



The International Treaty
ON PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE



Research Study 2

**Innovative Approaches For Enhancing The Flow Of
Funds Into The Benefit Sharing Fund Of The
International Treaty On Plant Genetic Resources For
Food And Agriculture
An Evaluation Of Options**

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LIST OF ABBREVIATIONS

BSF	Benefit Sharing Fund
CGIAR	Consultative Group for International Agricultural Research
FAO	Food and Agriculture Organization of the United Nations
IPRs	Intellectual Property Rights
ITPGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
MLS	Multilateral System of Exchange of Plant Genetic Resources under the International Treaty
NARS	National Agricultural Research Systems
PGR	Plant Genetic Resources
PVP	Plant Variety Protection
SMTA	Standard Material Transfer Agreement
TRIPs	Agreement on Trade Related Aspects of Intellectual Property Rights

Introduction

The *Ad hoc Advisory Committee on the Funding Strategy* of the International Treaty on Plant Genetic Resources for Food and Agriculture observed in its seventh meeting in March 2013 (ITPGRFA, 2013a) that the flow of funds to Benefit Sharing Fund of the Treaty had stagnated with no indications that the trend would reverse in the near future. It also observed that no benefits from the use of germplasm from the Multilateral System had accrued to the Benefit Sharing Fund, despite earlier expectations. The Committee, therefore, suggested that the Governing Body of the Treaty should explore innovative options to increase funds flowing into the Benefit Sharing Fund. The Committee noted that the “options should be based on the use of plant genetic resources for food and agriculture and that the flow of funds should be predictable, immediate and reliable” (p.3). The Committee suggested a set of six options which should be explored further through option papers prepared by the Treaty Secretariat. The six options were (ITPGRFA, 2013b):

1. Revisiting Article 6.11 of the Standard Material Transfer Agreement (SMTA). This could involve making the alternative payment option in SMTA Article 6.11 the preferred payment option.
2. Revisiting Article 6.7 of the SMTA. This could involve making mandatory some payment obligations that are currently voluntary.
3. Promoting regular seed-sales based contributions by Contracting Parties – Contracting Parties could be invited to make regular contributions to the Benefit Sharing Fund, similar to those pledged by Norway.
4. Expanding the coverage of the Multilateral System through re-examination of the desirable composition of Annex-I to the Treaty.
5. Novel ways to attract industry to volunteer funding.
6. Upfront payments on access, to be discounted against payments due on commercialisation of a product.

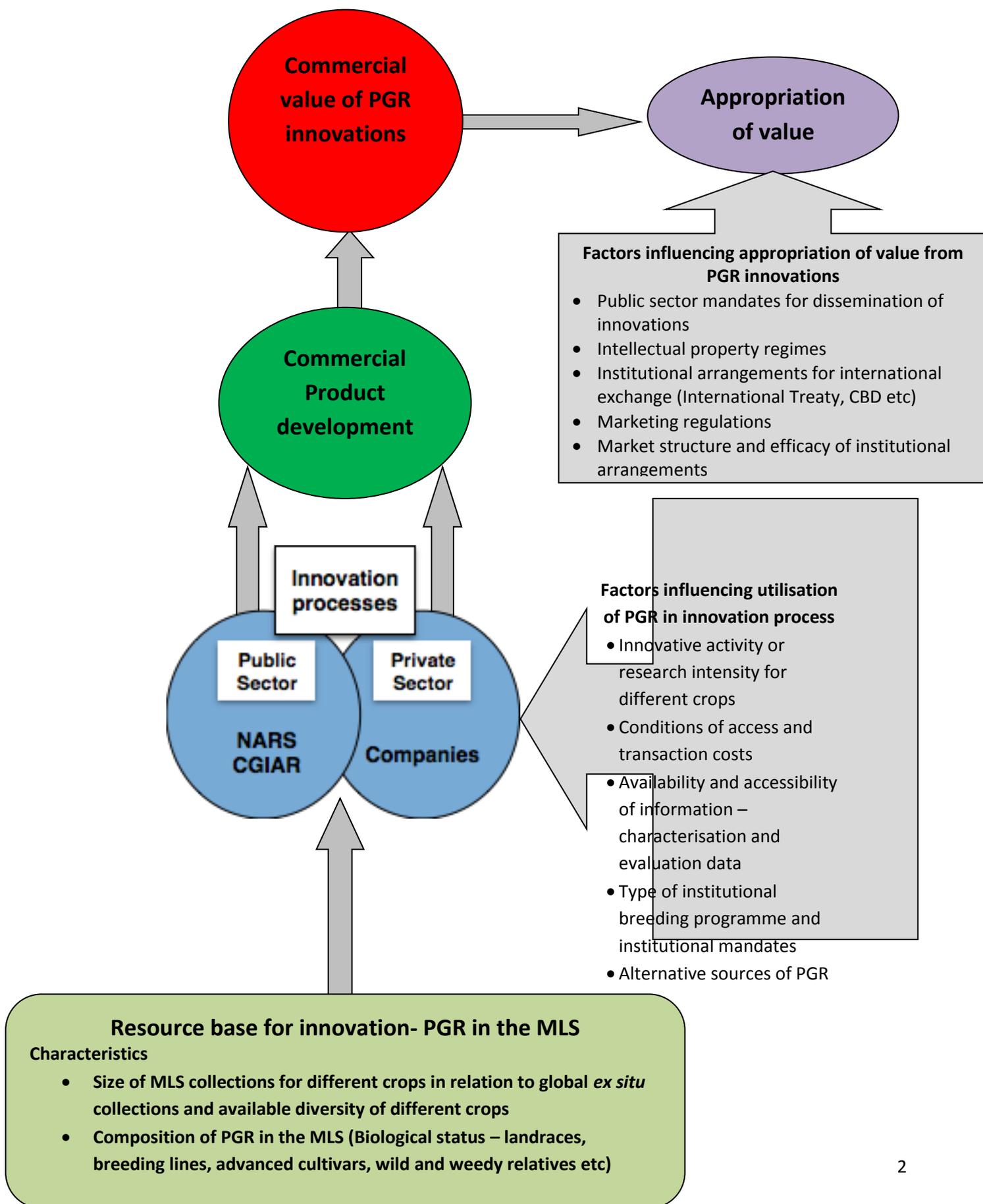
This report assesses the implications and revenue-generating potential of options 1, 2 and 4 above in the context of the structure of the global seed industry and the emerging landscape of plant variety innovation for different crops. The implementation of these options would require modification of Treaty/SMTA provisions to alter the nature of payment obligations related to different categories of products, the payment rates under different options and the coverage of crops in Annex-I to the Treaty.

Conceptual Framework

The conceptual framework for evaluating the options suggested by the Working Group is derived from an earlier study (Moeller and Stannard, 2013) on the potential benefit flows from the International Treaty and is presented in Figure-1. We do not discuss the conceptual framework in detail here but only note its key elements. The conceptual framework views the PGR available from the MLS primarily as a resource for plant variety innovation. The utilisation of this resource in innovation processes generates new products with commercial value. Institutional arrangements which include market structures and intellectual property regimes determine how the commercial value of innovations is appropriated by

different actors. SMTA-mediated PGR exchange under the Treaty is part of the institutional architecture that determines the appropriation of value and magnitude of flows into the BSF.

Figure-1: Conceptual Framework for Assessment of Benefit-Sharing Flows from PGR Exchange



Development of Options

Options 1 and 2 suggested by the Working Group (revisiting Articles 6.7 and 6.11 of the SMTA) could involve variations of different elements that determine payment obligations arising from the use of PGR accessed through SMTAs (hereinafter referred to as SMTA-PGR. The current architecture of payment obligations under SMTAs involves:

- (1) The alternative payment options offered to recipients of SMTA-PGR (here after called “Recipients”) – i.e., payment under Article 6.7 or Article 6.11 of the SMTA.
- (2) For each payment option:
 - (a) The categories of product innovations to which payment obligations apply.
 - (b) The nature of payment obligations – mandatory or voluntary- associated with each product innovation category.
 - (c) The rates of payment applicable to different product innovation categories.
 - (d) The duration for which payment obligations apply.

Under the current provisions of the SMTA, a Recipient can opt for payments into the BSF under Article 6.7 of the SMTA or alternatively opt for payment under Article 6.11 of the SMTA. Under Article 6.7 of the SMTA, a Recipient who commercialises a product innovation incorporating SMTA-PGR is required to make a mandatory payment of 0.77% (1.1% less 30%) of the sales of that product, if it is not available to others without restriction for further research and breeding. If the product is available to others without restriction for further research and breeding, then the Recipient is encouraged to make a voluntary payment, without any precise rate being specified, under Article 6.8 of the SMTA. A Recipient who opts for payment under Article 6.11 of the SMTA is obliged to make a payment of 0.5% of all sales of seeds/planting material of the crop to which the SMTA-PGR relates, whether or not the product derives from SMTA-PGR. The payment obligation under Article 6.11 subsists for a period of 10 years after which the Recipient can decide to opt out of application of this Article.

Mandatory versus Voluntary Payments: As noted above, mandatory payment obligations into the BSF arise only when innovations incorporating SMTA-PGR which are commercialised are not freely available to others without restrictions for further research and breeding. As explained below, an important implication of this provision is that mandatory payment obligations are confined to a very narrow range of innovations and may arise only in a limited number of countries. Although voluntary payments into the BSF are encouraged under Article 6.8 for innovations which are freely available to others for further research and breeding, both public and private sector users of SMTA-PGR have shown little inclination to make voluntary payments into the BSF. For enhancing revenue flows into the BSF an important option would be the conversion of voluntary payments into mandatory payments and/or the application of mandatory payments to a broader range of product innovation categories.

Product Innovation Categories: The principle underlying the architecture of the BSF is that benefit-sharing payments must arise when product innovations incorporating SMTA-PGR are commercialised. However, under Article 6.7, mandatory payment obligations arise only when the product innovation which is commercialised is *not* available without restriction to others for further research and breeding. The mandatory payment obligation under Article 6.7 has, therefore, been interpreted as being only applicable to product innovations that are protected by patents, because the “research exemption” or the permitted use of a patent-protected product for further research and development is extremely restricted.

However, most plant variety innovations in developed countries are protected not by patents, but by Plant Variety Protection (PVP), which is a *sui generis* form of intellectual property protection for plant variety innovations that takes into account the special characteristics of these innovations - their self-reproducing nature and their sequential nature where each innovation is dependent on previous innovations. The criteria for protection in the case of PVP are “Distinctness, Uniformity and Stability”¹ and it generally allows for two exemptions that distinguish it from patents (1) the breeders’ exemption, which allows a breeder to use a protected variety in the development of follow on innovations² and (2) farmers’ privilege/rights –which allows farmers to use farm-saved seed of protected varieties³ without payment of remuneration to the breeder. The availability of breeders’ exemption under PVP has been interpreted to mean product innovations protected by PVP are freely available without restriction to others for further research and breeding, and, therefore, do not attract mandatory payments under Article 6.7 if they incorporate SMTA-PGR. Only voluntary payments under Article 6.8 of the SMTA are encouraged for such innovations. A major implication is that the dominant proportion of plant variety innovations in developed countries that may incorporate SMTA-PGR are excluded from the purview of mandatory benefit-sharing arrangements under the International Treaty. It must also be noted that patents for plant varieties are available only in a limited number of countries⁴ (e.g., US, Australia, Japan, South Korea) and like all other forms of intellectual property rights, patents are national in scope. Thus, while a plant variety protected by patents in Australia and incorporating SMTA-PGR would be liable for mandatory payments, the same variety protected by PVP (or sold without protection) in another country would not attract mandatory payments. Moreover, following from the implementation of Article 27 (3) of the TRIPs Agreement, most developing countries are likely to adopt PVP or an appropriate *sui generis* system of protection for plant variety innovations rather than a system of patents. The current SMTA provisions exclude a dominant part of current and future plant variety innovations in both developed and developing countries from the purview of mandatory benefit-sharing arrangements. It should be noted that although PVP provides for breeders’ exemption, it is still an intellectual property right that provides monopoly rights to the innovator (for multiplication and

¹ As opposed to novelty, non-obviousness and potential for industrial application/commercial use in the case of patents.

² Researchers’ exemption under PVP has been sought to be circumscribed through the introduction of the “Essential Derivation” clause in the 1991 revision of the UPOV Convention (UPOV, 1994). The essential derivation clause seeks to prevent other breeders from appropriating returns from a protected variety through minor (agronomically unimportant) modifications of the protected variety. Under the essential derivation clause, if a new plant variety innovation is shown to “essentially derived” from a protected variety, then the commercialisation of that new variety requires the consent of the breeder of the original variety. The essential derivation clause seeks to strengthen the IPR protection provided by PVP by preventing second round innovators from appropriating returns due to first round innovators through “cosmetic breeding” or relatively unimportant modifications of a protected variety.

³ Farmers’ privilege to replant seeds of protected varieties without payment of remuneration to the breeder has been restricted in the PVP legislation of many European countries and farmers are required to pay (a reduced) PVP royalty on the use of farm-saved seeds of protected varieties. In the European Union wide PVP legislation administered by the Community Plant Variety Office (CPVO)(European Council, 1994), exemption from payment of royalties on farm-saved seed of protected varieties is available only for the category of “small farmers”.

⁴ The position regarding the patentability of plant varieties in the EU is complex. Although the European Patent Convention 1973 does not allow for plant varieties and essentially biological processes for the production of plants to be patented, the 1998 Directive of the European Parliament and the Council of the European Union on the legal protection of biotechnological inventions (European Council, 1998) allows the patenting of plants when the technical feasibility of the invention is not confined to a particular plant variety.

distribution of the variety), allowing the innovator to appropriate economic returns from the innovation. Therefore, extension of mandatory payment obligations to product innovations that are protected by PVP is an important option to be explored for enhancing revenue flows into the BSF, as it would bring a very large part of developed country innovations within the ambit of (mandatory) benefit-sharing arrangements.

National Agricultural Research Systems (NARS) in developing countries and the CGIAR centres that undertake breeding work for developing country environments are the largest users of SMTA-PGR (FAO, 2010). A very large proportion of innovations utilising materials accessed from the MLS has been derived from the research activities of NARS in developing countries, often in collaboration with International Agricultural Research Centres (IARCs) of the CGIAR. Starting from the “Green Revolution” varieties in wheat and rice in South Asia, NARS in developing countries have produced a steady stream of plant variety innovations that have transformed the production and productivity of a range of crops in developing country agriculture with very large welfare effects⁵. However, the innovations developed by NARS in developing countries have been disseminated freely for commercial multiplication and distribution by public and private sector agencies and have not been subject to any form of intellectual property rights. As these innovations have remained freely available for further research and breeding, they do not attract mandatory payment obligations if they incorporate SMTA-PGR. There have been no voluntary payments into the BSF under Article 6.8 of the SMTA for innovations developed by NARS in developing countries. This is presumably because NARS are mandated to provide widespread dissemination of their innovations and do not seek an economic return from their innovations. Moreover, many of the PGR accessed from the MLS for the development of these innovations may have been originally contributed to the MLS by developing countries themselves.

It should also be noted that in most developing countries, new varieties developed by NARS are subject to evaluation (for “value in cultivation and use”) through national trials before being released to farmers through variety release procedures. The varieties released to farmers through these variety release procedures⁶ are generally brought within the ambit of seed quality control regulations, as seed sales of these varieties are expected to be commercially significant. Once the new varieties are brought under the purview of quality control regulations, the production and distribution of seeds of these varieties may be subject to a number of restrictions designed to ensure that only quality seeds of these varieties are sold to farmers. For instance, it may be prescribed that only certified seed of these new varieties (produced in accordance with prescribed seed production norms/regulations⁷) may be sold. Bringing varieties developed by NARS under the purview of the quality control system is what enables public and private sector seed producers to develop and sustain a commercial market for seeds of these varieties

⁵ There is a large literature documenting the contribution of collaboration between the CGIAR centres and NARS to the development of plant variety innovations that have transformed agricultural productivity in developing countries. For instance, see Evenson and Gollin (2002) and Brennan and Malayabas (2011).

⁶ Variety release procedures differ across countries. They are generally intended to be in the nature of credible and authentic recommendations to farmers for the adoption of new varieties developed by NARS or other agencies in specific agro-ecological zones. To ensure that the farmers receive the most appropriate recommendations for adoption of varieties, new varieties are generally subjected to trials or testing over several crop seasons for “value in cultivation and use”. Only new varieties which perform well in the trials in respect of different agronomic characteristics and yield are recommended for adoption to farmers or “released” to farmers. The release of the variety sets in motion the process of seed multiplication and dissemination to farmers through public or private sector seed companies or other agencies.

⁷ This may require access to the “breeder seeds” of the variety produced by NARS.

and obtain an economic return from their multiplication and distribution. When we examine the innovations generated through the use of PGR sourced from the MLS, we can distinguish a large and significant category of “regulated” products, which although not (yet) subject to any form of intellectual property protection, are subject to regulations that govern seed production and marketing. The extension of some form mandatory payment obligation to this category of regulated products is a potential option for enhancing revenue flows into the BSF.

The above character of plant variety innovations of developing country NARS may undergo significant change in the future. As a consequence of Article 27(3) of the TRIPs Agreement, many developing countries have introduced or are in the process of introducing some form of PVP legislation (Tripp, Louwaars and Eaton, 2007). In developing countries where PVP systems have been introduced (e.g., India, Brazil), NARS appear to have been quite active in seeking protection for their innovations. In countries where the PVP legislation permits, NARS have also sought retrospective protection for their innovations developed before the entry into force of the PVP legislation. If this trend continues, a large part of the innovations of NARS in developing countries will become subject to PVP over time.

Payment rates associated with different options/product categories: The payment rates prescribed under Article 6.7 (0.77% of sales of product innovation incorporating SMTA-PGR) and Article 6.11 (0.5% of sales of all seeds of crops for which SMTA-PGR has been accessed) do not appear to have been informed by an analysis of the incentives they provide Recipients for choice of the payment option. At the current rates of payment prescribed under Article 6.7 and Article 6.11, it would economically advantageous for a Recipient to choose Article 6.11 only if SMTA-PGR derived products constitute more than 65%⁸ of the sales of seeds of a particular crop. For most plant breeding/seed firms of any size, this threshold of 65% would not be reached in the foreseeable future or may never be reached at all. It should also be noted that payment obligations under Article 6.7 commence only after an SMTA-PGR product is commercialised (which may happen only several years after SMTA-PGR has been accessed), whereas payment obligations under Article 6.11 commence immediately after SMTA-PGR has been accessed. From the perspective of the BSF, the current structure of payment rates appears to dissuade Recipients from opting for Article 6.11, which can generate earlier flows into the fund. Alteration of payment rates under Article 6.7 and Article 6.11 to incentivise the adoption of Article 6.11 by Recipients would be important option for enhancing the near term flow of funds into the BSF.

The current structure of payment rates involves a common rate applicable to (1) all product categories that attract mandatory payments under Article 6.7 and (2) all product categories that attract payment obligations under Article 6.11. However, it is well established in the intellectual property rights literature (see for instance Maskus, 2005), that the returns appropriated from an innovation by an innovator depend on the strength of intellectual property protection. A new plant variety protected by patents (which hence does not allow for breeders’ exemption or farmers’ rights) is likely to yield a higher economic return to an innovator than a variety that is protected by PVP (a relatively weaker form of protection) or a variety which falls in the “regulated” category of products which may not be protected by any form of intellectual property rights at all. If benefit-sharing obligations are to be related to the returns appropriated by innovators, then there would be a strong economic rationale for applying different payment rates to different product categories of product innovations based on their

⁸ The Article 6.11 option would be chosen by an SMTA Recipient only if:

Payment obligations under Article 6.11 < Payment obligations under Article 6.7

=> $0.005 \times \text{Commercial seed sales of SMTA-PGR crop} < 0.0077 \times \text{Commercial seed sales of SMTA-PGR crop} \times \text{Share of SMTA-PGR derived varieties in seed sales of that crop}$

=> $\text{Share of SMTA-PGR derived varieties} > 0.6493$ (or approximately 65%)

intellectual property protection status – with the highest rate being applied to patent protected products, a lower rate for PVP protected products and a still lower rate applied to “regulated” products.

Choice of payment options: As discussed above, from the perspective of enhancing (near term) flow of funds into the BSF, it may be advantageous to incentivise Recipients to opt for payments under Article 6.11. The most certain way of achieving this would be the elimination of the Article 6.7 option under the SMTA, leaving only the option under Article 6.11. The withdrawal of the Article 6.7 option (with suitable modifications to Article 6.11) could, therefore, be considered as an one way of enhancing revenue flows into the BSF. Less certain ways of creating this incentive would be to balance the relative payment levels for patents and for PVP in such a way that patents payment rates are substantially higher.

Static and Dynamic Analysis

Plant variety innovation is a dynamic and sequential process often involving long lead times between PGR access and the emergence of innovations that can be commercially exploited. Payment obligations to the BSF – voluntary or mandatory (under Article 6.7 and 6.8 of the SMTA) – are linked to the commercial exploitation of innovations developed using SMTA-PGR. This implies that payment flows into the BSF may arise with a considerable time lag after PGR has been accessed through an SMTA. Depending on the length of the breeding cycle and type of material accessed, the lag between PGR access and payment flows could be 10-15 years or more. The evaluation of the options suggested by the Working Group, therefore, need to be carried out from two perspectives (1) a **static perspective**, which examines the potential flows from the options given the current structure of the seed industry in developed and developing countries and the current status of innovation in different crops (which reflect past access and use of PGR from the MLS or its predecessor institutions) and (2) a **dynamic perspective**, which examines the potential flows from the options, reflecting the projected future use of SMTA-PGR and the generation of plant variety innovations over an extended period of time. This study presents the evaluation of options from a static perspective. The evaluation of options from a dynamic perspective is presented in a separate report.

Static Analysis

Options for Static Analysis

Based on the above discussion of possible variations in elements that constitute the current architecture of payment obligations under the SMTA, we have developed the following options for the static analysis of revenue-enhancing options.

Option 1 - Baseline or Status Quo Option: This option provides the benchmark for comparison with all other options. It assesses the potential flow of funds into the BSF retaining the current structure of payment obligations under the SMTA, the current payment rates under Article 6.7 and Article 6.11 and the nature of payment obligations (mandatory or voluntary) associated with different product categories.

Option 2 – Revisiting Article 6.7 of the SMTA - This option envisages extension of mandatory payments to product categories incorporating SMTA-PGR that currently do not attract mandatory payment obligations. We consider two scenarios under this option:

Scenario 1: This scenario envisages extension of mandatory payments to PVP products that incorporate SMTA-PGR.

Scenario 2: This scenario envisages extension of mandatory payments to PVP and regulated products that incorporate SMTA-PGR.

Under both these scenarios, we allow for varying rates of payments to be applied to different product categories – with patented products attracting a higher rate of payment than PVP products and PVP products attracting a higher rate of payment than regulated products (where applicable).

Option 3- Revisiting Article 6.11 of the SMTA: This option will assess the potential revenue flows into the BSF if Article 6.11 were to be made the sole payment option (i.e., with Articles 6.7/6.8 being withdrawn) with a narrowing of product categories that attract Article 6.11 payments and with lower payment rates applicable to different product categories. Again we provide for patented products attracting a higher rate of payment than PVP products and PVP products attracting a higher rate of payment than regulated products (where applicable). The assessment of potential revenue flows under this option is made on the assumption of universal use of SMTA-PGR by all players in the seed industry

Option 4 - Expansion of Crop Coverage under Annex-I: Separately, we will examine the impact of expanding the coverage of Annex-I to include all crops. We will examine the potential effects on revenue flows into the BSF of inclusion of certain major crops like soybean, vegetable crops like tomatoes and onions and industrial crops like cotton.

Data and Methodology

An assessment of the potential flow of revenue into the BSF in the above scenarios involves the following steps:

- (1) Identification of commercialised product innovations incorporating SMTA-PGR in national seed markets for crops covered in Annex-I of the International Treaty.
- (2) Identification of the intellectual property rights to which the commercialised product innovations are subject in different national jurisdictions.
- (3) Assessment of the commercial sales of product innovations incorporating SMTA-PGR in different national markets to derive the payment obligations under the SMTAs.

The assessment of potential revenue flows into the BSF, therefore, requires reliable data on national commercial seed markets, the share of products that incorporate SMTA-PGR and the intellectual property rights to which they are subject in different jurisdictions. Box-1 discusses the data sources and constraints related to the analysis of national seed markets. A major constraint is the general non-availability of variety-level information for commercial seed markets which is critical for the evaluation of the options.

Box-1: Data Sources and Constraints for Analysis of National Seed Markets

An accurate assessment of the value of the global commercial seed market is a difficult exercise because of the absence of reliable and consistent data sources across countries. In almost all countries, the extensive use of farm-saved seed for different crops implies that commercial seed use is a fraction of the total seed use. The proportion of commercial seed use to total seed use is reflected in the “Seed Replacement Rates” (SRRs) which vary widely across crop, type of variety (hybrid versus non-hybrids), countries and over time. Thus, even where reliable estimates of seed use are available from crop production data, the estimation of the volumes of commercial seed requires information on seed replacement patterns adopted by farmers. Derivation of the value of commercial seed sold from volume data further requires information on seed prices which are also subject to wide variation across individual varieties and countries.

Commercial seed is sold in seed markets by public and private sector companies of varying sizes – ranging from small independent seed companies producing and marketing seed locally to giant global companies that market seeds across continents. While published reports and accounts may provide some information on the seed sales of these companies, there is no organised statistical system for collection and consolidation of seed sales data at the provincial or national level in most countries. The information from published reports of seed companies may not provide information on the value of seed sales by crop. Variety level information (which is critical for assessment of payment obligations under SMTAs) is invariably never provided as companies regard variety level data to be commercially sensitive. For large global companies operating in several countries (often through a web of affiliated, “group” or subsidiary companies) and covering several different types of agricultural inputs, the assessment of the value of commercial seed sales by crop from published reports may be infeasible or very complex. Seed industry association at the national or international level do often compile seed sales of members – but again data coverage of crops and industry segments varies considerably and data may not be made available publicly at a disaggregated level. Variety information is again not available. In seed markets characterised by intense competition for market share, industry players have few incentives to disclose variety level information.

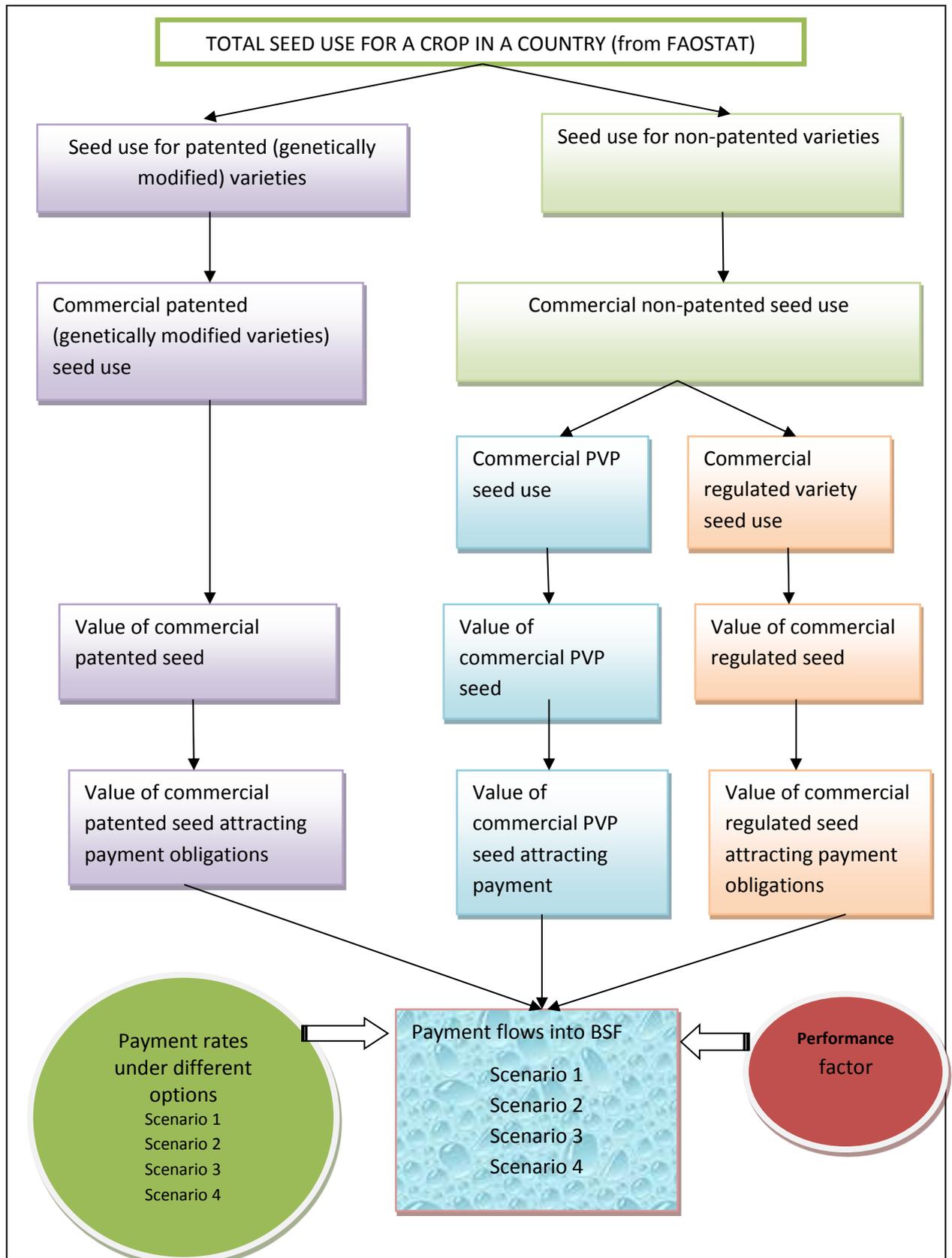
Commercial seed is sold in national jurisdictions subject to marketing and quality control regulations. It is data generated in the enforcement of these regulations that provide the most reliable data on commercial seed use at the crop (and at times, variety) level. In countries with variety registration systems, commercial seed can be sold only if a variety has been registered or inscribed in a national register. In the EU, varieties of agricultural plant species and vegetable seed can be marketed only if they are inscribed in the EU common catalogue of varieties, which is updated every year. Many countries also have variety release procedures or a list of recommended varieties (which are in the nature of recommendations to farmers for adoption). Variety registration systems and recommended variety lists are, therefore, an authentic source of information on the varieties that can be commercialised in different jurisdictions. Most countries also operate seed certification systems for quality control that may be mandatory or optional. In most EU countries, seed certification is compulsory, which implies that all commercial seed sales must be subject to seed certification. In countries, where seed certification is compulsory, seed certification statistics provide authentic data on variety-wise¹ volumes of commercial seed produced. However, in other countries (e.g., the USA and many developing countries), seed certification may be optional or may apply only to a set of varieties (e.g., released varieties) brought under the purview of quality control regulations. In such cases, seed certification statistics may provide only a partial view of the commercial seed market, although leading varieties may be covered. The OECD operates a certification scheme² for seeds of selected cereal, forage and vegetable crops moving in international trade. Nearly, 58 countries (including some non-OECD countries) participate in these schemes. The list of varieties eligible for certification under the OECD schemes is a useful source of information on varieties moving in international trade for the crops covered. Although, the OECD collects information on the volume of certified seeds traded under the scheme, variety level information is not published.

International seed trade statistics are another potential source of information on the size of the global commercial seed market, although, by definition, trade statistics exclude commercial seed produced and sold in domestic markets. The availability of data on seed trade at the crop level for different countries depends on the level of detail in the classification of goods adopted for generating international trade data. Trade statistics are recommended to be compiled under the Harmonized Commodity Description and Coding System (HS) of tariff nomenclature - an internationally standardised system of names and numbers for classifying traded products developed and maintained by the World Customs Organization (WCO) an independent intergovernmental organization with over 170 member countries based in Belgium. The HS system at the six digit level does not distinguish between seed and grain for most crops (i.e., the trade in seed is clubbed with trade in grain). However, some countries (e.g., EU, USA, China and India) have extended the classification to 9 or 10 digits (i.e., incorporated additional sub-categories) which allows “seeds for planting” to be distinguished as a separate category. Therefore, the availability of data on imports and exports of seeds at the crop level is available only for some countries that have gone beyond the mandatory six-digit classification of traded goods. Trade statistics on seeds even when they are available do not, however, provide any variety level information. Estimation of commercial seed volumes/value from international trade statistics is also confounded by the problem of import and re-export of seeds which is significant phenomenon for seeds of several crops (e.g., forage crops).

Data on the global commercial seed market is also available from a number of commercial market research reports and seed market databases. These reports and data bases are mainly intended to assess market opportunities and competition in different markets and vary greatly in their scope and coverage of crops, countries and companies (often focusing on the largest players in the market). (Reproduced from Moeller and Stannard, 2013, p 72-74).

Given the data constraints for commercial seed markets discussed in Box-1, this study constructs a simulation model for estimating revenue flows into the BSF under the different scenarios using FAOSTAT data (FAOSTAT, 2013) which is possibly the largest and most comprehensive database of country and global level agricultural statistics available. The modelling approach estimates the size of the commercial seed market for each crop in Annex-I of the International Treaty in each country and then attempts to assess the share of product innovations that incorporate SMTA-PGR. Starting with FAOSTAT data on area harvested, crop production, seed use and producer prices, the simulation model relies on a number of key parameters (e.g., seed replacement rates, factors relating seed prices to commodity prices, patterns of intellectual property rights of plant variety innovations etc – all of which are explained in detail below) whose initial values are derived from the literature and earlier studies assessing potential payment flows into the BSF. These parameters are applied to the FAOSTAT data on crop production and seed use to derive the commercial values of products incorporating SMTA-PGR that may give rise to mandatory or voluntary payments under the SMTA. The model allows the simulation of revenue flows into the BSF for the different scenarios with varying values of these parameters. The spreadsheet version of the model has been constructed in such a way that as more accurate and reliable information on the parameters becomes available, the estimates of inflows into the BSF can be updated. The model and the steps underlying the simulation exercise are described below. The overall schema of the model is presented in Figure-2.

Figure-2: Schema of Simulation Model for Estimating Potential Inflows in BSF



(1) In the first step, the 64 crops covered in Annex-I of the International Treaty were mapped to FAOSTAT crop categories for which data on crop production were available (Table-1). It may be seen from Table-1 that for a number of crop categories in Annex-I there is no data available in FAOSTAT. An important crop category for which no information is available in FAOSTAT is forages. It should be noted that the forages included in Annex-I of the International Treaty are mainly temperate forages, while tropical forages are excluded. MLS collections of PGR of temperate forages are relatively small in relation to those of cereal crops⁹. That is, the MLS may not be a very important source of PGR for temperate forages. For certain other categories of crops, although data on production quantity and values are available, there is no data on seed/planting material use. Some key categories for which seed/planting material data are lacking are:

- a. *Horticultural Crops*: Fruit crops like apples, strawberries and bananas are vegetatively propagated. Some horticultural crops are perennial crops (e.g., apples), which implies that growers may need to procure planting material only periodically. Although there is a significant commercial market in the planting material of horticultural crops, there appears to be no data available on the size or value of these markets.
- b. *Vegetable Crops*: The value of the global commercial vegetable seed/planting material market has been estimated at US \$ 6 billion in 2012 (MarketsandMarkets, 2013) with nearly US \$1.2 billion being accounted for by Annex-I crops. However, data on seed use for vegetable crops is not available from FAOSTAT. Seed use for these crops was estimated from the area cultivated in each country (for which data were available from FAOSTAT) and average seed use rates per hectare obtained from the literature.
- c. *Root and tuber crops*: Most root and tuber crops are propagated through the use of farm-saved seed tubers or through stem-cuttings (e.g., cassava) and there appears to be no significant commercial seed/seed tuber market for root and tuber crops with the significant exception of potatoes and sweet potatoes.

In view of these data constraints, forages and horticultural crops included in Annex-I have been excluded from the analysis. In the case of root and tuber crops, it has been assumed that there is no commercial seed/planting material market for cassava, yams and taro¹⁰. It should be noted that our assessment of potential revenue flows into the BSF excludes payments that may arise from the use of SMTA-PGR of these crops.

⁹ Forages constitute around 7% of the global ex-situ accessions of all crops (FAO, 2010).

¹⁰ While there appears to be no well defined commercial market for the propagating material of these crops, programme interventions in developing countries have focused on the supply of disease free planting material of these crops to farmers.

Table-1: Annex-I crops mapped to FAOSTAT crop categories

Annex-I Crop Category				FAOSTAT Crop Category
Crop	Genus	Classification	Subclass	
Oat	Avena	Food	Cereal	Oats
Barley	Hordeum	Food	Cereal	Barley
Rice	Oryza	Food	Cereal	Rice
Rye	Secale	Food	Cereal	Rye
Triticale	Triticosecale	Food	Cereal	Triticale
Wheat	Triticum et al.	Food	Cereal	Wheat
Maize	Zea	Food	Cereal	Maize
Finger Millet	Eleusine	Food	Millets	Millets
Pearl Millet	Pennisetum	Food	Millets	
Sorghum	Sorghum	Food	Millets	
Beans	Phaseolus	Food	Pulses and Beans	Beans
Faba Bean / Vetch	Vicia	Food	Pulses and Beans	
Pigeon Pea	Cajanus	Food	Pulses and Beans	Pigeon Pea
Chickpea	Cicer	Food	Pulses and Beans	Chickpea
Grass pea	Lathyrus	Food	Pulses and Beans	Peas
Pea	Pisum	Food	Pulses and Beans	
Cowpea et al.	Vigna	Food	Pulses and Beans	Cowpea
Lentil	Lens	Food	Pulses and Beans	Lentils
Sunflower	Helianthus	Food	Oilseed	Sunflower
Brassica complex		Food	Oilseed	Rapeseed & Mustard
Major aroids	Colocasia, Xanthosoma	Food	Roots and Tubers	
Yams	Dioscorea	Food	Roots and Tubers	Yams
Sweet Potato	Ipomoea	Food	Roots and Tubers	Sweet Potatoes
Cassava	Manihot	Food	Roots and Tubers	Cassava
Potato	Solanum	Food	Roots and Tubers	Potatoes
Asparagus	Asparagus	Food	Vegetable	Asparagus
Beet	Beta	Food	Vegetable	Sugarbeet
Carrot	Daucus	Food	Vegetable	Carrots and Turnips
Eggplant	Solanum	Food	Vegetable	Eggplant
Brassica complex	Brassica et al.	Food	Vegetable	Cabbages and other Brassicas
Breadfruit	Artocarpus	Food	Fruit/Food	No FAOSTAT data
Citrus	Citrus	Food	Fruit	All Citrus Fruits
Coconut	Cocos	Food	Fruit	Coconuts
Strawberry	Fragaria	Food	Fruit	Strawberry
Apple	Malus	Food	Fruit	Apples
Banana / Plantain	Musa	Food	Fruit	Bananas ;Plantains
Andropogon	gayanus	Forages	Grass	No FAOSTAT data
Agropyron	cristatum, desertorum	Forages	Grass	
Agrostis	stolonifera, tenuis	Forages	Grass	
Alopecurus	pratensis	Forages	Grass	
Arrhenatherum	elatius	Forages	Grass	
Dactylis	glomerata	Forages	Grass	
Festuca	arundinacea, gigantea, heterophylla, ovina, pratensis, rubra	Forages	Grass	

Annex-I Crop Category				FAOSTAT Crop Category
Crop	Genus	Classification	Subclass	
Lolium	hybridum, multiflorum, perenne, rigidum, temulentum	Forages	Grass	No FAOSTAT data
Phalaris	aquatica, arundinacea	Forages	Grass	
Phleum	pratense	Forages	Grass	
Poa	alpina, annua, pratensis	Forages	Grass	
Tripsacum	laxum	Forages	Grass	
Astragalus	chinensis, cicer, arenarius	Forages	Legume	
Canavalia	ensiformis	Forages	Legume	
Coronilla	varia	Forages	Legume	
Hedysarum	coronarium	Forages	Legume	
Lathyrus	cicera, ciliolatus, hirsutus, ochrus, odoratus, sativus	Forages	Legume	
Lespedeza	cuneata, striata, stipulacea	Forages	Legume	
Lotus	corniculatus, subbiflorus, uliginosus	Forages	Legume	
Lupinus	albus, angustifolius, luteus	Forages	Legume	
Medicago	arborea, falcata, sativa, scutellata, rigidula, truncatula	Forages	Legume	
Melilotus	albus, officinalis	Forages	Legume	
Onobrychis	viciifolia	Forages	Legume	
Ornithopus	sativus	Forages	Legume	
Prosopis	affinis, alba, chilensis, nigra, pallida	Forages	Legume	
Pueraria	phaseoloides	Forages	Legume	
Trifolium	alexandrinum, alpestre, ambiguum, angustifolium, arvense, agrocicerum, hybridum, incarnatum, pratense, repens, resupinatum, rueppellianum, semipilosum, subterraneum, vesiculosum	Forages	Legume	
Atriplex	halimus, nummularia	Forages	Other	
Salsola	vermiculata	Forages	Other	

- (2) For each Annex-I crop included in the analysis, data were extracted from FAOSTAT on area harvested, crop production, yield and seed use for the top 30¹¹ producing countries of each crop¹². These top 30 countries were classified as developed and developing countries based on the World Bank classification¹³. The entire analysis was carried out using FAOSTAT figures for 2011 as this was the most recent year for which country level data for most Annex-I crops were fully available.
- (3) For each crop and country, the seed use data in FAOSTAT reflects the total seed used (or set apart for planting) for a crop including farm-saved seed. In developing countries, farm-saved seed accounts for the dominant portion of total seed use. The size of the commercial seed market in each crop and country was derived using the Seed Replacement Rate (SRR) parameter. The SRR is a parameter well understood in the seeds sector and represents the proportion of seed use derived from commercial purchases of seed – it is the proportion of seed that is “renewed” or “replaced” through bought-in seed. SRRs vary over a wide range across crops and countries, with SRRs being significantly higher in developed countries in relation to developing countries.

For the purposes of the simulation, the commercial seed market for each crop and country was further broken up into the following categories.

- (i) Commercial seed market for patented varieties.
- (ii) Commercial seed market for PVP varieties.
- (iii) Commercial seed market for regulated varieties.

The break up into these three categories was required because the payment options being evaluated could involve different payment rates for each of these categories. The value of the commercial seed market in the three categories was derived through the following steps.

- (a) We first derived the total seed use for patented and non-patented varieties for each in the top 30 producers. To derive the share of patented varieties in the total seed use the following assumptions were made:

- i. Only genetically modified varieties (varieties developed through the application of agricultural biotechnology) are likely to be protected by patents.

¹¹ The rationale for including only the top 30 producers of each crop in the analysis was that no significant payments into the BSF could be expected from entities in contracting parties that were only minor producers of a crop.

¹² In identifying the top 30 producers of any crop, we considered all countries covered in FAOSTAT including those which are not currently members of the International Treaty. The rationale for this was that the SMTA-users in non-contracting parties are also bound by payment obligations to the BSF. For instance a seed company in the US (a non-contracting party) that accesses MLS material under an SMTA would be bound by payment obligations.

¹³ The World Bank (2014) classifies countries into lower, middle and higher income countries based on GDP per capita. Lower and middle income countries are classified as “developing” while higher income countries are classified as “developed” in this study.

ii. Patents for plant varieties developed through the application of biotechnology will continue to be available only in a limited number of countries (US, Australia, Japan, S. Korea).

iii. The proportion of patented seed use to total seed use for a crop can be estimated from the proportion of area sown to genetically modified varieties for that crop.

Therefore, where i indexes crops and j indexes countries,

$$(\text{Seed use for patented varieties})_{ij} = (\text{Total seed use})_{ij} \times \frac{(\text{Area under GM varieties})_{ij}}{(\text{Total area under cultivation})_{ij}}$$

and

$$(\text{Seed use for non-patented varieties})_{ij} = (\text{Total seed use})_{ij} \times \frac{(\text{Area under non-GM varieties})_{ij}}{(\text{Total area under cultivation})_{ij}}$$

While the figures for total seed use and total area under cultivation were derived from FAOSTAT, area under genetically modified varieties was estimated from the data available from the publications of the International Service for the Acquisition of Agri-Biotech Applications (ISAAA) (James, 2012).

(b) We then derived the commercial seed use for patented and non-patented varieties using the SRRs for these categories:

$$(\text{Commercial seed use for patented varieties})_{ij} = (\text{Seed use for patented varieties})_{ij} \times (\text{SRR-patents})_{ij}$$

where $(\text{SRR-patents})_{ij}$ = Seed Replacement Rate for patented varieties in crop i in country j.

and

$$(\text{Commercial seed use for non-patented varieties})_{ij} = (\text{Seed use for non-patented varieties})_{ij} \times (\text{SRR-non-patents})_{ij}$$

where $(\text{SRR-non-patents})_{ij}$ = Seed Replacement Rate for non-patented varieties in crop i in country j.

The commercial seed use for non-patented varieties was further divided into commercial seed use for PVP varieties and commercial seed use for regulated varieties using the share of PVP and regulated varieties in non-patented seed use:

$$(\text{Commercial seed use for PVP varieties})_{ij} = (\text{Commercial seed use for non-patented varieties})_{ij} \times (\text{PVP share})_{ij}$$

where $(\text{PVP share})_{ij}$ = Share of PVP protected varieties in non-patented seed use in crop i in country j.

and

$$(\text{Commercial seed use for regulated varieties})_{ij} = (\text{Commercial seed use for non-patented varieties})_{ij} \times (\text{Regulated share})_{ij}$$

where $(\text{Regulated share})_{ij}$ = Share of Regulated varieties in non-patented seed use in crop i in country j .

- (c) In the next step we derived the value of the commercial seed use (market) of patented, PVP and regulated varieties. The derivation of the value of the commercial seed market in these categories would require the market prices of seeds in each of these categories in different national markets. However, in the absence of information on seed prices in different markets, we estimated the value of the commercial market in these categories using a Seed Price Factor (SPF) parameter. The SPF is a parameter that relates seed prices for a crop to the level of producer prices for the commodity. For instance, if the producer prices for wheat in a country US \$ 200 per tonne while the average price of wheat seeds is US \$ 400 per tonne, then the value of the SPF would be 2. The SPF expresses seed prices for a crop as multiple of the prevailing producer prices for the crop. Protected varieties can be expected to command a higher SPF than non-protected varieties and patented varieties can be expected to have a higher level of SPF than PVP protected varieties. Producer prices for agricultural commodities are available from FAOSTAT, while the SPF was used as a parameter which could be varied in the simulations, with plausible values derived from the analysis of seed prices for a limited number of countries/crops for which data were available.

Therefore,

$(\text{Value of commercial seed market of patented varieties})_{ij} = (\text{Commercial seed use of patented varieties})_{ij} \times (\text{Producer prices})_{ij} \times (\text{SPF-patents})_{ij}$

where $(\text{SPF-patents})_{ij}$ = Seed Price Factor for patented varieties in crop i in country j .

$(\text{Value of commercial seed market of PVP varieties})_{ij} = (\text{Commercial seed use of PVP varieties})_{ij} \times (\text{Producer prices})_{ij} \times (\text{SPF-PVP})_{ij}$

where $(\text{SPF-PVP})_{ij}$ = Seed Price Factor for PVP protected varieties for crop i in country j .

$(\text{Value of commercial seed market of regulated varieties})_{ij} = (\text{Commercial seed use of regulated varieties})_{ij} \times (\text{Producer prices})_{ij} \times (\text{SPF-Regulated})_{ij}$

where $(\text{SPF-Regulated})_{ij}$ = Seed Price Factor for regulated varieties crop i in country j .

- (d) We then derived the value of the commercial patented seed, PVP seed and regulated seed that would attract payment obligations (mandatory or voluntary) to the BSF. This would require reliable data on the value share of varieties incorporating SMTA-PGR in each of these categories. Given the lack of data at the variety level in commercial seed markets, the share of SMTA-PGR derived varieties in each of these categories was treated as a parameter that could be varied in the simulations, with a range of plausible values derived from previous studies on the use of SMTA-PGR in commercial varieties in different crops in developed and developing countries.

Therefore,

$(\text{Commercial patented seed attracting BSF payments})_{ij} = (\text{Value of commercial seed market of patented varieties})_{ij} \times (\text{SMTA share-patents})_{ij}$

where $(\text{SMTA share-patents})_{ij}$ = Value share of varieties incorporating SMTA-PGR in the commercial seed market for patented varieties in crop i in country j .

(Commercial PVP seed attracting BSF payments)_{ij} = (Value of commercial seed market of PVP varieties)_{ij} x (SMTA share- PVP)_{ij}

where (SMTA share-PVP)_{ij} = Value share of varieties incorporating SMTA-PGR in the commercial seed market for PVP varieties in crop i in country j.

(Commercial regulated seed attracting BSF payments)_{ij} = (Value of commercial seed market of regulated varieties)_{ij} x (SMTA share- Regulated)_{ij}

where (SMTA share-Regulated)_{ij} = Value share of varieties incorporating SMTA-PGR in the commercial seed market for regulated varieties in crop i in country j.

- (e) Having derived the values of commercial patented seed, PVP seed and regulated seed attracting payments into the BSF for each Annex-I crop in the top 30 producers, we applied the payment rates for each category under different scenarios to derive the potential flows of revenue into the BSF.

Parameter Values for Simulation of Payment Flows into the BSF

The methodology described above for deriving the value of the commercial seed market that is likely to attract payment obligations under SMTAs relies on a number of critical parameters whose precise values are not known. To simulate the flow of options under different payment options, we have used plausible values of these parameters taken from previous studies and the literature related to the use of PGR exchanged under the MLS and its predecessor institutions (see Stannard and Moeller, 2012, which also provides references to the relevant literature). In the spreadsheet version of this model, the values of these parameters can be updated as more reliable information becomes available to derive more accurate projections of payment flows into the BSF. The values of the parameters used in the simulations are set out in Table-2 and are discussed below. While the value of each parameter can vary across crops and countries, to keep the analysis tractable we have used only two sets of parameters – one for all developed countries and another one for all developing countries.

Table-2 : Parameter Values Used in Simulation of Payment Flows into the BSF

Parameter	Value in Developed Countries	Value in Developing Countries
Seed Replacement Rates		
Seed Replacement Rates- patented varieties	100%	80%
Seed Replacement Rates- non-patented varieties	60%	20%
Share in non-patented seed use		
Share of PVP varieties in commercial seed market of non-patented varieties	100%	10%
Share of (non-protected) regulated varieties in commercial seed market of non-patented varieties	0%	90%
Seed Price Factor –Agricultural Crops		
Seed Price Factor-patented varieties	4	4
Seed Price Factor –PVP varieties	2.5	2.5
Seed Price Factor- regulated varieties	2	2
Share of varieties incorporating SMTA-PGR		
SMTA-share – patented varieties	5%	10%
SMTA –share- PVP varieties	10%	15%
SMTA-share- regulated varieties	15%	30%

Seed Replacement Rates –patented varieties: For the purpose of this study we have assumed that only genetically modified varieties are likely to be subject to patents and further that patents for plant varieties will continue to be available only in a limited number of countries. The application of patents to plant varieties allows seed companies to proscribe the use of farm-saved seed of these varieties. Moreover, in developed countries, genetically modified varieties are marketed under contractual arrangements that effectively prevent the use of farm-saved seed by farmers, necessitating fresh purchase of seed by farmers for each round of planting. Therefore, for developed countries, we have assumed an SRR-patents rate of 100%. In developing countries, while the use of farm-saved seed may not be prohibited, the potential for the use of farm-saved seed of genetically modified varieties may be limited. This may arise as a result of genetic modification being incorporated into hybrid varieties (which requires fresh seed to be bought for every round of planting to retain “hybrid vigour”) or on account of seed companies’ marketing efforts to convince farmers that benefits of genetically modified varieties may be considerably diminished with the use of farm-saved seed. We have, therefore assumed a lower, but still high SRR-patent rate for developing countries of 80%.

Seed Replacement Rates-non-patented varieties: Seed replacement rates for non-patented varieties are significantly different between developed and developing countries. In most developing countries, farm-saved seed still constitutes the dominant proportion of seed use and commercial seed accounts only for 10-20% of total seed use. The proportion of commercial seed use in developing countries is likely to increase over time as farmers adopt new commercial varieties and improved technologies and production becomes more market-oriented. In developed countries seed replacement rates for agricultural crops are much higher- and range from 50%-80% for non-hybrid varieties and nearly 100% for hybrid varieties [NIAB, 1990-2000]. In Europe, seed replacement rates for cereal crops which were as high as 80-90% in the 1990s in some countries (e.g., UK) appear to have declined over the last 15 years after the introduction of PVP royalties on farm-saved seed of protected varieties facilitated by provisions in the EU-wide PVP legislation (European Council, 1994) For the purpose of simulation of flows into the BSF we have assumed that SRR for non-patented varieties of 60% in developed countries and 20% in developing countries.

PVP and Regulated Varieties’ Share: In developed countries plant variety protection has been in existence for three to four decades. In these countries, nearly all new plant variety innovations are protected by PVP. Therefore, for developed countries we have assumed that the PVP share of non-patented seed use is 100% - reflecting the near universal use of PVP for new varieties. In most developing countries, PVP systems are yet to be introduced or their introduction has been very recent (in the last 5-10 years) and is not well established. A large part of plant variety innovations in use in developing countries may have been contributed by the public sector NARS and may not have been subject to PVP. We have assumed, therefore, that the PVP share of commercial non-patented seed use in developing countries is currently unlikely to exceed 10% although this share may increase over time with the wider adoption and enforcement of PVP legislation. We have further assumed that the remaining 90% of commercial non-patented seed use in developing countries will fall under the category of regulated varieties, subject to quality control and marketing regulations.

Seed Price Factor: The SPF is a parameter which expresses the price of seed as a multiple of the producer price of the agricultural crop. An examination of producer prices and seed prices for wheat in a number of developed and developing countries shows that SPF has a value of around 2; that is, seed prices on average tend to be twice the producer price for the crop. Seed prices of protected varieties

are generally higher than the seed prices of non-protected varieties. There is some evidence to show that varieties protected by PVP command a relatively small premium over non-protected varieties (Lesser, 1994). However, genetically modified (patented) varieties are considerably more expensive than conventional varieties and often involve the payment of a substantial premium in the form of a “technology fee”. Based on an examination of cereal seed prices in developed country markets, we have adopted the following SPF values in our simulations for all agricultural crops, except vegetable crops.

SPF for patented varieties:	4
SPF for PVP varieties:	2.5
SPF for (non-protected) regulated varieties:	2

The above SPF values are not applicable to vegetable crops because SPF values for vegetable crops are of an entirely different order of magnitude. For instance, average producer prices for carrots may be around US\$ 300 per tonne, but carrot seed prices can range between US \$ 20-30,000 per tonne, giving an SPF of 100. For vegetable crops we have estimated the SPF by examining the seed use rates per hectare, the seeds per gram and bulk seed prices in developed country markets. The SPF values used in the simulations for Annex-I vegetable crops are as follows:

Table-3: Seed Price Factors for Annex-I Vegetable Crops

Vegetable crop	SPF-patented varieties	SPF-PVP varieties	SPF-regulated varieties
Asparagus	96	60	48
Beet	1600	1000	800
Carrots	160	100	80
Cabbage	160	100	80
Eggplant	240	160	120

The extraordinarily high large SPF values for vegetable crops highlight the importance of these crops in determining the potential flow of payments into the BSF.

SMTA share: The non-availability of variety level information from commercial seed markets means that there are no reliable data on the share of SMTA-PGR derived varieties in the commercial seed market for patented, PVP and regulated varieties. For our simulations, we have relied on parameter values derived from previous studies that have examined the share of varieties incorporating material accessed from the MLS in selected crops (wheat, rice and maize) in developed and developing countries (Stannard and Moeller, 2012). The current share of varieties that incorporate material sources from the MLS (and predecessor institutions) in commercial seed markets can provide some pointers to the potential share of SMTA-PGR derived varieties over time. A number of considerations are relevant in setting the SMTA-share parameter values. Firstly, the largest users of the SMTA-PGR are the NARS in developing countries and the CGIAR centres themselves (which undertake breeding work aimed at developing country environments). Therefore, the largest share of innovations incorporating SMTA-PGR is likely to come from innovations developed for developing countries. In most developing countries the public sector NARS still plays a dominant role in plant breeding for agricultural crops. Most developing countries have either no intellectual property regime for plant varieties (patents or PVP) or else have only recently introduced PVP legislation (Deere, 2008). In developing countries where PVP has been introduced the extent to which the public sector/NARS will choose to participate in the PVP system is not yet clear. Therefore, while most of the innovations derived from the use of SMTA-PGR are likely to emerge in developing countries, only a small proportion of these innovations is likely to be protected by

any form of intellectual property rights. The use of SMTA-PGR by developed countries and the private sector is much less when compared to use by CGIAR centres and developing countries. The use of SMTA-PGR in the development of genetically modified (patented) varieties is likely to be limited as genetic modifications are likely to be applied to well-established varieties¹⁴ and may not involve the use of new material sourced from the MLS. Even for conventionally bred varieties protected by PVP in developed countries, the private sector may largely rely on their own PGR collections and breeding lines (or varieties available for further breeding and research under the researchers' exemption available under PVP) rather than source new material from the MLS using SMTAs. Given the history of dissemination of PGR from the CGIAR centres and international PGR exchange over the last four decades, it is likely that characteristics/traits of interest in MLS-PGR may have been largely assimilated into in-house collections and commercial varieties in developed countries – reducing the need for accessing PGR using SMTAs. In setting the values for the SMTA share parameter, we have, therefore, assumed that:

SMTA-share in developing countries > SMTA-share in developed countries

and

SMTA-share for patented varieties < SMTA-share for PVP varieties < SMTA-share for regulated varieties.

Based on these assumptions and a review of previous studies on the use of PGR sourced from the MLS (including its predecessor institutions), we have used the following values of SMTA-share in our analysis.

Table-4: Share of SMTA derived PGR in different Seed Market Product Categories

	SMTA-share –Patented varieties	SMTA-share - PVP varieties	SMTA-share - Regulated varieties
Developed countries	5%	10%	15%
Developing countries	10%	15%	30%

Payment Flows Into Bsf: Simulation Results

Option1: Baseline or Status Quo Option

The annual flow of payments into the BSF in the baseline scenario has been estimated based on the size of the commercial seed market for different Annex-I crops in 2011 using the methodology described above and assuming that (1) only patented varieties incorporating SMTA-PGR will attract mandatory payment obligations at the rate of 0.77% under Article 6.7 of the SMTA (2) PVP protected varieties and other varieties incorporating SMTA-PGR will attract only voluntary payment obligations under Article 6.8 of the SMTA and (3) payments under Article 6.11 of the SMTA will be at the rate of 0.5% of the sales of all seeds of the crop for which SMTA-PGR has been accessed, whether or not the product is protected any any IPRs . It should be noted that owing to data constraints, horticultural crops (fruits, breadfruit and coconuts) have been excluded from the analysis and, therefore, the estimates presented here do

¹⁴ These established varieties may have been developed using material accessed from the MLS prior to the entry into force of the Treaty.

not include potential payment flows into the BSF in relation to PGR accessed from the MLS for these crops. The estimates of potential payment flows presented are based on the values of key parameters assumed, which are different for developed and developing countries. The realisable flows in to the BSF will be dependent on the “performance factor” or the proportion of payment obligations that will be translated into actual payment flows into the BSF, as discussed later. The estimated potential for mandatory payments into the BSF is presented in Table-5.

Table -5: Option 1: Mandatory Payments into the BSF-(US \$ million)

Crop	Potential annual mandatory payments under Article 6.7 (patented varieties)		
	Developed countries (DCs)	Developing countries (LDCs)	Total potential
Maize	2.601	3.413	6.014
Rapeseed	0.053	0.000	0.053
TOTAL	2.653	3.413	6.067

The current potential for mandatory payments into the BSF is estimated at US \$ 6.06 million. This figure derived from only two crops reflects our assumption that only genetically modified varieties are likely to be subject to patents and that such patents will be available only in a limited number of countries. Among Annex-I crops, only maize and oilseed rape have seen the significant introduction and adoption of genetically modified varieties. Further, the development of genetically modified varieties through the application of biotechnology may not require the use of SMTA-PGR, i.e., material accessed from the MLS after the coming into force of the International Treaty. The contribution of US \$ 3.413 million from developing countries is related to the significant adoption of genetically modified maize in South Africa and Brazil. This however, assumes that genetically modified varieties can be protected by patents in these countries. While both South Africa and Brazil appear to allow for dual protection of genetically modified varieties through patents and PVP (Hirko, 2012; Rodrigues et al., 2011), this may not be the case in other developing countries.

The potential for voluntary payments under Article 6.8 in the baseline scenario (assuming that voluntary payments are made at the same rate as in Article 6.7) is presented in Table-6. The total potential for voluntary payments is nearly US \$53 million per annum. Of this only US \$ 10.6 million is associated with PVP protected varieties, nearly 80% of which is accounted for by developed countries – reflecting the wider adoption and use of PVP in developed countries. The largest share (US \$ 42.4 million) of voluntary payment obligations is associated with non-protected plant variety innovations in developing countries. This reflects the substantial use of SMTA-PGR by developing country NARS and CGIAR centres which do breeding work aimed at developing country environments.

Table-6: Scenario 1: Voluntary Payments into the BSF-(US \$ million)

	Potential voluntary payments under Article 6.8 from plant variety innovations incorporating SMTA-PGR					
	PVP varieties			Non-protected varieties		
	DCs	LDCs	Total potential	DCs	LDCs	Total potential
Wheat	2.165	0.351	2.515	0.000	5.050	5.050
Rice	0.264	0.389	0.653	0.000	5.608	5.608
Maize	1.174	0.824	1.999	0.000	11.872	11.872
Barley	0.793	0.064	0.856	0.000	0.915	0.915
Oats	0.218	0.017	0.235	0.000	0.244	0.244
Rye	0.155	0.006	0.161	0.000	0.086	0.086
Triticale	0.131	0.003	0.134	0.000	0.038	0.038
Millet	0.002	0.014	0.015	0.000	0.200	0.200
Sorghum	0.007	0.014	0.021	0.000	0.200	0.200
Beans	0.043	0.047	0.091	0.000	0.681	0.681
Pigeonpea	0.000	0.014	0.014	0.000	0.207	0.207
Chickpea	0.019	0.018	0.037	0.000	0.256	0.256
Peas	0.116	0.011	0.127	0.000	0.161	0.161
Cowpeas	0.003	0.017	0.019	0.000	0.244	0.244
Lentils	0.063	0.005	0.068	0.000	0.073	0.073
Rapeseed	0.091	0.015	0.105	0.000	0.209	0.209
Mustard	0.002	0.000	0.002	0.000	0.004	0.004
Sunflower	0.021	0.018	0.039	0.000	0.255	0.255
Potatoes	1.261	0.414	1.675	0.000	5.960	5.960
Sweet Potatoes	0.085	0.129	0.214	0.000	1.863	1.863
Cassava	0.000	0.000	0.000	0.000	0.000	0.000
Taro	0.000	0.000	0.000	0.000	0.000	0.000
Yams	0.024	0.461	0.485	0.000	6.640	6.640
Asparagus	0.001	0.000	0.001	0.000	0.005	0.005
Beet	1.061	0.108	1.168	0.000	1.548	1.548
Carrots	0.026	0.006	0.032	0.000	0.090	0.090
Cabbages	0.002	0.001	0.003	0.000	0.011	0.011
Eggplant	0.002	0.002	0.004	0.000	0.027	0.027
TOTAL	7.725	2.948	10.673	0.000	42.445	42.445

Table-7 presents the potential revenue flows into the BSF on the assumption that all seed industry players access SMTA-PGR and opt for payments under Article 6.11 of the SMTA. The potential payments to the BSF under these assumptions would be US \$211 million which is considerably higher than the projections of mandatory payments under Article 6.7 and voluntary payments under Article 6.8 of the SMTA. The assumption of universal of adoption of Article 6.11 by all seed industry players at the current rates of payment is clearly **not a realistic one**, especially when mandatory payment obligations under Article 6.7 and voluntary payment obligations under Article 6.8 are much lower. The figure of US \$ 211 million is simply 0.5% of the commercial seed market value of Annex-I crops and provides a

theoretical upper bound for potential payment flows into BSF. The potential revenue flows under this assumption are presented only to highlight the skewed economic incentive structure built into the SMTA influencing the choice of payment options. While the universal adoption of Article 6.11 payments would clearly yield much larger revenue flows into the BSF, the current payment rates under Article 6.7 and Article 6.11 are so structured that no seed industry player is likely to have an economic incentive to opt for Article 6.11 payments.

Table-7: Scenario 1: Payments into BSF under Universal Adoption of Article 6.11 Option- (US \$ million)

	Projected payments into the BSF under the assumption universal use of SMTA-PGR and Article 6.11 payment option (payment rate of 0.5% on sales of all commercial seed)		
	DCs	LDCs	Total potential
Wheat	14.055	12.448	26.503
Rice	1.713	13.824	15.537
Maize	41.403	51.429	92.832
Barley	5.147	2.255	7.402
Oats	1.415	0.602	2.016
Rye	1.004	0.213	1.217
Triticale	0.851	0.094	0.946
Millet	0.010	0.492	0.502
Sorghum	0.044	0.494	0.538
Beans	0.282	1.680	1.961
Pigeonpea	0.000	0.509	0.510
Chickpea	0.124	0.631	0.755
Peas	0.755	0.398	1.153
Cowpeas	0.016	0.602	0.618
Lentils	0.407	0.179	0.586
Rapeseed	1.273	0.516	1.789
Mustard	0.014	0.009	0.022
Sunflower	0.137	0.628	0.765
Potatoes	8.190	14.691	22.881
Sweet Potatoes	0.549	4.592	5.141
Cassava	0.000	0.000	0.000
Taro	0.000	0.000	0.000
Yams	0.153	16.369	16.522
Asparagus	0.007	0.012	0.019
Beet	6.887	3.817	10.703
Carrots	0.167	0.221	0.388
Cabbages	0.012	0.026	0.038
Eggplant	0.012	0.066	0.078
TOTAL	84.625	126.796	211.421

The skewed incentive structure of the current payment options under the SMTA can be illustrated through a “*parity point*” calculation which:

- (a) Calculates a payment rate under the provisions of Article 6.7 and Article 6.8 of the current SMTA that would yield the same quantum of payments into the BSF as Article 6.11 (assuming universal adoption) or alternatively,
- (b) Calculates a payment rate under Article 6.11 (assuming universal adoption) that would yield the same revenue as current payment rates applicable under Article 6.7 and Article 6.8.

In the status quo option, the potential revenues from universal adoption of Article 6.11 are US \$ 211 million. To generate the same revenue from mandatory payments under Article 6.7, and voluntary payments under Article 6.8 (with the current coverage of product categories under each Article) the payment rates under these articles would have to rise to 8-10% of seed sales of patented and PVP SMTA-PGR derived varieties from the current level of 0.77%. Alternatively, to generate the same level of revenue as provided in the baseline scenario by mandatory payments under Article 6.7 and voluntary payments under Article 6.8, the rate of payment under Article 6.11 could be lowered to 0.175-0.25% from the current level of 0.5% with payment obligations being applied only on commercial sales of patented and PVP varieties. The “parity point” calculations demonstrate that under the current SMTA provisions and payment rates, SMTA-users will have no incentive to opt for the Article 6.11 option. Developing a more balanced structure of incentives influencing selection of payment options under the SMTA would, therefore, call for either very sharp increases in payment rates under Article 6.7 and Article 6.8 or a significant reduction in payment obligations under Article 6.11. As sharp increases in payment rates under Article 6.7 and Article 6.8 are likely to be unacceptable to the seed industry and other SMTA-users, incentivising the adoption Article 6.11 through lowered payment obligations may represent the most feasible route for enhancing payment flows into the BSF.

Option 2: Revisiting Article 6.7

Under this option we consider the extension of mandatory payments to product categories which currently do not attract mandatory payment obligations. We consider two scenarios.

Scenario 1- Extension of mandatory payments to PVP products: In the first scenario under this option, we consider the extension of mandatory payments to product innovations incorporating SMTA-PGR which are protected by PVP (in addition to patented innovations). We also allow payment rates for mandatory payments under Article 6.7 to vary by product category – that is, we allow for a different rate for patented and PVP varieties, with a higher rate for patented varieties.

Table-8: Option 2 – Extension of Mandatory Payments to PVP Products – Payment Rates

	Article 6.7 (Patented and PVP varieties attract mandatory payments)
	Payment rates (Applicable to sales of seed of varieties incorporating SMTA-PGR)
Case 1	Patented varieties: 0.77% PVP varieties: 0.77%
Case 2	Patented varieties: 1.1% PVP varieties: 0.5%
Case 3	Patented varieties: 1.1% PVP varieties: 0.2%

Case 1 involves bringing PVP varieties under the purview of mandatory payments with the current payment rate of 0.77% being applied. The effect of this would be the conversion of voluntary payments for PVP varieties estimated in Table-6 (US \$ 10.67 million) into mandatory payments. There would be no change to the voluntary payments from non-protected varieties estimated in Table-6. The potential payment flows in Case 2 and Case 3 are presented in Table-9 below:

Table -9: Option 2 Extension of Mandatory Payments to PVP Products– Payment Flows into BSF-(US \$ million)

CASE 2	Potential mandatory payments under Article 6.7 (patented varieties)			Potential mandatory payments under Article 6.7 (PVP varieties)		
	1.10%			0.50%		
	DCs	LDCs	Total potential	DCs	LDCs	Total potential
Wheat	0.000	0.000	0.000	1.406	0.228	1.633
Rice	0.000	0.000	0.000	0.171	0.253	0.424
Maize	3.715	4.876	8.592	0.763	0.535	1.298
Barley	0.000	0.000	0.000	0.515	0.041	0.556
Oats	0.000	0.000	0.000	0.141	0.011	0.152
Rye	0.000	0.000	0.000	0.100	0.004	0.104
Triticale	0.000	0.000	0.000	0.085	0.002	0.087
Millet	0.000	0.000	0.000	0.001	0.009	0.010
Sorghum	0.000	0.000	0.000	0.004	0.009	0.013
Beans	0.000	0.000	0.000	0.028	0.031	0.059
Pigeonpea	0.000	0.000	0.000	0.000	0.009	0.009
Chickpea	0.000	0.000	0.000	0.012	0.012	0.024
Peas	0.000	0.000	0.000	0.075	0.007	0.083
Cowpeas	0.000	0.000	0.000	0.002	0.011	0.013
Lentils	0.000	0.000	0.000	0.041	0.003	0.044
Rapeseed	0.075	0.000	0.075	0.059	0.009	0.068
Mustard	0.000	0.000	0.000	0.001	0.000	0.002
Sunflower	0.000	0.000	0.000	0.014	0.011	0.025
Potatoes	0.000	0.000	0.000	0.819	0.269	1.088
Sweet Potatoes	0.000	0.000	0.000	0.055	0.084	0.139
Cassava	0.000	0.000	0.000	0.000	0.000	0.000
Taro	0.000	0.000	0.000	0.000	0.000	0.000
Yams	0.000	0.000	0.000	0.015	0.299	0.315
Asparagus	0.000	0.000	0.000	0.001	0.000	0.001
Beet	0.000	0.000	0.000	0.689	0.070	0.758
Carrots	0.000	0.000	0.000	0.017	0.004	0.021
Cabbages	0.000	0.000	0.000	0.001	0.000	0.002
Eggplant	0.000	0.000	0.000	0.001	0.001	0.002
TOTAL	3.791	4.876	8.667	5.017	1.914	6.931

CASE 3	Potential mandatory payments under Article 6.7 (patented varieties)			Potential mandatory payments under Article 6.7 (PVP varieties)		
	1.10%			0.20%		
	DCs	LDCs	Total potential	DCs	LDCs	Total potential
Wheat	0.000	0.000	0.000	0.562	0.091	0.653
Rice	0.000	0.000	0.000	0.069	0.101	0.170
Maize	3.715	4.876	8.592	0.305	0.214	0.519
Barley	0.000	0.000	0.000	0.206	0.016	0.222
Oats	0.000	0.000	0.000	0.057	0.004	0.061
Rye	0.000	0.000	0.000	0.040	0.002	0.042
Triticale	0.000	0.000	0.000	0.034	0.001	0.035
Millet	0.000	0.000	0.000	0.000	0.004	0.004
Sorghum	0.000	0.000	0.000	0.002	0.004	0.005
Beans	0.000	0.000	0.000	0.011	0.012	0.024
Pigeonpea	0.000	0.000	0.000	0.000	0.004	0.004
Chickpea	0.000	0.000	0.000	0.005	0.005	0.010
Peas	0.000	0.000	0.000	0.030	0.003	0.033
Cowpeas	0.000	0.000	0.000	0.001	0.004	0.005
Lentils	0.000	0.000	0.000	0.016	0.001	0.018
Rapeseed	0.075	0.000	0.075	0.024	0.004	0.027
Mustard	0.000	0.000	0.000	0.001	0.000	0.001
Sunflower	0.000	0.000	0.000	0.005	0.005	0.010
Potatoes	0.000	0.000	0.000	0.328	0.107	0.435
Sweet Potatoes	0.000	0.000	0.000	0.022	0.034	0.056
Cassava	0.000	0.000	0.000	0.000	0.000	0.000
Taro	0.000	0.000	0.000	0.000	0.000	0.000
Yams	0.000	0.000	0.000	0.006	0.120	0.126
Asparagus	0.000	0.000	0.000	0.000	0.000	0.000
Beet	0.000	0.000	0.000	0.275	0.028	0.303
Carrots	0.000	0.000	0.000	0.007	0.002	0.008
Cabbages	0.000	0.000	0.000	0.000	0.000	0.001
Eggplant	0.000	0.000	0.000	0.000	0.000	0.001
TOTAL	3.791	4.876	8.667	2.007	0.766	2.772

It should be noted that for Case 2 and Case 3, the rate of 1.1% under Article 6.7 for patented varieties has been derived by dropping the 30% deduction allowed for marketing and sales cost in the current structure of payment rates. Payment rates for PVP varieties under Article 6.7 are set at lower levels at 0.5% in Case 2 and 0.2% in Case 3.

In Case 2, the potential for mandatory payments would be US \$ 15.59 million of which US \$ 6.93 million (44%) would come from PVP varieties and US \$ 8.66 million (56%) would come from patented varieties. This would be considerably higher than the potential for mandatory payments assessed in Option 1. Nearly 72% of the payments for PVP varieties would come from developed country SMTA-users reflecting well-established PVP systems in these countries, where most commercial plant variety

innovations are subject to some form of protection. In Case 3, with a lower payment rate of 0.2% applied to PVP varieties, the potential for mandatory payments would be US \$ 11.44 million with PVP varieties contributing US \$ 2.72 million (24%) and patented varieties contributing US \$ 8.66 million (76%). Again nearly 72% of the payments for PVP varieties would come from developed countries.

The main implication of the analysis of Scenario 1 is that the extension of mandatory payments to PVP varieties will result in a very significant expansion of the innovation base from which payments into the BSF are derived. A large part (nearly 80%) of the enhanced payment flows in this scenario will come from SMTA-users in developed countries. The enhancement in mandatory payment flows from the inclusion of PVP varieties will be very significant even if a relatively low rate of payment is applied to PVP varieties.

Scenario 2-Extension of mandatory payments to PVP and regulated products: In this scenario, we consider the extension of mandatory payment obligations to both PVP-protected and regulated varieties. As discussed earlier, regulated varieties are plant variety innovations incorporating SMTA-PGR, which are not protected by any form of intellectual property rights – but are subject to seed quality control and marketing regulations and seed multiplication systems that require access to “breeder seed” of the variety. Seed production norms, quality control and marketing regulations facilitate and sustain the commercial exploitation of these varieties. In this scenario, while bringing regulated varieties under the purview of mandatory payments, we allow for payment rates under Article 6.7 to vary by product category. The highest payment rates are applied to patented varieties; lower rates are applied to PVP varieties while the lowest rates are applied to regulated varieties not subject to any form of intellectual property rights. We project the flows into the BSF under the following sets of rates.

Table-10: Option 2 –Extension of Mandatory Payments to PVP and Regulated Products-Payment Rates

	Article 6.7 (Patented, PVP and regulated varieties attract mandatory payments)
	Payment rates (Applicable to sales of seed of varieties incorporating SMTA-PGR)
Case 1	Patented varieties: 0.77% PVP varieties: 0.77% Regulated varieties 0.77%
Case 2	Patented varieties: 1.1% PVP varieties: 0.5% Regulated varieties 0.2%

Case 1 involves bring PVP and regulated varieties under the purview of mandatory payments with the current payment rate of 0.77% being applied to all product categories. The effect of this would be the conversion of voluntary payments for PVP and (non protected) regulated varieties estimated in Table-6 (Option 1) into mandatory payments. The potential for mandatory payments from regulated varieties would be US \$ 42.44 million, which would be considerably higher than mandatory payments from PVP varieties (US \$ 10.67 million). In this scenario, there would be no voluntary payment obligations as all product categories attract mandatory payment obligations. The projected payment flows in Case 2 are presented in Table-11 below. Payment rates for PVP varieties and regulated varieties under Article 6.7 are set at 0.5% and 0.2% reflecting the lower potential for appropriating economic returns from

innovations that are subject to weaker forms of intellectual property protection or are not subject to intellectual property protection at all.

Table -11-Option 2- Extension of Mandatory Payments to PVP and Regulated Products- Payments into BSF (US \$ million)

	Projected Mandatory Payments under Article 6.7								
	Patented Varieties			PVP varieties			Regulated varieties		
	1.1%			0.5%			0.2%		
	DCs	LDCs	Total potential	DCs	LDCs	Total potential	DCs	LDCs	Total potential
Wheat	0.000	0.000	0.000	1.406	0.228	1.633	0.000	1.312	1.312
Rice	0.000	0.000	0.000	0.171	0.253	0.424	0.000	1.457	1.457
Maize	3.715	4.876	8.592	0.763	0.535	1.298	0.000	3.084	3.084
Barley	0.000	0.000	0.000	0.515	0.041	0.556	0.000	0.238	0.238
Oats	0.000	0.000	0.000	0.141	0.011	0.152	0.000	0.063	0.063
Rye	0.000	0.000	0.000	0.100	0.004	0.104	0.000	0.022	0.022
Triticale	0.000	0.000	0.000	0.085	0.002	0.087	0.000	0.010	0.010
Millet	0.000	0.000	0.000	0.001	0.009	0.010	0.000	0.052	0.052
Sorghum	0.000	0.000	0.000	0.004	0.009	0.013	0.000	0.052	0.052
Beans	0.000	0.000	0.000	0.028	0.031	0.059	0.000	0.177	0.177
Pigeonpea	0.000	0.000	0.000	0.000	0.009	0.009	0.000	0.054	0.054
Chickpea	0.000	0.000	0.000	0.012	0.012	0.024	0.000	0.066	0.066
Peas	0.000	0.000	0.000	0.075	0.007	0.083	0.000	0.042	0.042
Cowpeas	0.000	0.000	0.000	0.002	0.011	0.013	0.000	0.063	0.063
Lentils	0.000	0.000	0.000	0.041	0.003	0.044	0.000	0.019	0.019
Rapeseed	0.075	0.000	0.075	0.059	0.009	0.068	0.000	0.054	0.054
Mustard	0.000	0.000	0.000	0.001	0.000	0.002	0.000	0.001	0.001
Sunflower	0.000	0.000	0.000	0.014	0.011	0.025	0.000	0.066	0.066
Potatoes	0.000	0.000	0.000	0.819	0.269	1.088	0.000	1.548	1.548
Sweet Potatoes	0.000	0.000	0.000	0.055	0.084	0.139	0.000	0.484	0.484
Cassava	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Taro	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Yams	0.000	0.000	0.000	0.015	0.299	0.315	0.000	1.725	1.725
Asparagus	0.000	0.000	0.000	0.001	0.000	0.001	0.000	0.001	0.001
Beet	0.000	0.000	0.000	0.689	0.070	0.758	0.000	0.402	0.402
Carrots	0.000	0.000	0.000	0.017	0.004	0.021	0.000	0.023	0.023
Cabbages	0.000	0.000	0.000	0.001	0.000	0.002	0.000	0.003	0.003
Eggplant	0.000	0.000	0.000	0.001	0.001	0.002	0.000	0.007	0.007
TOTAL	3.791	4.876	8.667	5.017	1.914	6.931	0.000	11.025	11.025

In Case 2 the total potential for mandatory payments would be US \$ 26.62 million with US \$ 11.02 million (42%) coming from regulated varieties, US \$ 6.9 million (26%) coming from PVP varieties and US \$ 8.66 million (32%) coming from patented varieties. Although nearly 72% of payments related to PVP varieties would still come from developed countries, in this scenario the largest share of mandatory payments (67%) would come from developing countries. The large share of developing countries in this scenario would reflect the size of the seed markets in these countries and the role of SMTA-PGR derived plant variety innovations in these markets.

The results from Option 2 highlight the fact that the current architecture of payment options under the SMTA relies on a very narrow sub-set of innovations derived from SMTA-PGR for generating mandatory payments. Patent-protected innovations constitute a very small proportion of innovations generated through the use of SMTA-PGR. As observed in Scenario 1, the extension of mandatory payments to PVP varieties would significantly broaden the base for innovations generating inflows into the BSF. However, Scenario 2 shows that even extension to PVP varieties would leave out a very significant proportion of innovations derived from SMTA-PGR that are commercially exploited. If the intention behind the architecture of payment options in the SMTA is that benefit-sharing payments should be triggered by commercial exploitation of innovations incorporating SMTA-PGR, then there may be a strong case for not restricting the set of innovations to those protected by intellectual property rights and for adopting a wider definition of commercial use.

Option 3 – Revisiting Article 6.11

We have note above that the universal adoption of the Article 6.11 option by all SMTA users can generate quicker and larger flows of payments into the BSF. However, given the current structure of payment obligations and payment rates under the SMTA, payment obligations under Article 6.11 would be larger by several orders of magnitude than payment obligations under Article 6.7 and Article 6.8. This implies that given the current structure of payment rates, SMTA-users would have no incentive to opt for Article 6.11. If SMTA users are to be incentivised to opt for Article 6.11, then payment obligations under Article 6.11 will need to be drastically reduced. The reduction in payment obligations under Article 6.11 can be brought about by:

- (1) Narrowing the product categories to which payment obligations apply under Article 6.11
- (2) Reducing the payment rates applicable to different product categories.

We have examined the potential for payment flows into the BSF under the scenarios for revisiting Article 6.11 described in Table-12. These scenarios assume universal use of SMTA-PGR by the seed the industry and universal adoption of Article 6.11 by all SMTA users. If payment obligations under these scenarios remain larger than the payment obligations under the revised Article 6.7, then SMTA users will still have no incentive to opt for Article 6.11. We, therefore, make the further assumption that in the scenarios described in Table-12, Article 6.11 would be the sole payment option (i.e., Article 6.7 and Article 6.8 would not be available to SMTA users). The payment rates for different product categories are assumed to be the same ratio as payment rates in the corresponding scenarios for revision of Article 6.7. While Scenario A corresponds to the status quo option, in Scenarios B and C it has been assumed that the current rate of 0.5% would apply only to patented products, with lower rates being applicable for other product categories.

Table-12 – Revisiting Article 6.11- Scenarios and Payment Rates

	Scenario A	Scenario B		Scenario C
Products categories attracting Article 6.11 payments	Sales of all seed relating to crop for which SMATA-PGR has been accessed	Sales of all patented and PVP seeds of crop for which SMATA-PGR has been accessed		Sales of all patented, PVP and regulated seeds of crop for which SMATA-PGR has been accessed
Payment rates		(1)	(2)	
Patented products	0.5%	0.5%	0.5%	0.5%
PVP products		0.23%	0.09%	0.23%
Regulated (non-protected) products		Nil	Nil	0.09%
Corresponding revision of Article 6.7 scenario for comparison	Status quo	Extension of mandatory payments to PVP products		Extension of mandatory payments to PVP and regulated products

The projected payments into the BSF under universal participation in Article 6.11 in Scenarios A , B and C are summarised in Table-13.

Table-13: Projected Payments into BSF under Article 6.11 for Different Scenarios (US \$ million)

	Scenario A	Scenario B		Scenario C
		(1)	(2)	
Developed countries (DCs)	84.625	57.262	43.581	57.264
Developing countries (LDCs)	126.796	27.964	24.484	44.671
Total payment potential under Article 6.11	211.421	85.226	68.065	101.934
Potential for mandatory payments under corresponding Article 6.7 scenario	6.067	15.59	11.44	26.62

In the all the above scenarios, the potential for payments into the BSF with Article 6.11 as the sole option is much larger than the mandatory payments generated by corresponding revisions to Article 6.7. In Scenarios B and C, although the gap between the potential for mandatory payments under Article 6.7 and potential payments from universal participation in Article 6.11 is smaller than under status quo, the potential payments under Article 6.11 (even with restriction of product categories and lower rates of payment) remain of a much higher order of magnitude than payments under Article 6.7. This again highlights the case for a significant reduction in payment obligations under Article 6.11 if SMATA-users are to be incentivised to opt for it.

Making Article 6.11 the sole payment option for SMTA-users with existing rates of payment is likely to have large adverse effects on the use of SMTA-PGR by seed industry players over the medium and long term. From a static perspective, making Article 6.11 the only option for SMTA-users would appear to have potential to boost payment flows into the BSF, which would be significantly larger than the mandatory payments expected under the different scenarios. We have already noted that the large divergence between mandatory payments under Article 6.7 and payments under Article 6.11 imply that SMTA-users would have little incentive to opt for Article 6.11. If SMTA-users are to be persuaded to opt for Article 6.11 without hampering the future uptake of PGR from the MLS, then Article 6.11 needs to be made “revenue neutral” – that is, payment obligations under Article 6.11 must not be larger than mandatory payment obligations under Article 6.7. In our static analysis scenarios, this can be achieved if the rate of payment under Article 6.11 is lowered to around 0.2% and only product categories covered by patents and PVP are subject to payment obligations. Therefore, to persuade SMTA-users to opt for Article 6.11 or making “Article 6.11 as the sole payment option” acceptable to SMTA-users, the rates of payment under Article 6.11 would need to be sharply lowered.

Option 4: Expansion of Annex-I to all Crops

In this scenario we will examine the implications for potential payment flows into the BSF if Annex-I of the International Treaty is expanded to cover all crops. While we do not have data on the full range of food, fodder and industrial crops, we will illustrate the potential impacts of expansion of Annex-I on payment flows into the BSF by examining the effects of inclusion of some key crops which are currently excluded from Annex-I. The crops that we will consider are:

1. Tomatoes
2. Onions
3. Soybean
4. Cotton

Table-14: Option 4- Payments into BSF- Impact of Expansion of Crop Coverage in Annex-I

	Mandatory payments under Article 6.7 (patented varieties)			Voluntary payments under Article 6.8 (PVP varieties)			Voluntary payments under Article 6.8 (Regulated varieties)		
	DCs	LDCs	Total potential	DCs	LDCs	Total potential	DCs	LDCs	Total potential
Soybeans	1.711	2.037	3.747	0.138	0.058	0.196	0.000	0.832	0.832
Cotton	0.186	1.120	1.305	0.030	0.012	0.042	0.000	0.173	0.173
Tomatoes	0.000	0.000	0.000	0.242	0.093	0.336	0.000	1.343	1.343
Onions	0.000	0.000	0.000	0.205	0.257	0.462	0.000	3.700	3.700
TOTAL	1.896	3.156	5.053	0.615	0.420	1.036	0.000	6.048	6.048
All current Annex-I crops	2.65	3.41	6.07	7.73	2.95	10.67	0.00	42.44	42.44

Table-14 shows the potential payments into the BSF from the inclusion of the four crops in Annex-I with the current payment obligations and rates of payment (Option 1). The table also compares the potential payments from these four crops to the total potential flows from all current Annex-I crops. It may be seen from Table-14 that the largest effect of inclusion of the four crops in Annex-I will be on mandatory

payments under Article 6.7. This is on account of the large global area share for genetically modified varieties of soybean and cotton which we assume to be patented products. The potential flows into the BSF from the inclusion of soybean and cotton are estimated at US \$ 5.05 million which is 85% of the total potential flows from all crops currently included in Annex-I. It is interesting that the potential for voluntary payments in respect of PVP-protected varieties of tomatoes is larger than potential voluntary payments from PVP-protected varieties of soybean and cotton. This is on account of the extraordinarily high seed price factor (SPF) for tomatoes (tomato seeds are priced at US \$ 100-300,000 per tonne) with the commercial seed market for tomatoes valued at nearly US \$ 1.6 billion in 2013 (MarketsandMarkets, 2013). Onions also command a high seed price factor (with seed prices of nearly US \$ 160,000 per tonne). It should, however, be noted that our estimated potential flows from onions may be overstated because the analysis assumes that all onions will be planted from seeds. In practice, a large proportion of the onion crop is planted from “onion-sets” or bulbs that cost significantly less- which implies that the size of the commercial market for onion seed may be much lower than what we have projected in the simulation. The potential for voluntary payments from non-protected varieties of the four crops is estimated at US \$6.05 million. This again highlights the role of SMTA-PGR in commercial plant variety innovations not protected by any form of intellectual property rights in developing country markets.

Our analysis demonstrates that the expansion of Annex-I to include all crops will substantially enhance the potential for payment flows into the BSF. The potential for mandatory payments will be significantly impacted by the inclusion of crops that have seen significant application of genetic modification or biotechnology in the development of innovations. The development and large scale adoption of genetically modified vegetable crops in the future may further enhance the potential for mandatory payments. There is also significant potential for payment flows from PVP-protected varieties of high value vegetable crops where the seed price to commodity price ratios tend to be radically different from that of cereals crops. The inclusion of high value vegetable crops in Annex-I will also have the effect of bringing the most profitable and dynamic sector of the plant breeding industry within the ambit of SMTA-mediated exchange of PGR and provide a major stimulus to innovation through more intensive use of PGR available in the MLS.

Performance Factor

The figures for payments into the BSF projected in the scenarios described above reflect the potential for payment flows based on the current size of the commercial seed markets for different crops and an assessment of the shares of varieties incorporating SMTA-PGR for each crop. The extent to which the potential is realised will depend on the “performance factor” – i.e., the proportion of the potential for payment for different product categories that translates into actual payment flows into the BSF. The current architecture of the SMTA relies entirely on SMTA-users to monitor the use of SMTA-PGR in different commercialised products, accurately assess the quantum of payment obligations under the SMTA and effect the payments in a timely fashion. In the case of voluntary payments under Article 6.8 of the SMTA, SMTA-users are only “strongly encouraged” to make payments into the BSF. The BSF has thus far not received any mandatory or voluntary payments related to the use of SMTA-PGR in commercial products, although our analysis clearly shows that such payment obligations may subsist in the current global seed market. A large gap between potential and actual flows into the BSF may persist even when the innovative options suggested by the Working Group are implemented. This suggests that in addition to modifying the structure of payment obligations under the SMTA for enhancing payment flows, it may also be necessary to revisit the exclusive reliance on user-adherence to contractual obligations under the SMTA. While monitoring/audit of individual SMTA-users may be clearly infeasible and not in consonance with the spirit of the International Treaty, there may be a strong case for the

Treaty to undertake a systematic review of the use of MLS-PGR in commercialised plant variety innovations periodically. Such periodic reviews would not only provide updated information on the contribution of MLS-PGR to the plant variety innovation in both developed and developing countries, but would also support user-adherence to contractual obligations under the SMTAs. Collection and dissemination of information on the contribution of the MLS to plant variety innovations can be expected to provide a strong stimulus to the realisation of payment flows into the BSF.

Till such time as reliable information flows on the use of SMTA-PGR in commercial plant variety innovations are built up from intellectual property rights databases or other innovation databases, it is likely that a large gap will persist between potential and realisable payment flows into the BSF. The magnitude of the gap is likely to be different for different product categories. It can be expected that adherence to payment obligations will be greater when more information on innovations is available in the public domain. Information on intellectual property rights-protected innovations is generally available from patent and PVP databases. Intellectual property rights applications may also generally call for disclosure of parental material used in the breeding of plant variety innovations. The gap between potential and realisable payment flows into the BSF for different product categories/payment options can be captured in a “performance factor” parameter which is the proportion of the potential payment flows which can be expected to be realised. We have assumed the following “performance factor” values for different product categories/payment options.

Performance factor for payments for patented varieties under Article 6.7	= 80%
Performance factor for payments for PVP varieties under Article 6.7	= 50%
Performance factor for payments for regulated varieties under Article 6.7	= 20%
Performance factor for payments for PVP varieties under Article 6.8	= 10%
Performance factor for payments for non-protected varieties under Article 6.8	= 5%
Performance factor for Article 6.11 payments	= 10%

The high compliance factor assumed for payments for patented varieties under Article 6.7 of the SMTA reflects the fact that these innovations will be relatively few and will be easily identifiable from patent databases that also provide information on the provenance and genealogy of these varieties. Varieties protected by PVP can also be readily identified from PVP databases, but much less information is available from these databases on the breeding history or genealogy of the protected varieties. Much less information is likely to be available on the provenance/genealogy of regulated varieties not subject to any form of IPRs. We also assume that the performance factor for voluntary payments under Article 6.8 will be considerably lower than that for mandatory payments under Article 6.7. The very low compliance factor assumed for Article 6.11 payments reflects the fact that these payment obligations may arise from a complex maze of transactions where SMTA-PGR is transferred from one Recipient to another (and hence may be difficult to monitor and track) and the difficulties in obtaining reliable crop level seed sales data of SMTA-users bound by Article 6.11 payment obligations.

The realisable flows of payments into the BSF under different scenarios with the above performance factors are summarised in Table-15 below. The large gap between potential and realisable payments highlights the need to address issues influencing the performance factor. The application of innovative

approaches for enhancing payment flows into the BSF must not only enhance the potential for revenue generation but also examine systemic changes required to realise that potential.

Table-15: Potential and Realisable Payment Flows into the BSF under All Scenarios (US \$ million)

ARTICLE 6.7 AND 6.8 PAYMENTS						
Option 1- Payment rates - Patented Products (0.77%), PVP Products (0.77%), Non-Protected (0.77%)	Patented varieties (mandatory payments)		PVP varieties (voluntary payments)		Non-protected varieties (voluntary payments)	
	Potential	Realisable	Potential	Realisable	Potential	Realisable
	6.07	4.85	10.67	1.07	42.44	2.12
Option 2-Scenario 1-Extension of mandatory payments to PVP products	Patented varieties (mandatory payments)		PVP varieties (mandatory payments)		Non-protected varieties (voluntary payments)	
	Potential	Realisable	Potential	Realisable	As in Scenario 1	
	Case 1-Patented Products (0.77%), PVP Products (0.77%),	6.07	4.85	10.67		
Case 2-Patented Products (1.1%), PVP Products (0.5%),	8.67	6.93	6.93	3.47		
Case 3-Patented Products (1.1%), PVP Products (0.2%),	8.67	6.93	2.77	1.39		
Option 2-Scenario 2-Extension of mandatory payments to PVP and Regulated products	Patented varieties (mandatory payments)		PVP varieties (mandatory payments)		Regulated varieties (mandatory payments)	
	Potential	Realisable	Potential	Realisable	Potential	Realisable
	Case 1-Patented Products (0.77%), PVP Products (0.77%), Regulated Products (0.77%)	6.07	4.85	10.67	1.07	42.44
Case 2-Patented Products (1.1%), PVP Products (0.5%), Regulated Products (0.2%)	8.67	6.93	6.93	3.47	11.02	2.20
ARTICLE 6.11 PAYMENTS						
Option 3 -	Payment on all commercial seed of SMTA-PGR crop		Payment on all patented and PVP varieties of SMTA-PGR crop		Payment on all patented, PVP and regulated varieties of SMTA-PGR crop	
	Potential	Realisable	Potential	Realisable	Potential	Realisable
Scenario A	211.42	21.14				
Payment rates from Scenario B (1) -Patented Products (0.5%), PVP Products(0.23%)			85.23	8.52		
Payment rates from Scenario B (2) -Patented Products (0.5%), PVP Products(0.09%)			68.06	6.81		
Payment rates from Scenario C - Patented Products (0.5%), PVP Products(0.23%), Regulated Products (0.09%)					101.93	10.19

Conclusions from Static Analysis

PGR from the MLS supports a large base of plant variety innovations over a range of crops. Our analysis shows that the architecture of the SMTA restricts benefit-sharing payments to a narrowly defined subset of the innovations facilitated by the use of MLS-PGR. The exclusion of a significant proportion of innovations from the purview of benefit-sharing arrangements arises, first from the restricted coverage of crops in Annex-I of the Treaty. Annex-I currently excludes several crops that play an important role in global agriculture and farm-based livelihoods. In particular, it excludes certain crops like soybean and cotton that have witnessed accelerated innovation through the application of biotechnology. The widespread adoption of these innovations and the rapid growth of the commercial seed market values for these crops have not translated into potential for enhanced payment flows into the BSF. Similarly, the exclusion of some important vegetable crops like tomatoes and onions has meant that some of the most dynamic and profitable segments of the seed industry remain outside the purview of benefit-sharing arrangements envisaged in the Treaty. The extension of crop coverage in Annex-I to all crops would significantly enhance the potential for payments into the BSF. There may be a case for inclusion of crops in Annex-I based on their wider role in rural and farm livelihoods than on their relevance to food security alone.

Even for crops that are currently included in Annex-I, benefit-sharing payments are restricted to a relatively small proportion of innovations facilitated by the use of SMTA-PGR. This is the result of the delineation of product categories that attract mandatory payments into the BSF. Restricting mandatory payment obligations to plant variety innovations protected by patents alone, effectively excludes the dominant portion of innovations developed using SMTA-PGR in both developed and developing countries. Most plant variety innovations in developed countries are protected by PVP rather than by patents. Although PVP-protected varieties generally remain available for further research and breeding to others, PVP does allow the appropriation of economic returns by innovators, a portion of which could devolve to the BSF. Bringing PVP-protected varieties within the purview of mandatory payments would significantly enlarge the innovation base that supports the BSF. Developing country NARS and CGIAR centres that breed for developing country environments are the most intensive users of SMTA-PGR. The innovations that they generate constitute the dominant proportion of innovations derived from SMTA-PGR and probably have larger productivity and welfare effects than innovations in developed countries. Even if these innovations are not subjected to intellectual property rights, their commercial exploitation is facilitated by regulatory structures related to variety release, quality control and marketing. If the fundamental principle underlying the SMTAs is that benefit-sharing arrangements should be triggered by commercial exploitation of innovations incorporating SMTA-PGR, then these innovations should also contribute to the benefit-sharing payment flows. In developing countries where intellectual property rights systems for plant variety innovations either do not exist or are in the early stages of establishment, intellectual property rights protection of an innovation may not be a reliable or useful guide to its commercial potential.

It should be noted that Article 6.8 of the SMTA already strongly encourages SMTA-users to make payments into the BSF for PVP-protected and non-protected varieties developed using SMTA-PGR. However, it is left to the discretion of SMTA-users whether to effect any voluntary payments. The experience of the International Treaty thus far suggests that exhortations for voluntary payments are unlikely to generate any significant payment flows into the BSF. Conversion of voluntary payment

obligations into mandatory ones may be an important step in providing a reliable and stable base for generating payment flows into the BSF.

Enhancement of payment flows into the BSF will also call for a radical restructuring of the payment rates under Article 6.7 and Article 6.11. With the current structure of payment rates, the economic incentives for SMTA-users are highly skewed towards the selection of the Article 6.7 option. Although adoption of the Article 6.11 option by SMTA-users has the potential to generate larger revenue flows more quickly, no SMTA-user will have the incentive to do so at the current levels of SMTA-PGR use in plant variety innovations. Enhancing payment flows into the BSF through a large increase in the payment rate under Article 6.7 would not be feasible as such increases would be unacceptable to SMTA-users and would adversely impact the uptake of PGR from the MLS. Incentivising the adoption of Article 6.11 by a larger proportion of SMTA-users may, therefore, be a key approach to enhancing payment flows into the BSF. This will, however, call for a sharp reduction in the payment obligations under Article 6.11 through a combination of a sharp reduction in the payment rates and narrowing of product categories that attract Article 6.11 payments with the possible option of applying different rates to different product categories.

The application of the innovative approaches suggested by the Working Group (involving restructuring of payment obligations and payment rates) can substantially enlarge the potential for payment flows into the BSF. However, the realisation of the enhanced potential will require a climate that supports meticulous adherence to contractual obligations by SMTA-PGR Recipients. Systematic and independent periodic assessments of the state of plant variety innovation in different crops can improve the effectiveness of SMTAs and sustain the benefit-sharing provisions of the International Treaty.

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