetic resources.

8. The twenty-one identified features of GRFA were grouped into seven clusters and are presented below, each of them followed by explanatory notes referring to specificities of subsectors, where applicable.

Cluster A: The role of GRFA for food security

A.1 GRFA are an integral part of agricultural and food production systems and play an essential role for achieving food security and the sustainable development of the food and agriculture sector.

9. Alongside with soil and water, GRFA constitute the basis for any agricultural production and are one of the most important raw materials for farmers, livestock keepers, foresters, fisher folk, breeders and scientists. The use of genetic diversity plays a fundamental role in adapting agricultural production systems to changing environmental conditions, new biotic and abiotic stressors, and evolving human needs and preferences. In order to be able to cope with the challenges of climate change and a growing global demand for food and agricultural products, the whole range of existing agricultural biodiversity needs to be at the disposal of researchers, breeders and producers beyond national borders.

10. In all GRFA subsectors, agricultural production builds upon genetic diversity. Future food security and livelihoods therefore depend on the smooth flow of germplasm through the value chain and a proper integration of conservation, improvement and production activities. The use of GRFA may contribute to livelihoods in different ways, including the provision of food, fiber, construction material, fuel, traction, etc. The relative importance of the various purposes may differ from one subsector to another. Non-food products, such as construction material, may play a relatively bigger role in forestry than in other subsectors.

11. The importance of GRFA for achieving food security worldwide and for sustainable development of agriculture in the context of poverty alleviation and climate change has been recognized by the Nagoya Protocol[7]. The achievement of global food security is a common concern of the international community and could be considered as an important policy objective in future ABS measures. In this context, ABS measures could aim at conserving and sustainably using agricultural biodiversity for food security and agricultural development.

A.2 Plant, animal, invertebrate and micro-organism GRFA form an interdependent network of genetic diversity in agricultural ecosystems.

12. Agricultural ecosystems and their productive capacity depend on complex interactions between cultivated and bred species (such as crops, domesticated animals, cultivated tree species or farmed aquatic organisms), and associated biodiversity (such as weeds, soil and water microorganisms, pollinators, pests, diseases and their natural enemies etc.) providing important ecosystem functions or posing a threat to production. The interactions between cultivated and

[7] Nagoya Protocol, Preambel and Article 8(c).

associated biodiversity are increasingly subject to research and are often the starting point for product development. Consequently, research and development programmes, but also production itself, rely on the combined use of, and access to, various groups and subsectors of GRFA. Research on and the improvement of the digestibility of forages by ruminants require access to animal, plant as well as micro-organism GRFA; the development of growth stimulating mycorrhiza for forest plantations relies on forest and micro-organism GRFA; the improvement of pest control in farmed salmon is based on the use of aquatic as well as invertebrate GRFA. Invertebrate and micro-organism GRFA may differ from other subsectors in the sense that they are mostly used as associated biodiversity and only rarely cultivated directly, although examples for this exist, e.g. honey bees or yeasts. They can therefore rarely be used in isolation from other subsectors and depend on the combined access to GRFA from various subsectors.

13. Measures targeting specific aspects of GRFA should thus take into account the interdependence of genetic diversity in the various subsectors of food and agriculture and the need of many stakeholder to access genetic resources from several subsectors of GRFA.

Cluster B: The role of human management

B.1 The existence of most GRFA is closely linked to human activity and many GRFA can be regarded as human-modified forms of genetic resources.

14. Humans have shaped the evolutionary processes by which GRFA have developed through the modification of living conditions in natural ecosystems and the provision of artificial habitats in agricultural production systems. Furthermore, GRFA are often the result of long and complex processes of domestication and selective breeding, which have considerably altered the genotypic and phenotypic characteristics of the original wild species and populations, and adapted them to the changing needs of production and consumption. GRFA continue to evolve in a dynamic interaction between the environment, human management practices and the genetic diversity itself.

15. The degree and manner of human influence on the evolution of GRFA differs considerably between subsectors and species within subsectors. It is certainly most pronounced for animal and plant GRFA that have been subject to domestication and systematic genetic improvement for about ten thousand years. While wild relatives of crops are still occasionally used to introduce particular traits of interest into advanced breeding material, the sourcing of genetic material from wild animal populations can even be regarded as negligible, as many wild ancestors of domesticated livestock species have become extinct. In aquaculture and forestry, the history of domestication and genetic improvement is much more recent and includes only some of the commercially most relevant species. While improved varieties have been developed for those species, the gene pools of the majority of species still remain wild or semi-wild and reproductive material is often collected from the wild. Nevertheless, there is a consistent increase in the number of species being domesticated and subjected to improvement programmes. Invertebrate and micro-organism GRFA have rarely undergone an improvement process (with some notable exceptions like food processing micro-organisms and honeybees) and are mainly of wild origin. However, many wild GRFA have been shaped by humans in a less direct form, as their living conditions depend on agricultural practices and they often evolve in parallel with cultivated species. This is illustrated by biological control, where natural enemies of crop pests have evolved in parallel with the pests and depending on the relevant production system. The same can, for example, be said for nitrogen-fixing microbes associated with the cultivation of particular crops and influenced in their living conditions by agricultural practices.

16. As many GRFA have evolved in parallel with human societies, they also have been moved around the world with them (see feature C.1) and owe their existence, including their distinctive properties, to people or communities distant from the places in which they are currently found (see feature D.1). More importantly, they depend on human use and are threatened by under-utilization rather than by over-exploitation (see feature B.2).

B.2 The maintenance and evolution of many GRFA depend on continued human intervention, and their sustainable utilization in research, development and production is an important instrument to ensure conservation.

17. As GRFA have evolved as an integral part of agricultural and food production systems, they are adapted to and dependent on living conditions shaped by human management. Rather than being a threat to their survival, human use is consequently often a precondition to their persistence. One of the main reasons for the loss of agricultural biodiversity is when particular genetic resources drop out of utilization because of changing agricultural practices and production systems. Other important reasons are the degradation of habitats, the loss of ecosystems, over-exploitation and the introduction of alien species. The sustainable management of agro-ecosystems and the utilization and further development of GRFA in research, breeding and production are essential components of effective conservation strategies.

18. Human management is certainly most relevant to the maintenance and evolution of farmed and genetically improved GRFA. This applies in particular to the livestock and crop sectors, but also to some aquatic and forest species. But also GRFA closely linked to cultivated or bred species find their habitat in agricultural production systems and thus depend on the continued human intervention in the form of agricultural practices. This is also true for many invertebrate and micro-organism GRFA, like pollinators, natural enemies to pathogens and plant and animal symbiotes. Wild GRFA, that can be found in natural habitats and that have so far not been shaped by agricultural practices, do obviously not depend on human intervention for their maintenance and further evolution. Human intervention/ conservation strategies to conserve such GRFA for potential future uses may nonetheless be necessary.

Cluster C: International exchange and interdependence

C.1 Historically, GRFA have been widely exchanged across communities, countries and regions over often long periods of time, and a relevant part of the genetic diversity used in food and agriculture today is of exotic origin.

19. As GRFA are inherently linked to human livelihoods and food security, they have historically moved together with people throughout the world, spurred by migration, colonization and trade. Furthermore, it has been common practice in the food and agriculture sector to exchange genetic material among local communities, farmers, livestock keepers, foresters and breeders, as part of customary improvement and production processes. Successful production systems and technologies, including the associated genetic diversity, have also frequently been transferred to other countries and regions. As a result, a significant part of the genetic diversity used in current agricultural and food production systems is of exotic origin, at least in a historic sense.

20. The extent of the historical exchange of germplasm and the proportion of exotic diversity used vary between subsectors and species. While animal and plant GRFA have extensively been exchanged over the last 10 000 years, and livestock and crop production in most regions of the world today utilizes genetic resources that originated or were developed elsewhere, the situation in the forestry and aquaculture sectors, which are at much earlier stages of development, is mixed. Some of the commercially most relevant species have been moved extensively throughout the world and are cultivated now far beyond their natural distribution ranges. Several other species are just starting to be farmed in aquaculture, or are only used within their natural habitat in native forests, and their exchange has been limited so far. Micro-organism and invertebrate GRFA have often been exchanged unintentionally, spreading together with the farmed species and production systems they were associated to.

21. As the international exchange of genetic material is longstanding practice in the food and agriculture sector, many stakeholders rely on it and business practices have been structured accordingly, often characterized by transnational specialization and division of labour (see feature

C.3). Together with the widespread use of exotic genetic diversity, this makes countries highly interdependent with regard to GRFA (see feature C.2). Furthermore, for those GRFA that have been moved widely, it may be difficult to determine the country of origin according to the definitions of the CBD (see feature D.1).

C.2 Countries are interdependent with regard to GRFA and act both as providers of some GRFA and as recipients of others.

22. The fact that an important part of agricultural and food production relies on the use of species of exotic origin also means that countries are usually not self-sufficient with regard to GRFA. Most countries need to access some genetic resources from elsewhere to sustain their agricultural production and food security, and can consequently be regarded as interdependent. For the same reason, it is very difficult to draw a clear line between provider and recipient countries, as most countries may, at least potentially, be providers of some types of genetic diversity and recipients of others. Another reason for the interdependence of countries regarding GRFA lies in the increasing specialization and division of labour among actors across national borders. In other words, countries are not only interdependent with regard to the genetic material, but also with regard to research, development and production capacities.

23. In general, interdependence plays a role in all subsectors of food and agriculture. However, it may be more or less pronounced in different branches of production and different geographical regions. For example, while the management of native forests relies only on genetic diversity that can be found locally, the production of fast-growing plantation tree species often depends on reproductive material coming from far away. Also the reasons for interdependence may vary. The sector using microbial GRFA is for example highly dependent on international cooperation due to the need to specialize and distribute the overwhelming amount of organisms to be researched and managed. In classical biological control, the interdependence arises instead from the fact that the methodology itself is based on the introduction of exotic species. The use of exotic diversity often, but not always, entails interdependence. There may, for example, be situations in which countries are self-sufficient even with respect to reproductive material of species that originated elsewhere, because the historical movement of germplasm has led to the establishment of a sufficiently broad genepool of the introduced species in the recipient country. It may also be that the exotic origins of a species lie quite far back in time, and that the introduced material has in the meanwhile become adapted to the new environment and local needs, making it more attractive for further use than genetic material from the centre of origin. Conversely, there may be cases in which countries rely on the supply of reproductive material from foreign sources even for native species, because of increasing specialization and division of labour among actors across national borders. There may also be cases in which little attention is paid to genetic factors in the initial exchange and introduction of new exotic species, and where the production of the species in the receiving country is actually based upon regular replenishment of genetic diversity from the centre of origin.

24. While some countries may not depend on genetic resources of other countries with regard to all sub-sectors of GRFA, it seems all countries depend at least with regard to some GRFA subsector on other countries. Taking GRFA as a whole, it seems that indeed no country is self-sufficient and all countries depend on GRFA of other countries, even though to varying degrees.

C.3 The international exchange of GRFA is essential to the functioning of the sector, and its importance is likely to increase in future.

25. To the same extent that agriculture and food production have become a globally interlinked activity, the international exchange of GRFA fulfils an indispensable function in this system. As a consequence of the historical movement of germplasm around the world, most countries make use of genetic diversity that originated or was developed elsewhere. This trend is likely to increase in the future, as the shift of agro-ecological zones provoked by climate change will need to be matched with adapted genetic material. In addition, the complexity and magnitude of the global task to conserve and

use GRFA in a sustainable manner, requires international division of labour and specialization among different actors across national borders. This relies on the cross-border transfer of genetic material at different stages in the value chain.

26. The international exchange of genetic resources fulfils a crucial role in all subsectors of food and agriculture in the sense that its inhibition would have severe consequences. Nevertheless, the actual volume and direction of the flow of genetic material varies considerably among different subsectors, species, countries and over time. The volume and direction of germplasm flow may also change in the future, as many of the traits needed to respond to the effects of climate change may be found in locally adapted breeds. ABS measures, as applied to GRFA should reflect the need for and the volume of international exchanges of genetic material.

Cluster D: The nature of the innovation process

D.1 The innovation process for GRFA is usually of incremental nature and the result of contributions made by many different people, including indigenous and local communities, farmers, researchers and breeders, in different places and at different points in time.

27. GRFA are often used in a process of incremental innovation, in the sense that the genetic material is being improved continuously over multiple successive generations and the gains are cumulative. One innovative step is added to another and products are not the final result, but rather an intermediate step in an ongoing chain of improvement, as they can themselves be used as an input to further innovation. In the course of this continuous improvement process, genetic material is frequently exchanged and mixed with other genetic resources. Consequently, many GRFA have been developed over long periods of time, based on material originating from different parts of the world and thanks to the contributions made by many different people.

28. In all subsectors that make use of systematic genetic improvement (animal, aquatic, forest and plant GRFA), the innovation process for GRFA is of incremental nature. However, the degree to which currently used GRFA are already the result of dispersed contributions, depends on the lengths and intensity of the incremental improvement processes to which they have been subject. For most animal and plant GRFA, the history of incremental improvement goes back several thousand years, and it can be concluded that they are the products of the efforts of many people in places that are sometimes geographically very distant from each other. In the aquaculture and forestry sectors, domestication and genetic improvement activities are often so recent that only a moderate number of innovative steps have accrued so far, and contributions to the development of a specific genetic resource can more easily be attributed to individual people, communities or countries. However, it can be expected that as the improvement process progresses, contributions will be increasingly dispersed. For both invertebrate and micro-organism GRFA genetic improvement is only used in exceptional cases.

29. For those GRFA that are already the result of dispersed contributions and that owe their development to a range of actors and environments, it would be quite complex to determine their countries of origin according to the definitions of the CBD. The CBD stipulates that the country of origin of a genetic resource is the country “which possesses those genetic resources in in-situ conditions”, which, in the case of domesticated or cultivated species, are “the surroundings where they have developed their distinctive properties”. In the course of many years of incremental improvement under frequent exchange, GRFA have often acquired their distinctive properties in several different surroundings, not just in the one where they are currently found.

D.2 Many GRFA products are not developed out of an individual genetic resource, but with the contributions of several GRFA at different stages in the innovation process.

30. Product development based on GRFA usually implies the use of a broad range of genetic diversity. Often, large numbers of samples of genetic material are accessed at different stages in the research and innovation process, and many GRFA contribute in one way or another to the creation of a specific genepool and the products developed from it. Therefore, products are often developed with the contribution of several GRFA from different providers and being added to the development process at different points of time. In many cases, it is quite complicated, if not impossible, to assess the extent to which each individual genetic resource has contributed to the development of a specific product.

31. The various subsectors may differ as to the way in which genetic diversity is used for product development. In some subsectors, like micro-organism and invertebrate GRFA, a wide array of GRFA is used in the early stages of product development and contributes to the screening of the existing diversity and the identification of the most suitable genetic material. In the other subsectors, genetic resources can also be incorporated in different phases of the genetic improvement process and directly contribute their parts and components to the genetic set-up of the resulting products. While this process can be observed in animal, aquatic, forest and plant GRFA, the complexity of pedigrees varies between the different subsectors and is certainly most pronounced in crops.

32. Assessing the contribution of an individual GRFA to the development of a specific product will be often a challenging task and providers and recipients may wish to explore options to avoid the need for monitoring/ tracking of such individual contributions.

D.3 Most products developed with the use of GRFA can in turn be used as genetic resources for further research and development, which makes it difficult to draw a clear line between providers and recipients of GRFA.

33. Most of the products derived from the use of GRFA comprise genetic material containing functional units of heredity and are, at least theoretically, ready to be reproduced and used for further research and development based on their genetic set-up. Furthermore, it is common practice in agricultural research and development to make use of products as an input to further innovation processes. It is consequently very difficult to make a clear distinction between providers and recipients of genetic resources, as every recipient of genetic material will usually also act as a provider if his or her products are used by others.

34. Fish fingerlings may be sold by hatcheries for commercial grow-out in production ponds. Instead of being exclusively used for grow-out and final human consumption, they could also be used to reproduce and build up new broodstock. The same situation could occur in the farm animal sector when live animals are being sold. They may be used for meat production only or as parent animals in a breeding population.

35. It will be important for ABS for GRFA that ABS measures specify in detail in which cases of access to GRFA PIC (“prior informed consent”) and MAT (“mutually agreed terms”) are required and in which not. ABS measures should specify whether or under which conditions multiplication of an animal breed qualifies as “genetic utilization” and address the issue of change of intent, i.e. the situation where GRFA originally provided and received for purposes (e.g. human consumption) clearly outside the scope of ABS measures end up being used for research and development on their genetic and/or biochemical composition. In this context, it will also be relevant for ABS measures to consider customary practices of GRFA use and exchange (see feature F.1) and possible implications for agricultural commodity trade (see feature D.4).

D.4 Many agricultural products reach the market place in a form in which they may be used both as biological resources and as genetic resources.

36. Many agricultural products, including commodities, are sold in a form that potentially allows their use as a genetic resource, for instance in multiplication and breeding activities. Whether they are going to be used only as a biological resource (e.g. consumption) or also as a genetic resource (i.e. for research and development on their genetic and/or biochemical composition) will be often unclear and unpredictable at the time of the market transaction. It might sometimes be difficult to distinguish between exchanges of biological resources and exchanges of genetic resources.

37. While this is in principle true for all subsectors, the proportion of agricultural commodities that can be used for reproduction varies among subsectors and species. Plant GRFA are a prominent case, as for the major crops on which the world's food supply depends, the main commodity is at the same time the reproductive unit, the seed. It is less pronounced, for instance in the livestock or forestry sector, where the main commodities, like milk, meat or wood, are not the reproductive unit. But also in those sectors reproductive units are sold as commodities for production and grow-out (see examples under D.3 above). The degree to which the purpose of use is predictable in those cases, depends on the level of differentiation and specialization in breeding/reproduction on the one hand, and production on the other. If reproduction and breeding have been centralized in the hands of specialized actors and separated from production and grow-out, this often also implies that genetic material with different characteristics is developed for the different purposes, and it usually becomes easier to determine which genetic material is going to be used for which purpose. For example, forest reproductive material of mixed progeny might be sold for plantation purposes, while genetic material of single progeny would be supplied if the intention is further breeding. Another factor that makes the use of genetic material as a genetic resource more predictable, is the existence of specialized conservation activities. For example, it can be assumed that the majority of germplasm accessed from a genebank will be used for further research and breeding and not for direct production.

38. Therefore, targeting ABS measures exclusively at the use and exchange of genetic resources and not at the exchange of biological resources, in order not to interfere with ordinary market transactions of agricultural commodities, may become a complex exercise.

Cluster E: Holders and users of GRFA

E.1 GRFA are held and used by a broad range of very diverse stakeholders. There are distinct communities of providers and users with respect to the different subsectors of GRFA.

39. In the food and agriculture sector, many different stakeholders are involved in the management of genetic resources, including, *inter alia*, subsistence farmers and local communities, the market-oriented farming sector, public and private genebanks and collections, research institutions at national and international levels, and small- and large-scale companies. The different holders and users of GRFA operate in very diverse realities, with different financial, technical and legal capacities. While all subsectors of food and agriculture are characterised by the large diversity of stakeholders managing genetic resources, the number of involved actors may differ. For instance, compared to the livestock and crop sectors, the user communities of the forestry and even more the invertebrate sectors is rather small.

40. The diversity of stakeholders, their different roles, including bargaining power, are issues ABS measures could address through a variety of measures, such as capacity-building.

E.2 The different stakeholders managing and using GRFA are interdependent.

41. The conservation, management and utilization of GRFA are a major endeavour that requires extensive resources and capacities as well as highly specialized skills and knowledge. The work is divided among a broad range of actors holding and using GRFA and fulfilling different functions along the value chain. Consequently, GRFA are frequently exchanged and many stakeholders act both as providers and recipients of genetic material. No single actor or stakeholder group may perform all the required tasks and the activities are intertwined in a complex network of interdependencies. Cooperation among stakeholders becomes the cornerstone of effective conservation and sustainable utilization, for food security and agricultural development.

42. The interdependence among highly specialized stakeholders applies to all subsectors of food and agriculture and can for example be observed in the development of a new biological control agent. The process might start with preliminary surveys of the target pest and its natural enemies carried out by partner research institutions in several countries. Some specimens of pests and natural enemies would usually be sent for identification and taxonomic studies to international specialists in academic institutions around the world. Subsequent detailed studies on natural enemies to assess their potential as biological control agents could be carried out by again another public research centre or university in the source country, while host-specificity studies involving plants or animals not naturally occurring in the source country would be carried out in quarantine in the target country or in a third country. The development of rearing, distribution and release methods may be undertaken by commercial producers.

43. Where cooperation of many different stakeholders is a prerequisite for the effective conservation and use of GRFA, the regulatory environment, including ABS measures, could be designed to facilitate such cooperation.

E.3 A significant amount of GRFA is privately held.

44. As an integral part of agricultural and food production systems, GRFA are often held and exchanged privately by farmers and producers, breeding companies and other suppliers of agricultural inputs, the food processing industry and commercial traders. Genetic resources may be owned in many different forms, such as live animals, commercial seed, brood stock, seedlings, genetic material in private collections, and breeding pools of private companies.

45. The proportion of GRFA that are under private ownership varies considerably among subsectors. While privately owned material accounts for the majority of genetic resources held and exchanged in the farm animal sector, the situation in the sectors using micro-organism, plant and aquatic GRFA seems to be more balanced between privately and publicly held material. For forest and invertebrate GRFA, privately held genetic material only plays a minor role. The impact of ABS measures covering privately held genetic material is therefore likely to vary depending on the sector and the relative importance privately held GRFA plays in it.

E.4 An important part of GRFA is held and can be accessed *ex situ*.

46. Many genetic resources of special value for food and agriculture have been collected from their *in situ* environments and are stored and made available by *ex situ* facilities. *Ex situ* collections may fulfil different purposes, including: conservation and regeneration of genetic diversity; characterisation and authentication of genetic material; and working collection for research or breeding programmes. Depending on its characteristics, the genetic material is stored in different forms and under different conditions, ranging from in vivo to in vitro and seed and deep-freezing storage systems. *Ex situ* facilities are often, but not always, maintained by public institutions at national, regional and international levels. They mostly act as intermediaries in the value chain, in the sense that they are neither the original providers of the genetic resource nor the end users in terms of

product development and commercialisation. However, they perform an indispensable function in the overall operation of the sector and constitute an important part of GRFA exchanges.

47. Many GRFA are held in *ex situ* collections. This is particularly true for plant and microbial GRFA, where national and international collections play a particularly important role. It is much less true for forest and animal GRFA. Although *ex situ* collections do not play a role for aquatic GRFA at the moment, it can be expected that they will become more important for some species in the future. A particular characteristic of microbial culture collections is that they serve as a depository of authenticated samples, required for quality management in research and for patent applications. *Ex situ* collections of animal and forest GRFA mainly fulfil conservation purposes and are less involved in the provision of genetic material for breeding purposes.

48. As *ex situ* collections receive and provide genetic resources, including GRFA, ABS measures might be relevant to them. Their established exchange practices which often foresee the use of material transfer agreements (MTAs) could may provide useful models for GRFA-subsector specific ABS measures. Their role as intermediaries of GRFA might deserve special attention by ABS policy-makers.

Cluster F: GRFA exchange practices

F.1 The exchange of GRFA takes place in the context of customary practices and existing communities of providers and users.

49. The exchange of genetic material is a long-standing practice among various stakeholder groups and user communities in the food and agriculture sector. Genetic resources are often exchanged in the context of wider collaborative efforts towards research and development, and the different actors are bound to each other by recurrent interactions. Over time, many user communities have established their own practices and modalities of exchange, which may be formalized to varying degrees.

50. While all subsectors are characterized by existing communities of providers and users, the degree to which the established practices and modalities of exchange are formalized varies considerably among subsectors, production branches and stakeholder communities. Informal arrangements among members of professional networks and research communities have been a long-standing practice in many subsectors, including the biological control, forestry and aquaculture communities. More formalized arrangements include regional and international networks of microbial culture collections that have agreed on the use of common terms and conditions for the deposition of material and its further distribution. It might be useful to involve the existing communities of providers and users in the development of ABS measures, and to build upon existing practices and capacities related to the exchange of GRFA.

F.2 An extensive transfer of genetic material between different stakeholders along the value chain occurs in research and development.

51. GRFA are exchanged in often large numbers of samples of genetic material at different stages in the research and innovation process. At the beginning of the product development process, large numbers of germplasm samples may be accessed to screen the existing genetic diversity for interesting traits and identify the most suitable genetic material for the desired purpose. At later stages, there may be a recurring demand for access to germplasm in order to add new genetic variation to the research and development cycle. As different stakeholders fulfil different functions in the value chain, GRFA are frequently passed on from one person to the other before reaching the stage of commercialisation. Some of the stakeholders act more as a type of intermediaries in the process, providing certain services like characterisation, authentication or multiplication. All these factors lead to a high number of exchange events and imply that the transfer of genetic resources is normally not a one-shot event at the beginning of the research and product development process, but needs to be repeated many times.

52. Differences between and within subsectors may exist with regard to the reasons and timing of genetic material transfers. For example, screening and research purposes at early stages may play an important role in the development of a plant-growth promoting micro-organism and may lead to large numbers of exchanged material. In the case of cattle breeding, transfers of genetic resources may accrue over longer periods of time, as new diversity (in the form of breeding animals or semen) is added to an existing breeding population. Similarly, the division of tasks between partnering institutions in a rice-breeding programme may imply that genetic material is exchanged many times between the different institutions over the course of the breeding cycle. ABS measures could therefore aim to reflect that in many cases the transfer of GRFA is not a one-shot event but needs to be repeated many times during research and development.

Cluster G: Benefits generated with the use of GRFA

G.1 While the overall benefits of GRFA are very high, it is difficult to estimate at the time of the transaction the expected benefits of an individual sample of GRFA.

53. The monetary and non-monetary benefits that a potential recipient of GRFA can expect from the exchange and utilization of an individual germplasm sample, is often unknown at the moment of exchange and usually estimated to be rather low. This is, for example, the case when large numbers of genetic resources are exchanged for screening purposes, but only a very small fraction of the exchanged samples is eventually included in product development. It is also the case when genetic resources are exchanged in the course of incremental improvement and incorporated as one of many genetic components in potential products, contributing only a tiny part to their genetic set-up. However, the expected benefits from the use of an individual genetic resource usually augment with increasing characterization and generation of knowledge about the material.

G.2 The use of GRFA may also generate important non-monetary benefits.

54 The utilization of GRFA in research and development frequently generates non-monetary benefits that may in some cases be even more relevant than the profits that can be made. Non-monetary benefits may also arise independently of whether or not the product reaches the market place. At the same time, the potential for non-monetary benefit-sharing mechanisms, such as technology transfer, capacity building and information sharing, is increased by the fact that many countries make use of the same species, establish similar production systems and struggle with the same biotic and abiotic stressors. ABS measures have the opportunity to realize this potential.

G.3 The use of GRFA may lead to external effects going far beyond the individual provider and recipient.

55. Activities involving the use of GRFA, including product development and release, often generate external effects that go far beyond the individual provider and recipient of the respective genetic material. These external effects may, for example, contribute to the creation of important public goods such as rural development and poverty alleviation, environmental protection, food security and cultural diversity. At the same time, some of the potential benefits of using GRFA can only be realized at the collective level. This can, for example, be observed in the case of information and knowledge generated through use activities, which in some cases may unfold their full potential only by being compiled and made available to a broader public.