The International Treaty
ON PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE

Dynamic analysis of possible changes in the provisions governing the functioning of the Multilateral System, and possible income

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INTRODUCTION

1. The Governing Body, in its Fifth Session, established an *Ad Hoc* Open-ended Working Group to Enhance the Functioning of the Multilateral System of Access and Benefit-sharing, with the task of developing a range of measures for consideration and decision by the Governing Body at its Sixth Session that will:

   (a) Increase user-based payments and contributions to the Benefit-sharing Fund in a sustainable and predictable long-term manner, and

   (b) Enhance the functioning of the Multilateral System by additional measures.

2. In this context, the Governing Body decided that the:

   "the Secretariat should prepare a number of short, strategic preliminary studies, taking into account all available information, including the recent study, *Assessing the potential for monetary payments from the exchange of plant genetic resources under the Multilateral System of the International Treaty on Plant Genetic Resources for Food and Agriculture*,"[1] including:

   "A study estimating income to be expected from possible changes, consistent with the objectives of the Treaty, in the provisions governing the functioning of the Multilateral System, taking into account reports of the *Ad Hoc* Advisory Committee on the Funding Strategy and the Ad Hoc Technical Advisory Committee on the Multilateral System and SMTA".

The present document is a technical input to the Background paper, *Estimating income to be expected from possible changes in the provisions governing the functioning of the Multilateral System*, which is available at http://www.planttreaty.org/content/background-study-paper-1. It is not intended to be prescriptive, or to make recommendations on the decisions that the Governing Body will need to take, but to provide data and technical analysis that may help identify both problems and opportunities, and so support the Working Group in its task.

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[1] This study is available on line at http://www.planttreaty.org/node/4791, and is cited in the present study as "*Potential*".

Calibrating Articles 6.7 and 6.11 of the SMTA, and expansion of the Treaty's crop coverage

Assumptions

3. In order to be able to compare the current status with possible changes to the SMTA, it is necessary to make a number of assumptions regarding what these changes could be, as the basis for comparison. These assumptions have been based on paragraphs 84–96 of *Background*, which the Working Group considered at its last meeting.

4. The possible structural changes, which are used as assumptions, in this study, were described as follows:

    a. Since Articles 6.7 and 6.11 are logically and operationally inter-dependent, the key technical question is how to coordinate the relationship of the payment levels under the two payment options, so as to:

        i. begin from a parity of opportunity cost for users, in deciding for one option or another, and prevent one option driving out the other, as happens at present; and then to

        ii. implement the policy objectives that the Governing Body may wish to establish, for example, to promote one or other of the options, or to seek a more rapid generation of funds, by modifying the parity rate.

    b. If the Governing Body decides to vary the levels of payment under Articles 6.7 to differentiate between different categories of product, in terms of whether they are commercialized (1) under patents, GURTs or restrictive licensing, (2) plant variety protection (PVP), or (3) without restriction for further research and breeding, it would appear logical to similarly differentiate the payment levels under Article 6.11 as well, in a parallel manner, though not at the same absolute levels.

    c. Because the two payment options are technically interlinked and interdependent, then the relative levels of payment between the two options will need to be set in such a way that the option that will provide the least income to the Treaty does not drive out the option which would provide more income: in theoretical terms, a perfect balance of rates between options might be described as a "parity of opportunity cost to users, in deciding for one option or another".

    d. The Governing Body may also, in establishing the levels of payment under the two options, consider modifying the parity levels, so as to create an incentive or a disincentive for a specific option, on policy grounds, and because of the potential income to the Benefit-sharing Fund.

    e. The Working Group may wish to first consider the technical question of the *relative* levels of payment between the two options, before considering the *absolute* levels of payment, which will define the probable income to the Benefit-sharing Fund.

5. In line with the above, it is assumed that mandatory payments[2] will be required for products marketed under either patents or PVP, in both Articles 6.7 and 6.11. Other products will not pay, in either option. For this reason, Article 6.8 no longer has a function, and drops away.

6. It is assumed that separate payments levels will be set for patents and PVP, and that the same relative levels between these levels will apply in both Articles 6.7 and 6.11. It is also assumed that the overall payment obligations under Article 6.11 will be lower than under Article 6.7.

7. The Article 6.11 option will continue to be implemented by crop, or crop group, because different users will have different mixes of crops within their product pool.

8. Under Article 6.7, payments will continue to be required on a product-by-product basis, and under Article 6.11, payment will continue to be reqired for all a breeder or seed company's products of the crop or crops in question.

Preliminary caveats

*Quantification clarifies issues which qualitative analysis leaves fuzzy. It is more readily contestable and likely to be contested. It sharpens scholarly discussion, sparks off rival hypotheses, and contributes to the dynamics of the research proces*s.

Angus Maddison, *Contours of the World Economy 1-2030 AD: Essays in Macro-economic History* (2007, p. 1)

9. The dynamic inter-relationship of two alternative payment options is best understood by using a model, but it is necessary to make a number of strong initial caveats. A model is not a picture of the real world, but an analytical tool to show the logic and inter-relationship of the elements. A good model allows crucial elements to be isolated, rigorously described, and mathematically manipulated. Although numbers are put on outcomes in the analysis below, these are not real world estimates, but designed to show relative values, and changes under different scenarios.

10. The real world is subject to strategic decisions by real people, and their stochastic decisions, including to avoid the Treaty and its SMTA entirely, or to segregate SMTA materials in their breeding pool, so as to avoid obligations to the Treaty that would arise from crossing these materials widely into their commercial products, are not modelled. Decisions in the real world may be considered more fruitfully, once the basic model to which real people react has been understood.

11. Moreover, in the real world, individual breeders and seed companies make individual decisions. The model cannot replicate this diversity of individual circumstances and choices, but assumes that breeders and companies, as it were, make a single choice, based on a single portfolio.

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[2] For a discussion of mandatory and voluntary payments, see *Background*, paragraphs 40–47 (*Avoidance of SMTA material and the problem of voluntary payment*) and paragraphs 54–56 (*Addressing the problem of voluntary payment*).

The dynamic relationship of Articles 6.7 and 6.11

Adapting the reference model

Figure 1. Structural elements of the reference model

Source: *Potential*, p. 121, fig. 3.1
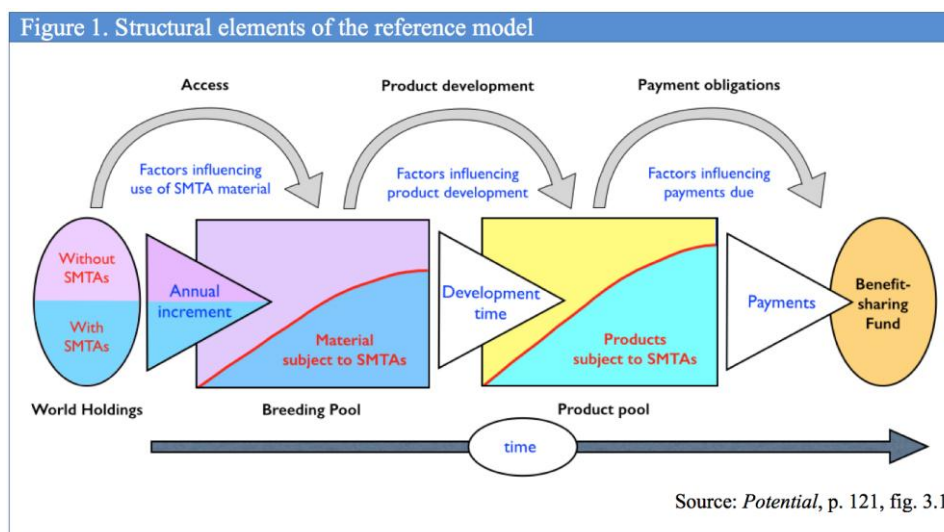
12. The reference model on which the analysis of the dynamic relationship of Articles 6.7 and 6.11 rests is that used in *Potential*, including in order to be able to compare the results of this analysis with the earlier analysis. The structure of the reference model is shown diagrammatically in fig. 1.

13. A brief description of the main elements of the model is as follows:

   a. The model starts from world *ex situ* holdings of accessions of plant genetic resources for food and agriculture and identifies those that are under the Treaty, which should be available with SMTAs, and those that are not available with SMTAs.[3]

   b. These materials enter the world breeding pool at a standard rate, which causes the part of the world breeding pool subject to the terms and conditions of the SMTA to grow over time.

   c. The world product pool follows the same dynamic, whereby the part of world products with obligations to contribute to the Treaty increases over time, at a time distance of an average development time.

   d. The part of the world product pool with obligations to the Treaty, at any particular time, is the basis for attributing a corresponding part of the value of world sales, according to the provisions and the payment rate of Article 6.7 of the SMTA.[4]

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[3] Appendix to IT/OWG-EFMLS-2/14/inf.3, *The current status of the Multilateral System of Access and Benefit-sharing*, available on line at http://www.planttreaty.org/content/background-study-paper-1.

[4] In *Potential*, the model allows for *avoidance of materials under an SMTA* (υ, see pp. 138) and for an *effective rate of* payment for payments that are voluntary (ρ, see pp. 131–132). In the current analysis, these factors are ignored: that is, avoidance is not allowed for, and it is assumed that all payments are mandatory.

14. The reference model was adapted, in order to:[5]

   a. Break-up the seed market values (V) into four categories: products protected by patents ($Q1$), products protected by PVP ($Q2$), "regulated" products ($Q3$), and non-regulated products ($Q4$)".

   b. Introduce vegetables as a separate, new category in the analysis ($V4$ and $V5$).

   c. The potential of payment for each of these categories, and, where relevant, the level of payment, derives from the intellectual property regime under which they are commercialized (ι_1– ι_4 respectively), and the payment rates (μ_1– μ_4 respectively).

15. The relevant structure of the adapted reference model, as adapted, is shown diagrammatically in fig. 2.

Figure 2. Revised crops/crop groups, Intellectual Property status, and payment rates

Adapted from *Potential*, p. 131, fig. 3.3
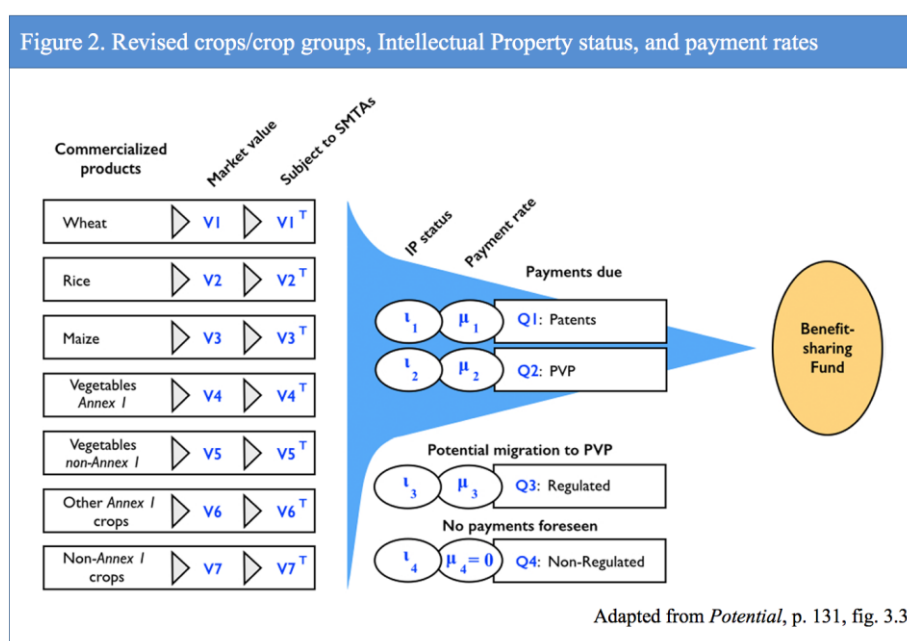
16. By "regulated" products is meant varieties released under variety release procedures, within the ambit of seed quality control regulations,[6] mainly in developing countries. The reason for specifically identifying this category is that Article 27.3b of the TRIPS Agreement requires members of the World Trade Organization to "provide for the protection of plant varieties either by patents or by an effective *sui generis* system or by any combination thereof". It is assumed that a part of the currently regulated category will migrate to the category of PVP over time, which the model therefore investigates.

17. Non-regulated products account for very small part of the commercial seed market (V), and virtually none of them will have incorporated material received under an SMTA. They

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[5] The formal symbols used in this section of the report are those defined in *Potential*, pp. 124–125, section 3.1.7, with the revision of the definitions of ι, μ, Q and V, described here, and the introduction of the new symbols, P, U, R and σ, defined in the *Formal statement of Parity Point methodology*, below.

[6] See also C.S. Srinivasan's parallel research paper, *Application of innovative approaches for enhancement of income flows into the Benefit-sharing Fund: Assessing the potential impact of revision of SMTA provisions in the current world seed market and plant breeding innovation scenario*.

attract no payments under any scenario.

The Parity point methodology

FORMAL STATEMENT OF THE PARITY POINT METHODOLOGY

1. The Parity Point is the date, t_P, when the annual payments by the user would be the same, under either Article 6.7 or Article 6.11.
2. Let U be the ratio between the payment level for products under PVP (μ_2) to patented products (μ_1) ; $U = \mu_2/\mu_1$.
3. U applies in both Article 6.7 and Article 6.11.
4. Let σ be total annual payment due, where $\sigma_{6.7}$ is the total annual payments due in accordance with Article 6.7, and $\sigma_{6.11}$ the total annual payments due under Article 6.11.
5. Let R be a ratio of annual payments due; $R = \sigma_{6.7}/\sigma_{6.11}$.
6. T is that part of a user's product pool, P, that is derived from material received under an SMTA, and obligated to the Treaty, and T/P is ratio of products with payment obligations to total products.
7. By the reference model, t advances by annual increments to the breeding pool, and, in a linked manner, annual increments to the part of T in T/P.
8. Under Article 6.11, *all* products are paid for, so that, for *any* t, $T/P = P$,
9. t_P is reached when, in the projections of the reference model, payment under the two options is equal:
$$[T/P \times \{(_{\sigma6.7}(\mu_1) \times \iota_1) + (_{\sigma6.7}(\mu_2) \times \iota_2)\}] = \{(_{\sigma6.11}(\mu_1) \times \iota_1) + (_{\sigma6.11}(\mu_2) \times \iota_2)\}.$$
10. On the assumption that all users opt for Article 6.11 *after* Parity Point, the maximum possible income, every year, to the Benefit-sharing Fund is:
$$\sum\{(_{\sigma6.11}(\mu_1) \times \iota_1) + (_{\sigma6.11}(\mu_2) \times \iota_2)\}_{tP}.$$
11. On the assumption that all users opt for Article 6.7 *before* Parity Point, the maximum possible income until then, in any specific year, is:
$$\sum[T/P \times \{(_{\sigma6.7}(\mu_1) \times \iota_1) + (_{\sigma6.7}(\mu_2) \times \iota_2)\}]_t.$$

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18. The Parity Point methodology is based on a simple assumption, namely that recipients are rational cost-minimizers, that is, that their choice of whether to use the Article 6.7 or the Article 6.11 option will be based primarily on its economic advantage, that is the relative cost to them, of the two options.

19. They will base their decision upon two factors:

    a. The proportion of their products for which they will be obliged, by the terms and conditions of the SMTA, to make payment to the Treaty, and

    b. The total annual payment that will result.

20. The Parity Point methodology exploits the capacity of the reference model to make projections of income to the Benefit-sharing Fund, at any point in time. The reference model assumes that the proportion of SMTA material in a breeder's breeding pool will increase over time, at a constant rate, and that the proportion of products in the breeder's

product pool, for which payments are due, will accordingly increase at a similar rate, at a date distant by the time necessary to breed a product.

21. The major structural difference between the Article 6.7 and the Article 6.11 options is that Article 6.7 payment option requires payment for *individual* commercialized products that have incorporated SMTA materials. The 6.11 payment option, however, requires payment on *all* of a breeder's commercialized products, whether or not they incorporate SMTA materials.

22. As in the current SMTA, it is assumed that, in revisiting the Articles, the Governing Body will set different overall payment levels for the Article 6.7 and 6.11 options.

23. A breeder's economic advantage is therefore governed simply by the two inter-relationship of these two factors, the percentage of his breeding pool obligated to the Treaty, and the different price levels set in the two options, that is:

    (Percent of breeding pool obligated to the Treaty) × (the option's payment rates).

24. The Parity point is therefore the date at which the total payments due under the Article 6.7 option equal payments due under the Article 6.11 option. Economic rationality means that the breeder will always opt for Article 6.7 *until* Parity Point is reached, and will always opt for Article 6.11 *after* it is reached.

25. The Article 6.11 payment level, at the Parity Point, therefore defines the maximum potential income to the Benefit-sharing Fund.

Figure 3. Illustration of the Parity Point methodology
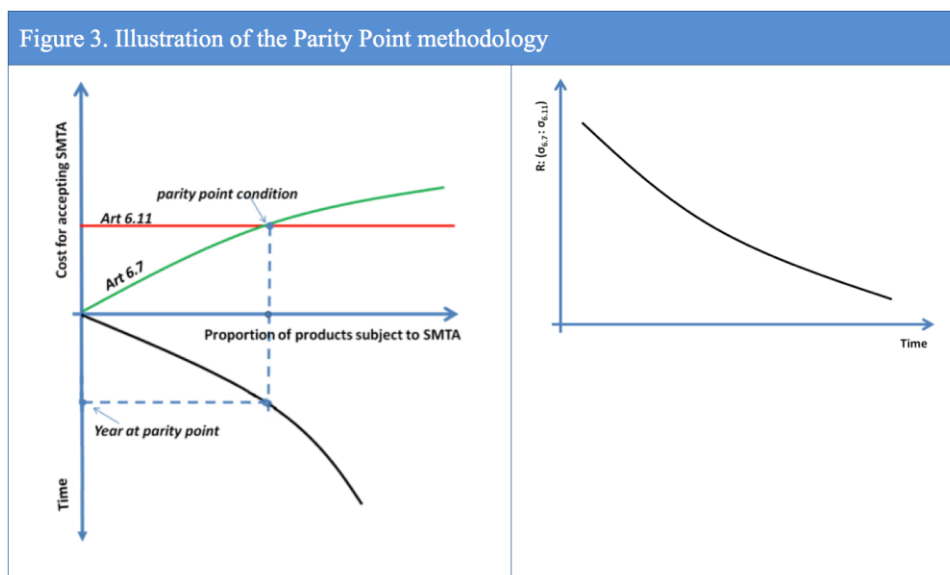
26. Fig. 3 illustrates the Parity Point methodology. The figure on the left shows that Parity Point is reached when Article 6.7 payment intersects with Article 6.11 payment, which defines the Parity Point year (t_P). The figure on the right shows how the Parity Point year responds to the ratio of Article 6.7 obligations to Article 6.11 obligations (R): the more the ratio tilts towards Article 6.7, the sooner the Parity Point year is reached; the more it tilts towards Article 6.11, the longer it takes to reach Parity.

Analysis of the dynamic relationship between Articles 6.7 and 6.11

It vexed me to understand no more from Reeve, … he understanding the acting part but not one bit of the theory, nor can make anyone understand it.

The Diary of Samuel Pepys, Sunday, 19 August, 1666.

27. The dynamics of the inter-relationships between payment rates, Parity Point year, and maximum potential, are complex. Because breeders and seed companies act as rational economic actors, they can be expected to change to Article 6.11 when Parity Point is reached. The level at which the Article 6.11 rate is set therefore defines the total potential income to the Benefit-sharing Fund.

28. Fig. 4 shows Parity Point and projected income, using the parameters shown below the figure. These should not be taken in any way to be recommendations to the Working Group, but are theoretical levels, intended to be held constant in scenarios investigating the dynamics of a dual option payment system. The rate assumed for patents is: in Article 6.7, the current rate of 0.77%, and in Article 6.11, the current rate of 0.5%. There is no precedent on which to base a rate for PVP, and this has been set arbitrarily at: in Article 6.7, 0.20%, and, in Article 6.11, 0.13%. The "projections of income" are totally dependent on the rates assumed, and not estimations of real, expected income. These payment rates correlate to a **U** (patent rate/PVP rate) of 0.26 in both Articles 6.7 and 6.11. They also correlate to an **R** (payment rates in Article 6.7/payment rates in Article 6.11) of 1.54.

29. Parity Point is reached in 2038, and the projected annual income at that year is US$ 42.68 million. This defines the theoretical maximum, at any later date.

Figure 4. Trade-offs: Parity Point year and projected benefits

Year	U	R	$\sigma_{6.11}(\mu_1)$	$\sigma_{6.11}(\mu_2)$	$\sigma_{6.7}(\mu_1)$	$\sigma_{6.7}(\mu_2)$	Benefits (US$ millions)
2038	0.26	1.54	0.5	0.13	0.77	0.2	42.68
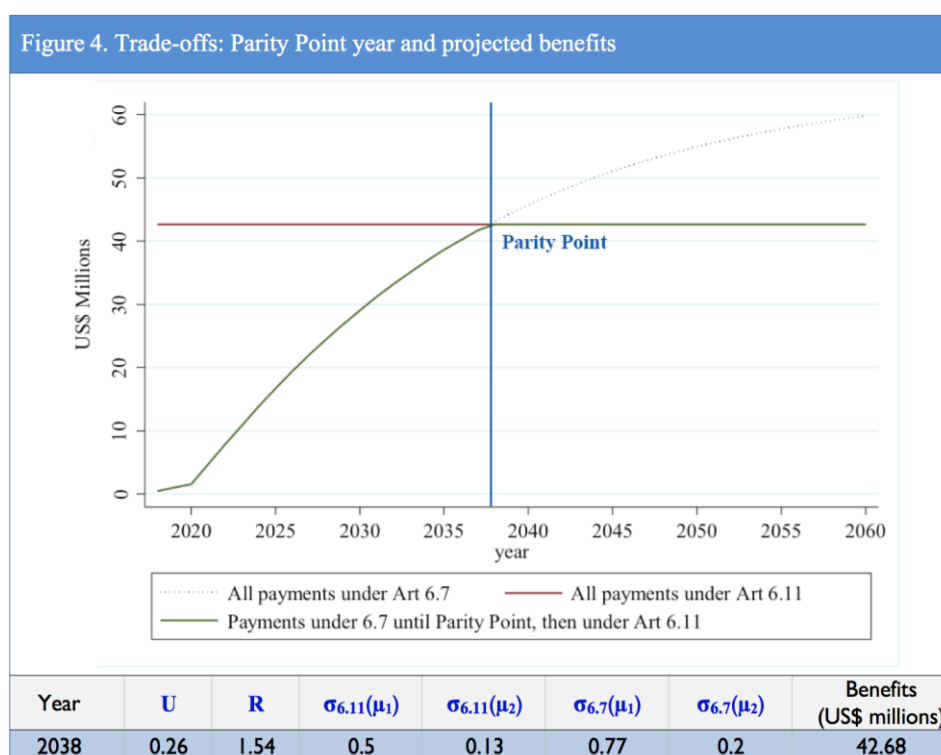
30. The role of the payment rates in Article 6.11 in defining the theoretical maximum is further shown in fig. 5. The parameters are the same as in fig. 4 for the two key parameters, **U** (PVP/patent rates) and **R** (Article 6.7/Article 6.11 rates), but the payment rate for Patents under Article 6.11 ($\sigma_{6.11(\mu_1)}$) is given at a range of rates, and, of course, the other payment rates vary accordingly. The effect is clear: the Parity Point year (2038) does not change, but the income rises substantially, in accordance with the total payment obligations.

Figure 5. Trade-offs: Fixed parity year and total potential income

Line	U	R	$\sigma_{6.11(\mu_1)}$	$\sigma_{6.11(\mu_2)}$	$\sigma_{6.7(\mu_1)}$	$\sigma_{6.7(\mu_2)}$	Parity Point year	Benefits at parity (US$ millions)
Blue	0.26	1.54	0.3	0.078	0.462	0.12	2038	25.61
Red	0.26	1.54	0.4	0.104	0.616	0.16	2038	34.11
Green	0.26	1.54	0.5	0.13	0.77	0.20	2038	42.68
Orange	0.26	1.54	0.6	0.156	0.924	0.24	2038	51.22
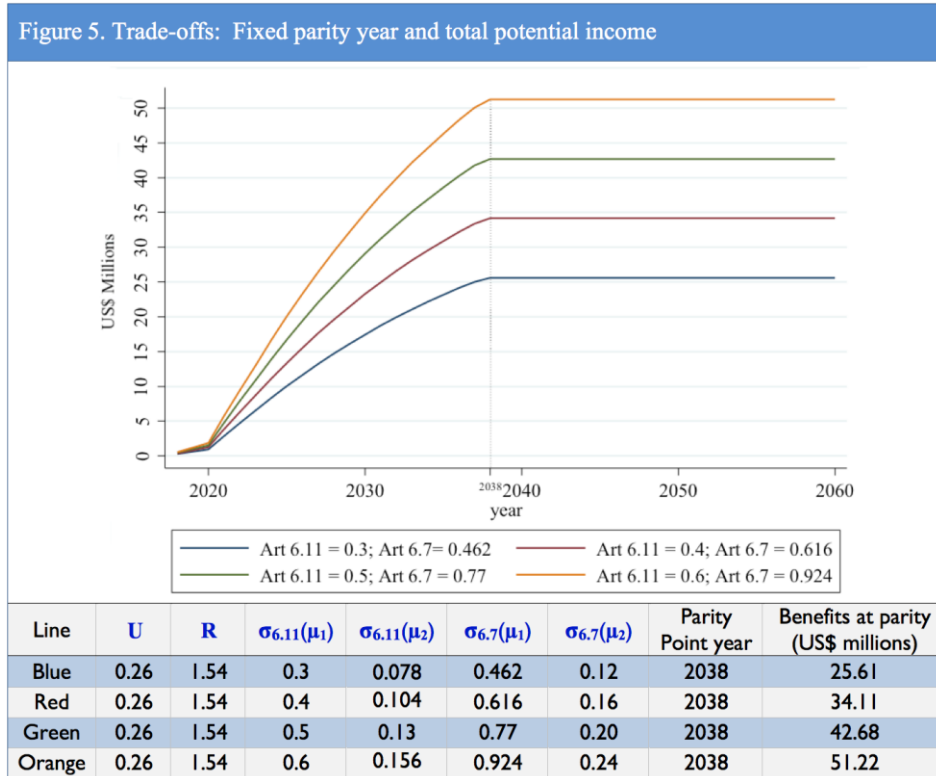
31. Fig. 6 shows another set of trade-offs. The curve on the left shows the years to Parity Point for Article 6.7, against **T/P** (the ratio of products derived from SMTA material to total products). The curve on the right plots the Article 6.7 payment rate for patents (μ_1), at Parity Point Year, against **T/P**. The two readings against these curves, A and B, link the Parity Point year on the left, to the Article 6.7 rate for patents on the right. Reading A uses the same parameters as in fig. 4. In reading B, only **R** (the ratio of total payment obligations for Article 6.7 to total payment obligations for Article 6.11) is changed, and nearly doubled.

Figure 6. Trade-offs between the Article 6.7 rate, T/P and the Parity Point year

	R	U	$\sigma_{6.11}(\mu_1)$	$\sigma_{6.11}(\mu_2)$	$\sigma_{6.7}(\mu_1)$	$\sigma_{6.7}(\mu_2)$	Parity Point year	Benefits at parity (US$ millions)
A	1.54	0.26	0.5	0.13	0.77	0.2	2038	42.68
B	3.00	0.26	0.5	0.13	1.5	0.39	2027	42.68
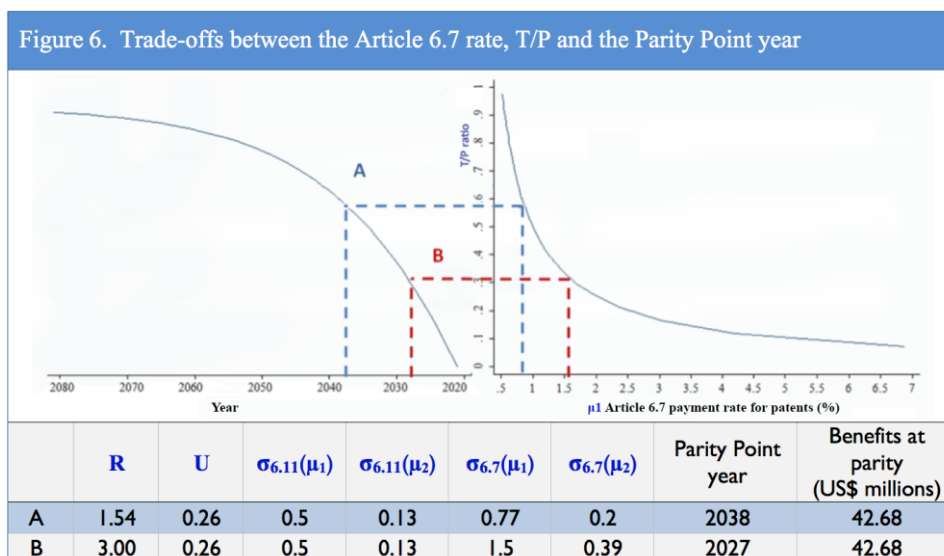
32. There is no change in the theoretical maximum, which remains at US$ 42.68 million annually, as a consequence of the increase of the relative cost of the 6.7 option over the 6.11 option, but the Parity Point year shifts 11 years closer, from 2038 to 2027. This dynamic is because the higher the payment differential between Article 6.7 and Article 6.11 (the higher **R**), the smaller is the part of the breeding pool required for parity, and the assumption of the reference model is that SMTA material in the breeding pool accumulates at a steady rate.

33. Fig. 7 plots changes in **R**, the Article 6.7 /6.11 ratio, against the Parity Point year. The parameters are the same as in fig. 4, except that **R** is varied, with the payment rates in Article 6.11 held constant. The figure may be used to estimate **R** at any specific year. The Parity Point indicated corresponds to fig. 4. To bring the Parity Point year much closer requires a substantially higher **R**, which would have to rise to 5, for example, to reach Parity in 2024.

Figure 7. Trade-offs between the Article 6.7 / 6.11 ratio and the Parity Point year

R	U	$\sigma_{6.11}(\mu_1)$	$\sigma_{6.11}(\mu_2)$	$\sigma_{6.7}(\mu_1)$	$\sigma_{6.7}(\mu_2)$	Parity Point year	Benefits (US$ millions)
1.1	0.26	0.5	0.13	0.55	0.143	2060	42.68
1.3	0.26	0.5	0.13	0.65	0.169	2045	42.68
1.54	0.26	0.5	0.13	0.77	0.2	2038	42.68
2.2	0.26	0.5	0.13	1.1	0.286	2031	42.68
2.5	0.26	0.5	0.13	1.25	0.325	2029	42.68
3	0.26	0.5	0.13	1.5	0.39	2027	42.68
5	0.26	0.5	0.13	2.5	0.65	2024	42.68
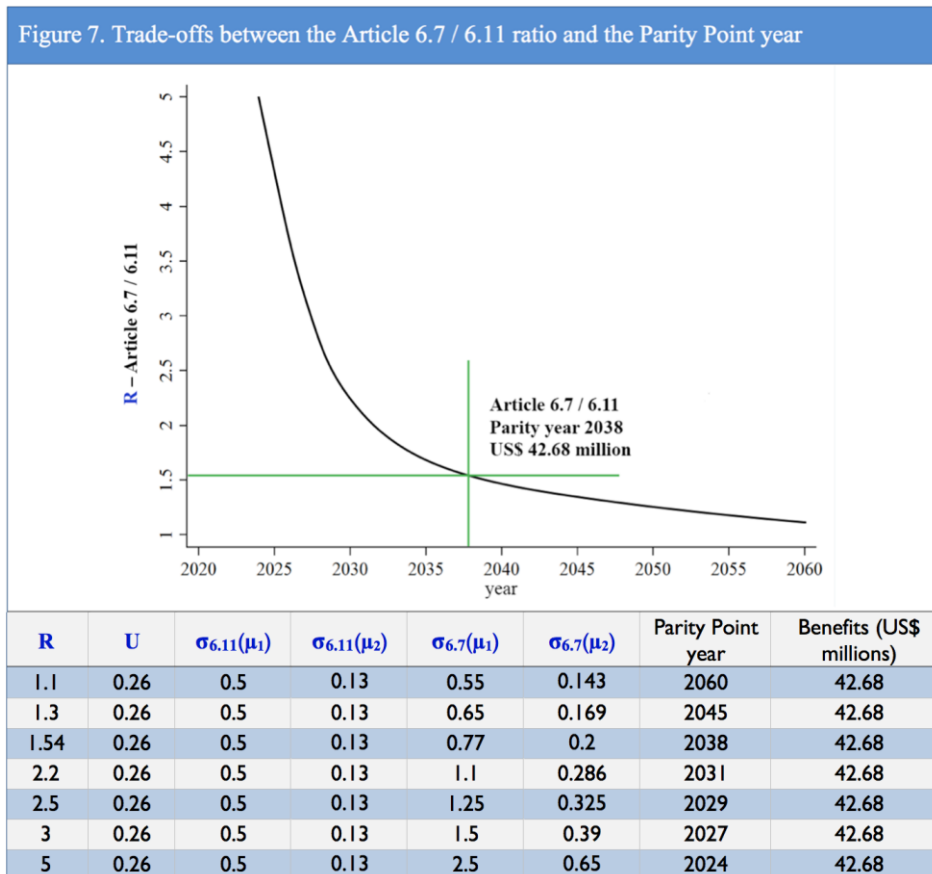
34. As we have seen, the Parity Point year depends upon **R**, the ratio of Article 6.7 payment rates to Article 6.11 payment rates ($\sigma_{6.7}/\sigma_{6.11}$). It is possible also to investigate the effects of holding either $\sigma_{6.11}$ or $\sigma_{6.7}$ constant, and varying the other element of the ratio.

35. Fig. 8 holds the two Article 6.7 payment rates ($\mu_1 + \mu_2$) constant, and varies only the Article 6.11 rates. Two curves are plotted against the x-axis (which is expressed, for simplicity, in terms of the Article 6.11 rate for patents): projected annual benefits are read from the right y-axis, and the Parity Point year from the left y-axis. This is shown here for the same parameters as in fig. 4.

Figure 8. Varying R – changing Article 6.11 payment rates, with a fixed 6.7 rates

R	U	$\sigma_{6.11}(\mu_1)$	$\sigma_{6.11}(\mu_2)$	$\sigma_{6.7}(\mu_1)$	$\sigma_{6.7}(\mu_2)$	Parity Point	Benefits (US$ millions)
2.57	0.26	0.3	0.078	0.77	0.2	2029	25.58
1.924	0.26	0.4	0.104	0.77	0.2	2033	34.15
1.54	0.26	0.5	0.13	0.77	0.2	2038	42.68
1.28	0.26	0.6	0.156	0.77	0.2	2046	51.22
1.1	0.26	0.7	0.182	0.77	0.2	2060	59.76
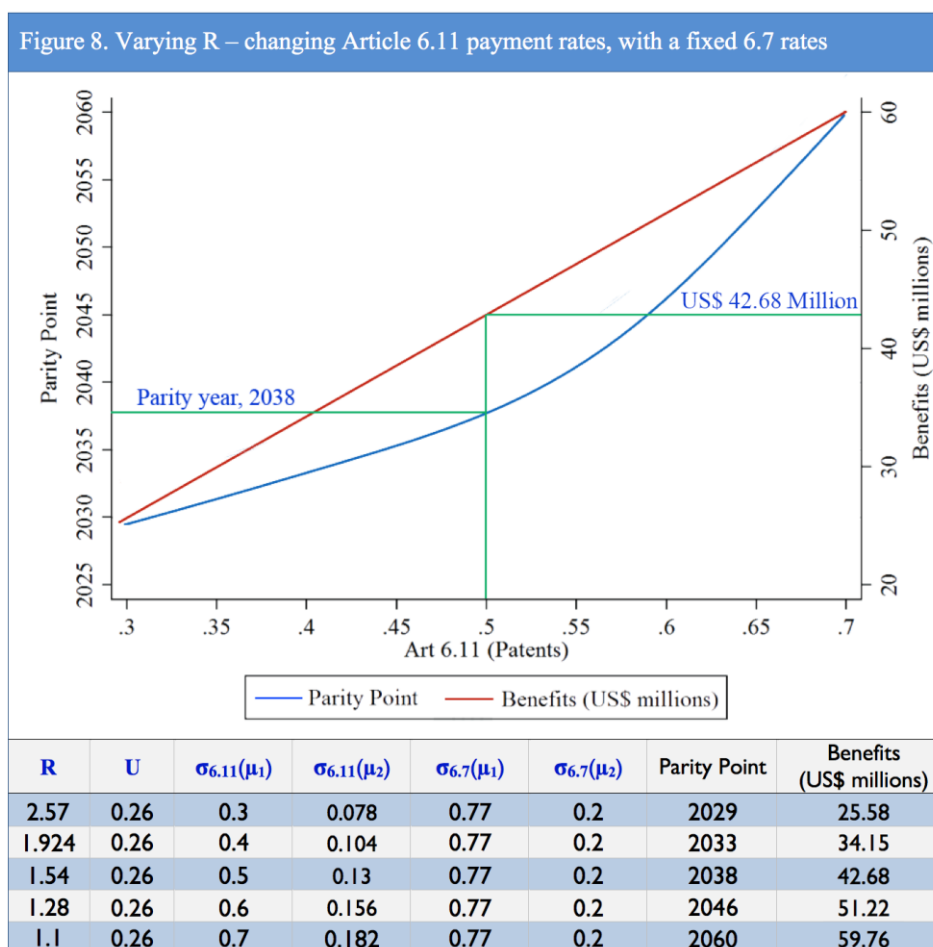
36. There are two consequences:

   a. As demonstrated, the theoretical maximum depends upon the payment rates for Article 6.11, in relation to Article 6.7. The higher this is, the higher the theoretical maximum is. With the Article 6.11 patent rate set to 0.6%, the theoretical maximum annual income is US$ 51.22 million, while when it is set to 0.7%, this rises to US$ 59.76 million.

   b. As also demonstrated, the speed with which Parity Point is reached depends upon the Article 6.7 rates, in relation to the Article 6.11 rates. With the Article 6.7 rates held constant, they become relatively smaller as the Article 6.11 rates increase. With the patent rate for Article 6.11 set to 0.3%, the Parity Point is reached in 2029, while when it is set to 0.6%, Parity Point is reached in 2046.

37. Fig. 9, on the other hand, holds Article 6.11 payment rates, $\sigma_{6.11}(\mu_1 + \mu_2)$, constant, and varies only the Article 6.7 rates, $\sigma_{6.7}(\mu_1 + \mu_2)$. As demonstrated, the rates in Article 6.11 govern the theoretical maximum, and those in Article 6.7 govern the Parity Point year, as shown in the figures below the graph. Until Parity Point is reached, however, the maximum probable income is set by Article 6.7, because it is not in a breeder or seed company's interest to choose the Article 6.11 option.

Figure 9. Varying R – changing Article 6.7 rates, with fixed 6.11 rates

R	U	$\sigma_{6.11}(\mu_1)$	$\sigma_{6.11}(\mu_2)$	$\sigma_{6.7}(\mu_1)$	$\sigma_{6.7}(\mu_2)$	Parity Point	Benefits (US$ millions)
1.1	0.26	0.5	0.13	0.55	0.143	2060	42.68
1.3	0.26	0.5	0.13	0.65	0.169	2045	42.68
1.54	0.26	0.5	0.13	0.77	0.2	2038	42.68
2.2	0.26	0.5	0.13	1.1	0.286	2031	42.68
2.5	0.26	0.5	0.13	1.25	0.325	2029	42.68
3	0.26	0.5	0.13	1.5	0.39	2027	42.68
5	0.26	0.5	0.13	2.5	0.65	2024	42.68
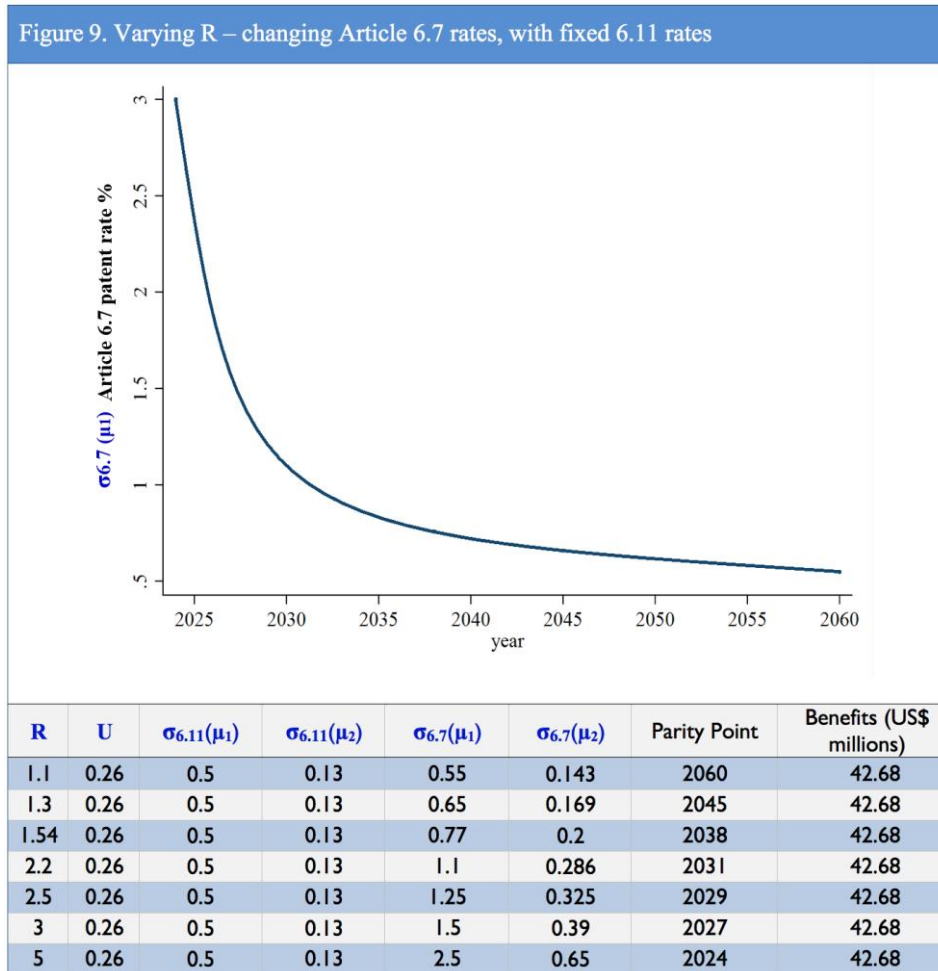
38. By holding the Article 6.11 rates constant, and varying the Article 6.7 rates, it is also possible to derive estimates of the rate at which income would build up. This is illustrated in fig. 10, which plots projected income at 10 and at 20 years, against the increase in the Article 6.7 payment rates, with Article 6.11 held constant. For simplicity, the x-axis is expressed in terms of the Article 6.7 rate for patents $\sigma_{6.7}(\mu_1)$. The higher the Article 6.7 rates, the sooner Parity Point is reached, but Article 6.11 rates establish the theoretical maximum, which peaks at US$ 42.68 million.

Figure 10. Benefit flows at 10 and 20 years, with a changing Article 6.7 rate

R	U	$\sigma_{6.11}(\mu_1)$	$\sigma_{6.11}(\mu_2)$	$\sigma_{6.7}(\mu_1)$	$\sigma_{6.7}(\mu_2)$	Parity Point	Benefits at 10 years	Benefits at 20 years
1.1	0.26	0.5	0.13	0.55	0.143	2060	9.89	26.36
1.3	0.26	0.5	0.13	0.65	0.169	2045	11.69	31.15
1.54	0.26	0.5	0.13	0.77	0.20	2038	13.85	36.90
2.2	0.26	0.5	0.13	1.1	0.286	2031	19.78	42.68
2.5	0.26	0.5	0.13	1.25	0.33	2029	22.48	42.68
3	0.26	0.5	0.13	1.5	0.39	2027	26.98	42.68
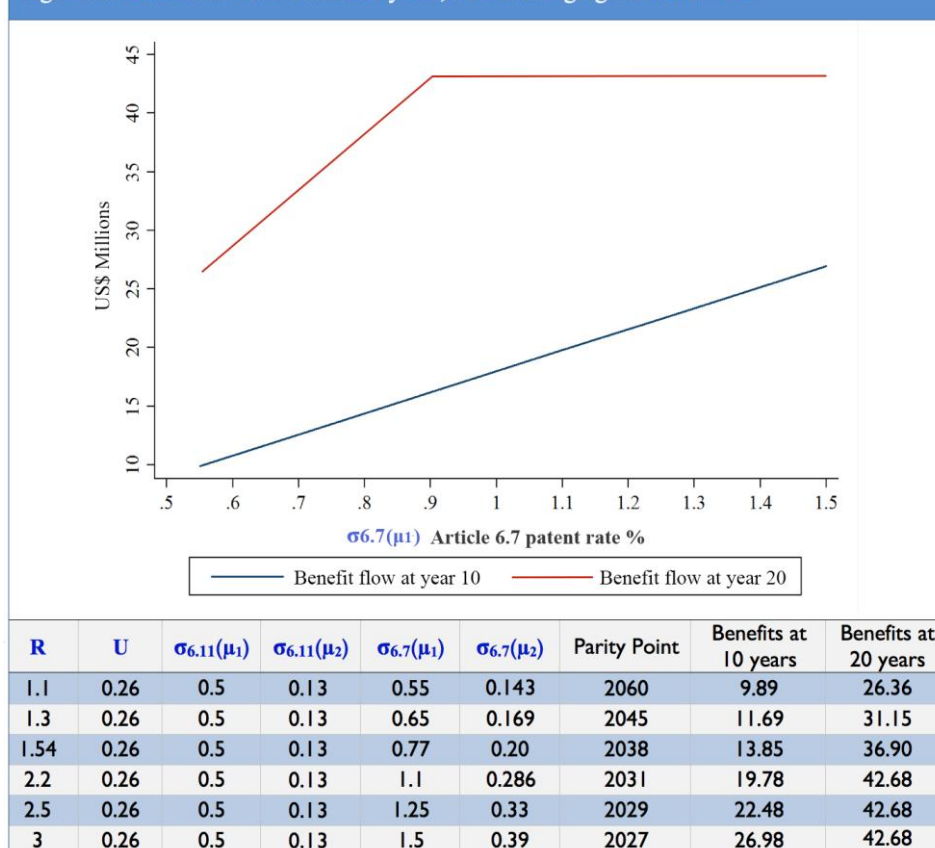
Conclusions regarding the dynamic relationship between Articles 6.7 and 6.11

39. From this analysis, we can draw a number of conclusions regarding the dynamics involved in the SMTA making provision for two different payment options, in Article 6.7 and 6.11.

   a. Users of SMTA material, as rational economic actors, will decide on which option to accept in terms of the overall cost to them.

   b. The first factors in their choice derive from the structure of the payment options themselves. The second reflect individual decisions they can make regarding the choice and management of individual SMTA materials. The model deals only with the former, but the latter is the more real and ultimately important.

   c. The key factor on which decisions will be based is simple: the overall cost to a user depends strictly on how much SMTA material is in his breeding pool, and the price of the two options. These two factors combine as follows:

   (Percent of breeding pool obligated to the Treaty) × (the option's payment rates).

   d. Because Article 6.11 requires payment for *all* of a seed company's products, whereas Article 6.7 lays payment obligations only on products descended from SMTA materials, a rational economic actor can only accept the Article 6.11 option after the

cost of payment under Article 6.7 and 6.11 become the same. The point at which this occurs is the "Parity Point". After this point, the Article 6.11 option is cheaper.

   e. If it is assumed that the percent of SMTA material in the breeding pool grows at a steady rate (the reference model assumes an annual rate of 4.2%)[7], then it is possible to express the "Parity Point" in terms of time.

   f. The dynamic structure of using the two payment options is as follows:

     i. The rates in Article 6.11 govern the theoretical maximum, because, once reached, this is the cheaper option.

     ii. The rates in Article 6.7, relative to Article 6.11, govern the Parity Point date.

     iii. The higher the Article 6.7/6.11 ratio, the sooner the Parity Point arrives. Conversely, the lower the Article 6.7/6.11 ratio, the longer it takes to reach Parity Point.

40. These conclusions relate only to the *structure* of the two-option system, and are independent of real values, which depend on the actual rates stipulated in the SMTA. They have, however, important real world implications.

   a. Breeders and seed companies have many ways to avoid reaching a high percentage of SMTA material in their breeding pool, which — at any reasonable payment rates in Article 6.7 — means they will never be in a situation where they find Article 6.11 cheaper:

     i. They can avoid use of material under an SMTA altogether, or, more likely, can take only a few materials under SMTAs, when they judge these to be especially valuable to their breeding programme, and when they cannot get them elsewhere.

     ii. They can segregate materials received under SMTAs within their breeding programmes, so that only a small number of their products — where there is a real economic advantage — have ancestors received under SMTAs. Discussions with companies during this study confirm that this is already the case.

   b. In these circumstances, the Governing Body, if it wishes to make the Article 6.11 option the default option, could consider radically increasing the Article 6.7/6.11 ratio — that is, decreasing the percentage of a breeding pool that is needed to trigger a user's decision to move to the Article 6.11 option — in one of four ways:

     i. It could drastically raise the relative cost of the Article 6.7 option, but if this is raised too high, it will seriously reduce a company's economic ability to use SMTA material at all. Moreover, the higher the relative rates for Article 6.7 are set, the lower will be the theoretical maximum.

     ii. It could drastically reduce the relative cost of the Article 6.11 option, but this would result in risible income for the Benefit-sharing Fund.

     iii. Or it could try to vary the rates in both options, and in the process increase the spread between the two payment rates. This is unlikely to be effective, because of the real world ability to avoid, or segregate the use of, SMTA material.

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[7] *Potential*, p. 257.

iv. It might offer only an Article 6.11 option, but this would probably lead to users accepting no SMTA materials at all, as they would be required to pay on *all* their products, even when few descended from SMTA materials. This would create a structural disincentive to introducing SMTA materials into their breeding pool, particularly when they had, as yet, a limited number.

41. The inevitable conclusion of the dynamic analysis is that it would be extremely difficult to create an effective balance of Article 6.7 and 6.11 options, such that the Article 6.11 option can be the default option, by structural economic incentives alone.

Policy modifications of the Parity Point

Figure 11. Parity Point, Article 6.11/6.7, patent and PVP rates, and income to the Treaty

Article 6.11 rates	Patent	0.5	0.4	0.3	0.2	0.1
	PVP	0.25	0.2	0.15	0.1	0.05
Parity Point Year	R	Art 6.7 patent rate / Art 6.7 PVP rate				
2025	4.75	2.375 / 1.188	1.900 / 0.950	1.425 / 0.713	0.950 / 0.475	0.475 / 0.238
2035	1.79	0.895 / 0.448	0.716 / 0.358	0.537 / 0.269	0.358 / 0.179	0.179 / 0.090
2046	1.30	0.650 / 0.325	0.520 / 0.260	0.390 / 0.195	0.260 / 0.130	0.130 / 0.065
2056	1.15	0.575 / 0.288	0.460 / 0.230	0.345 / 0.173	0.230 / 0.115	0.115 / 0.058
2066	1.08	0.540 / 0.270	0.432 / 0.216	0.324 / 0.162	0.216 / 0.108	0.108 / 0.054
2075	1.05	0.525 / 0.263	0.420 / 0.210	0.315 / 0.158	0.210 / 0.105	0.105 / 0.053
Benefit flow at Parity Point ($ Million)		49.19	39.35	29.51	19.68	9.84

42. Fig. 11 demonstrates the way the Parity Point Methodology can be used to establish parameters for **R** (the ratio of Article 6.7 rates to Article 6.11 rates), in order to realize a specific theoretical maximum income, on the basis of specific payment rates. Since Article 6.11 governs the theoretical maximum, a number of Article 6.11 rates are offered, in the row entitled "Article 6.11 rates", which generate different incomes. **U** (the ratio of PVP to Patent rates) is constant at 0.5. From each choice of 6.11 rates, a theoretical maximum

follows, and these are listed in the row entitled "Benefit flow at Parity Point". A variety of values of **R** are given in the relevant column, which govern the rates, in Article 6.7, which patents and PVP would need to pay. **R** also governs the Parity Point year.

43. For example, if patent and PVP rates in Article 6.11 are established at 0.3% and 0.15%, respectively, the theoretical maximum will be US$ 29.51 million. To reach this in 2035 — in other words, in 21 years — it would be necessary to set the patent rate at 0.537% and the PVP rate at 0.269%.

44. Fig. 12 demonstrates the way in which, instead, a target may be established, and the Parity Point date varied. With the Article 6.11 rates held constant — which governs the theoretical maximum — varying **R** changes both the Parity Point year, and the speed of build-up of income.

Figure 12. Fixing an income target with $\sigma_{6.11}$ and changing build-up speed with $\sigma_{6.7}$

Article 6.7 payment rate for patents $\sigma_{6.7}(\mu_1)$

— 0.39% — 0.53% — 0.77% — 1.42%

R	U	$\sigma_{6.11}(\mu_1)$	$\sigma_{6.11}(\mu_2)$	$\sigma_{6.7}(\mu_1)$	$\sigma_{6.7}(\mu_2)$	Parity Point	Benefits at 10 years	Benefits at 20 years
1.3	0.26	0.3	0.078	0.39	0.10	2045	7.01	18.69
1.76	0.26	0.3	0.078	0.53	0.138	2035	9.53	25.40
2.57	0.26	0.3	0.078	0.77	0.2	2029	13.85	25.58
4.750	0.26	0.3	0.078	1.425	0.371	2024	25.58	25.58
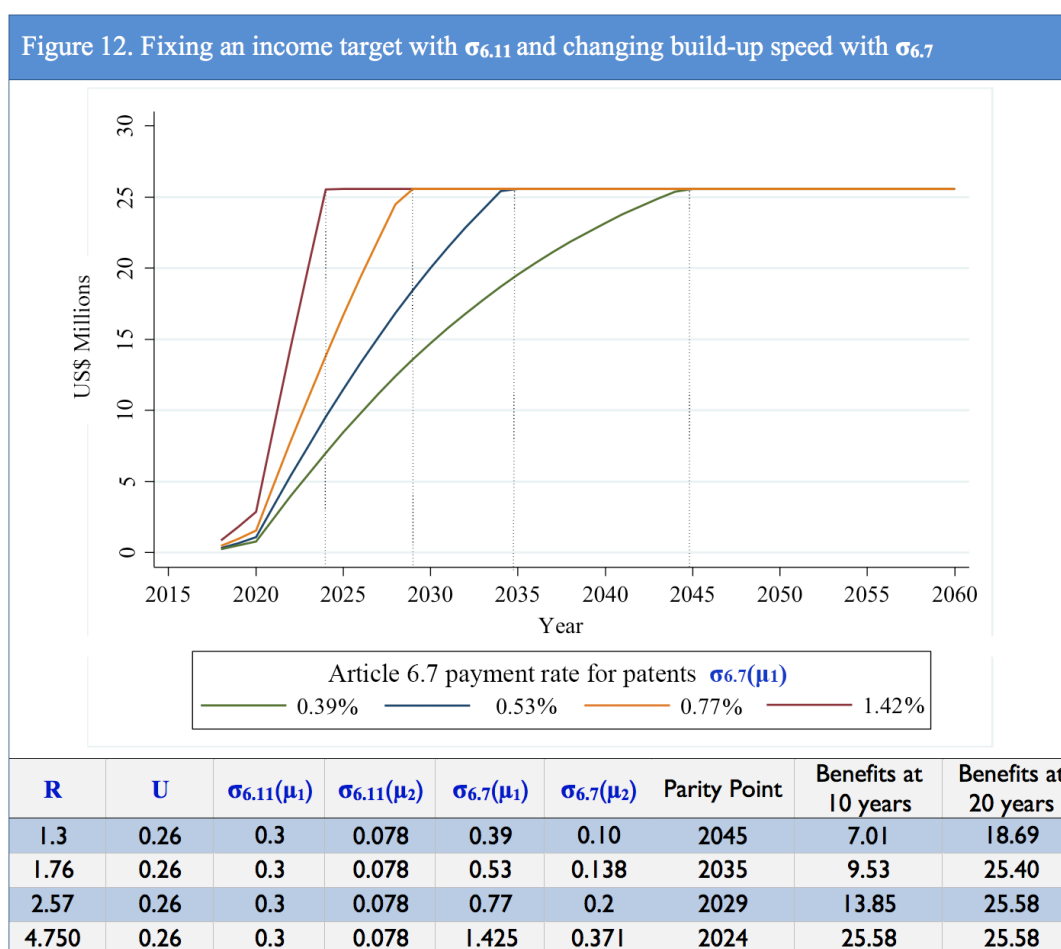
45. It is important to note that there is no reason for the Governing Body to establish rates for Articles 6.7 and 6.11 in accordance with the Parity Point methodology, which is an analytical tool only. It may, however, provide a starting point from which to consider setting rates, on the basis of policy objectives, for example, to create an incentive or a disincentive for one or other of the options. This could be done respecting the Parity Point, or arbitrarily.

Using the "New Interface" to the Computer model

Figure 13. The "New Interface"
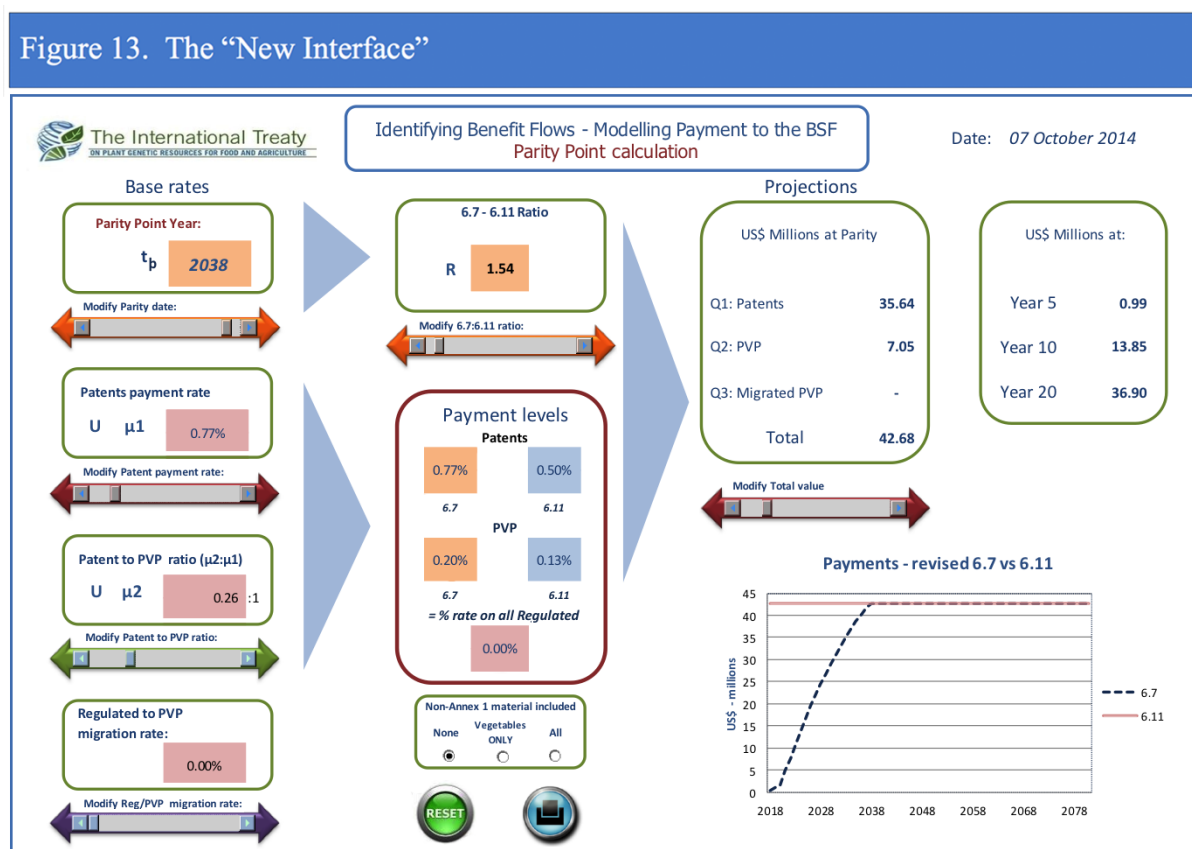
46. A "New Interface" to the reference model was prepared, which makes it possible to vary the various parameters of the Parity Point analysis independently, and to set and test the effect of different payment rates. The elements and the lay-out of the New Interface are shown in fig.13. This was the tool used to develop the analysis presented here.

47. The New Interface may be accessed at http://www.planttreaty.org/content/background-study-paper-1, and used to test the effects of varying parameters and values. It is hoped that this will provide the Working Group with a flexible instrument to use in its further work.

48. It must once again be stressed that a model is not an estimation of real world values, but an analytical tool. The reference model involves a large number of assumptions, though no major new structural assumptions have been added in developing the New Interface, beyond those regarding the possible structure of revisited Articles 6.7 and 6.11, which were needed in order to make a coherent model.

49. The New Interface is initially set to Parity Point at the parameters used in fig. 4, as in the illustration, and it is possible to return to these, at any time, with the "reset" button.

50. The values of the individual items of the Parity Point status may be changed with the "sliders" under the individual components, which in turn recalculate the other values.

   a. The payment rates may be varied: the patents rate (μ_1) may be varied directly, and the PVP rate — which is locked, as a ratio (U), to the PVP rate (μ_2) — may be then varied by varying U.

   b. The ratio of Article 6.7/6.11 payment rates (R), and the Parity Point year (t_p), may both be varied separately.

   c. The payment rates in both Articles 6.7 and 6.11 that result appear in the box, "Payment Levels".

   d. The buttons in the box, "Non-Annex 1 material included", will add either vegetables only, or all non-Annex 1 material, to the analysis.

   e. The possible migration of Regulated materials to PVP may be tested by the slider below the relevant box: this adds a percent of the World's Regulated products to the calculations, at PVP rates, and, for comparison, the equivalence of a payment rate on all regulated products is shown.

   f. Projections at Parity are broken down by IP, and projections at years 5, 10 and 20 are given. The total income may then be varied with the slider.

   g. A graph shows the rate of increase of income under the Article 6.7 option, until the theoretical maximum deriving from the Article 6.11 rates is reached.

Projections of possible income from the revisited Articles 6.7 and 6.11

Figure 14. The influence of **U** (the PVP/Patents rates ratio) on income

R	U (μ_2/μ_1)	$\sigma_{6.11}(\mu_1)$	$\sigma_{6.11}(\mu_2)$	$\sigma_{6.7}(\mu_1)$	$\sigma_{6.7}(\mu_2)$	Parity Point	Benefits (US$ millions)
1.54	1	0.5	0.5	0.77	0.77	2040	62.74
1.54	0.5	0.5	0.25	0.77	0.385	2039	49.19
1.54	0.26	0.5	0.13	0.77	0.2	2038	42.68
1.54	0.1	0.5	0.05	0.77	0.077	2038	38.35
1.54	1	0.4	0.4	0.616	0.616	2040	50.19
1.54	0.5	0.4	0.2	0.616	0.308	2039	39.35
1.54	0.26	0.4	0.104	0.616	0.16	2038	34.15
1.54	0.1	0.4	0.04	0.616	0.062	2038	30.68
1.54	1	0.3	0.3	0.462	0.462	2040	37.64
1.54	0.5	0.3	0.15	0.462	0.231	2039	29.51
1.54	0.26	0.3	0.078	0.462	0.12	2038	25.61
1.54	0.1	0.3	0.03	0.462	0.046	2038	23.01

51. Fig. 14 shows the relative importance of materials sold under PVPs in the potential income flow. In the graph, three projection are given, where the rate for patents is constant, and **U** is varied, which varies the relative rates for PVP accordingly. In the figures below the box, the difference between **U** at 0.1 and 1, in each projection, shows the relative importance of PVPs in total income.

52. Fig. 15 plots the percent of potential income that could derive from patents. The rates for PVP are constant, and **U** is varied, to create different rates for patents. 56.8% of potential income would come from products marketed under patents, if the rates for payents and PVP were the same (**U = 1**).

Figure 15. Influence of the rate of PVP in U on Benefits

R	U	$\sigma_{6.11}(\mu_1)$	$\sigma_{6.11}(\mu_2)$	$\sigma_{6.7}(\mu_1)$	$\sigma_{6.7}(\mu_2)$	Benefits (US$ millions)		
						Patents	PVP	% from patents
1.54	0.1	0.5	0.05	0.77	0.077	35.64	2.71	92.9%
1.54	0.26	0.5	0.13	0.77	0.2	35.64	7.05	83.5%
1.54	0.5	0.5	0.25	0.77	0.385	35.64	13.55	72.45%
1.54	1	0.5	0.5	0.77	0.77	35.64	27.10	56.8%
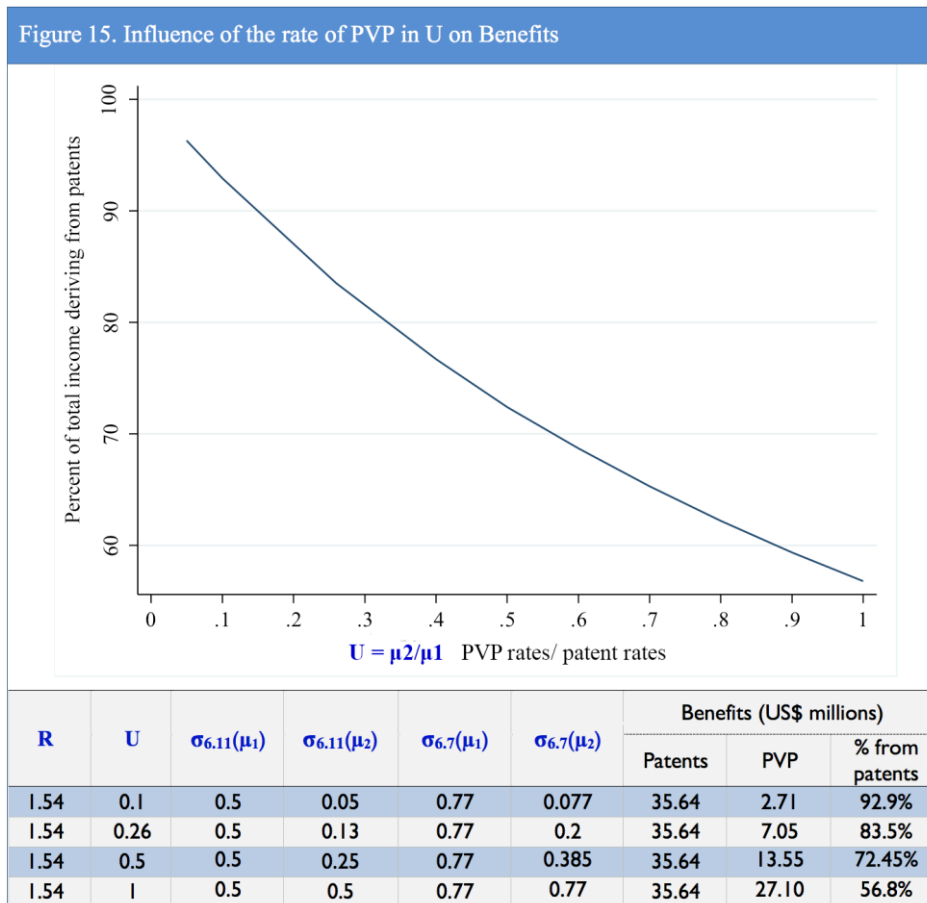
53. Fig. 16 gives a picture of total potential income, with the same parameters as in fig. 4, by crop/crop group, with vegetab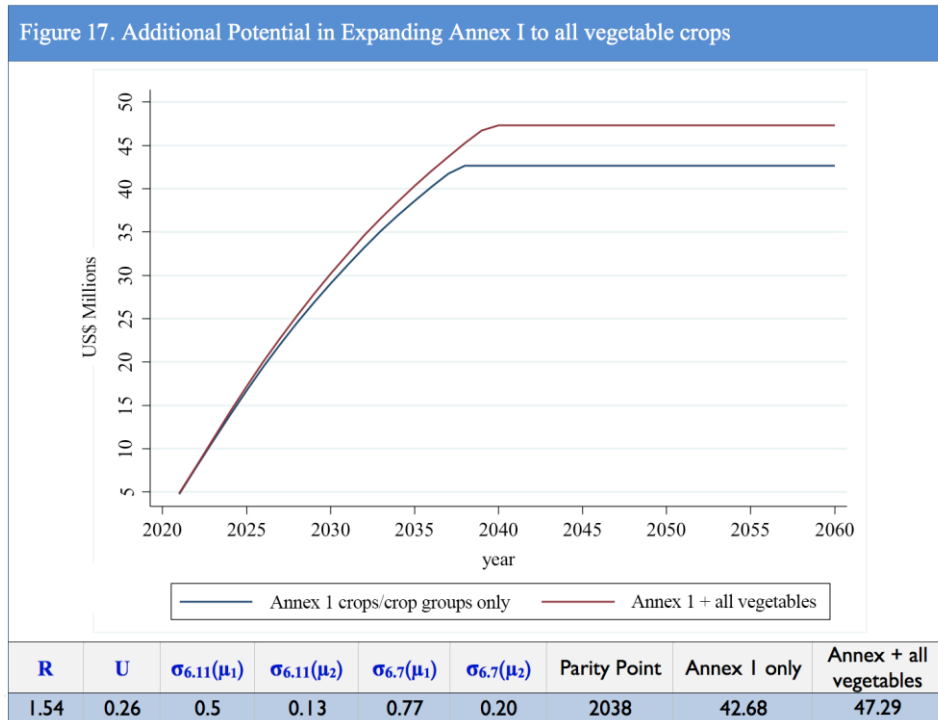le crops specifically identified, both those currently in Treaty *Annex 1*, and those not currently included, as well as other non-*Annex 1* crops. As vegetable breeders have consistently pointed out, during discussions with members of the industry in the preparation of this study, vegetable crops are sorely under-represented in *Annex 1*, which limits their potential contribution to benefits. Moreover, vegetable breeders are not able to benefit from the facilitated access provided by the Treaty, and the legal certainty provided by use of the SMTA, which is becoming increasingly important, as the *Nagoya Protocol to the Convention on Biological Diversity, on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization* is translated into national implementing legislation and regulations. As was also pointed out in these discussions, vegetable breeding enjoys a higher profit margin than most of the seed industry, and vegetable breeders are accordingly the most anxious to see the rapid extension of the crop coverage of the Treaty, and the best placed to be able to make effective contributions to the Benefit-sharing Fund.

54. Vegetable crops currently not in *Annex 1* represent 28% of the total potential value of non-*Annex 1* crops/crop groups.

55. As is immediately evident, maize marketed under patents represents by far the largest potential income. The huge imbalance of potential income towards patented maize is a structural problem in the workings of the Treaty's benefit-sharing system, because it creates a strong incentive to avoid the use of maize under SMTAs, which drastically reduces potential income. Patented products account for 66% of the potential income from crops/crop groups not currently in *Annex 1* (oil seeds, soya, *etc.*)

Figure 16. Benefit flows at Parity Point in 2038, by crop/crop group

R	U	$\sigma_{6.11}(\mu_1)$	$\sigma_{6.11}(\mu_2)$	$\sigma_{6.7}(\mu_1)$	$\sigma_{6.7}(\mu_2)$	Parity Point
1.54	0.26	0.5%	0.13%	0.77%	0.2%	2038
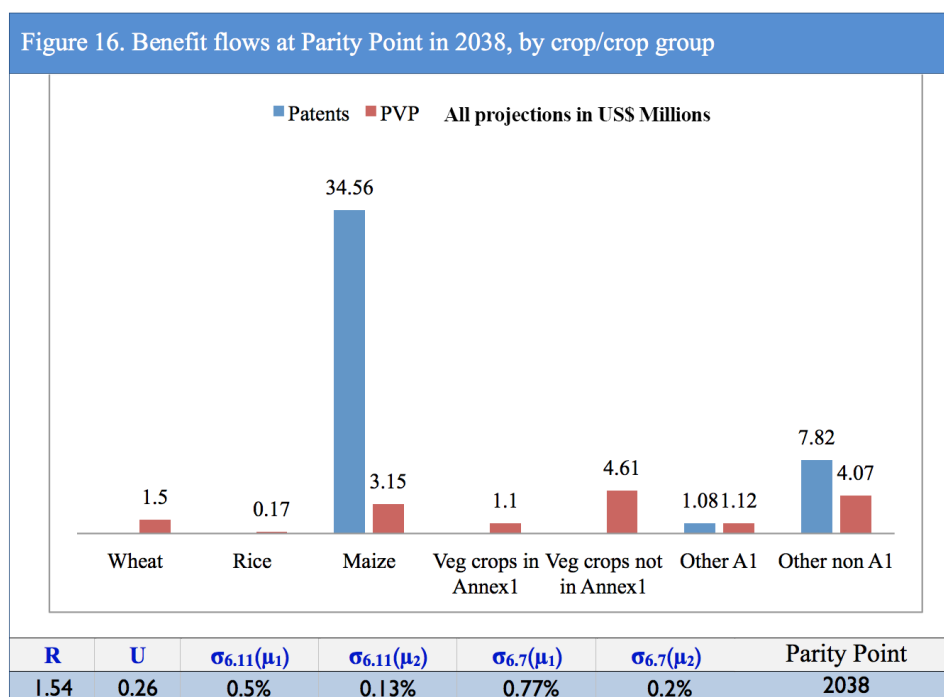
56. Fig. 17 provides a picture of the possible build-up of income projections, over time, using the same parameters as in fig. 4, both without the expansion of *Annex 1*, and with the inclusion in *Annex 1* of all vegetable crops not currently included. As vegetables seeds and planting materials are not often marketed under patent protection, by far the larger part of this potential comes from PVP.

Figure 17. Additional Potential in Expanding Annex I to all vegetable crops

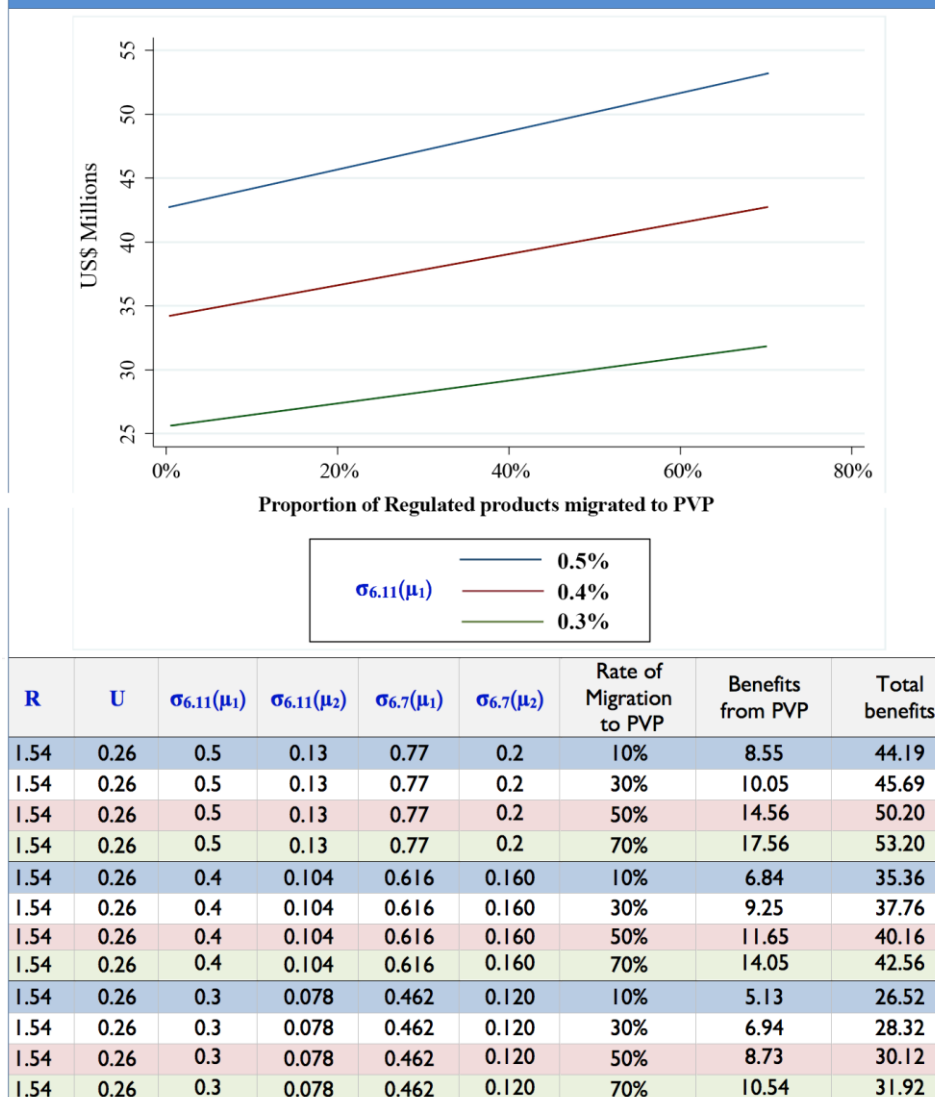| R	U	$\sigma_{6.11}(\mu_1)$	$\sigma_{6.11}(\mu_2)$	$\sigma_{6.7}(\mu_1)$	$\sigma_{6.7}(\mu_2)$	Parity Point	Annex I only	Annex + all vegetables
1.54	0.26	0.5	0.13	0.77	0.20	2038	42.68	47.29

57. In the preparation of the New Interface, Regulated products were specifically identified, because the obligations of members of the World Trade Organization to provide intellectual property protection for seeds and planting materials, and the increasing growth of markets and market sophistication in developing countries and emerging economies, will over time lead to a considerable portion of Regulated products passing to commercialization under PVPs. The total potential of Regulated products, assessed on the same parameters as in fig. 4, is some US$ 15.02 million annually, at Parity Point in 2038. The break-up of this potential by crops/crop groups is shown in fig. 18.

Figure 18. Maximum potential of Regulated Products at Parity Point (US$ Millions annually), at 100% migration

Wheat	Rice	Maize	Annex I Vegetables	Non-Annex I Vegetables	Other Annex I	Other Non-Annex I	Total Annex I
3.49	3.22	3.62	0.47	1.97	4.21	14.23	15.02

R	U	$\sigma_{6.11}(\mu_1)$	$\sigma_{6.11}(\mu_2)$	Parity Point
1.54	0.26	0.5	0.13	2038
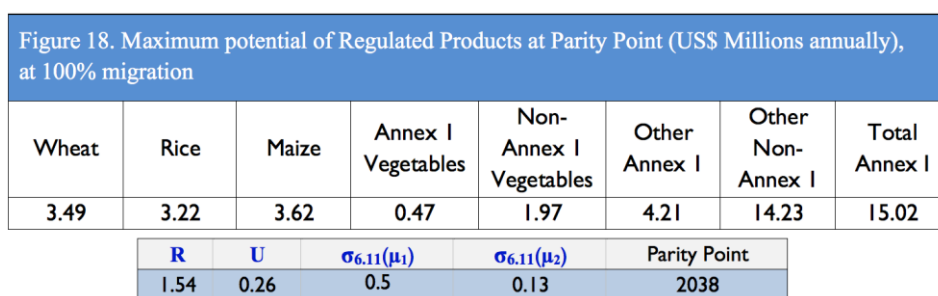
58. Fig. 18 assumes that *all* Regulated products will have migrated to PVP by that date, which is, of course, very improbable. Fig. 19 accordingly plots the potential contribution of Regulated products to PVP, at migration rates of 10%, 30%, 50% and 70%. Four different sets of rates are graphed, with the Article 6.11 PVP rate set at 0.3%, 0.5% and 0.5%, U = 0.26, and R = 1.54.

Figure 19. Projected income at Parity Point at different rates of migration of Regulated products to PVP

R	U	$\sigma_{6.11}(\mu_1)$	$\sigma_{6.11}(\mu_2)$	$\sigma_{6.7}(\mu_1)$	$\sigma_{6.7}(\mu_2)$	Rate of Migration to PVP	Benefits from PVP	Total benefits
1.54	0.26	0.5	0.13	0.77	0.2	10%	8.55	44.19
1.54	0.26	0.5	0.13	0.77	0.2	30%	10.05	45.69
1.54	0.26	0.5	0.13	0.77	0.2	50%	14.56	50.20
1.54	0.26	0.5	0.13	0.77	0.2	70%	17.56	53.20
1.54	0.26	0.4	0.104	0.616	0.160	10%	6.84	35.36
1.54	0.26	0.4	0.104	0.616	0.160	30%	9.25	37.76
1.54	0.26	0.4	0.104	0.616	0.160	50%	11.65	40.16
1.54	0.26	0.4	0.104	0.616	0.160	70%	14.05	42.56
1.54	0.26	0.3	0.078	0.462	0.120	10%	5.13	26.52
1.54	0.26	0.3	0.078	0.462	0.120	30%	6.94	28.32
1.54	0.26	0.3	0.078	0.462	0.120	50%	8.73	30.12
1.54	0.26	0.3	0.078	0.462	0.120	70%	10.54	31.92

59. The various projections made in the previous discussions are based on relatively high payment rates. Fig. 20, constructed with the same methodology as fig. 11, accordingly presents a range of potential incomes, with the aim of more closely approximating to the real world. Even these projections, it must be stressed, are theoretical, and certain to be far too optimistic, for a number of reasons:

   a. The model assumes that all Contracting Parties have already made all their *ex situ* holdings available, and as the *Appendix* to *The current status of the Multilateral System of Access and Benefit-sharing*,[8] shows, this is not the case. The projection must therefore be discounted by this factor. Every delay in making material effectively available also pushes potential benefits further forward in time.

   b. The model also makes no allowance for avoidance of SMTA material, while it is

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[8] IT/OWG-EFMLS-2/14/inf.3, http://www.planttreaty.org/content/background-study-paper-1.

clear, and corroborated by discussions with members of the industry, and the results of the simulation exercise,[9] that users have been avoiding SMTA materials, when they are breeding for a product that is to be marketed under patent protection. They have been using materials in cases, where, in accordance with the current SMTA, only *voluntary* contributions are foreseen, and none have been made.[10] If mandatory payment is now extended to PVP, it is likely that the level of avoidance of SMTA materials will rise substantially, particularly when, as is often the case, alternative sources of materials are available. The projections should be further discounted to allow for this.

60. The values given in fig. 20 are maximum potentials at Parity Point in 2038. In the first row of projections, no payment is made for PVP. Potential benefit are projected at between US$ 7.16 and 35.63 million annually, at a rate for patents of between 0.1% and 0.5%. With PVP paying at half the rate of patents, the projections are between US$ 9.84 and US$ 49.19 million annually. With patents paying at the same rate as PVP, the projections are US$ 12.55 to 62.74 million annually.

Figure 20. Article 6.11 rates: Maximum potential at Parity Point (US$ Million), at different U					
Patent / PVP at U = 0	Patent 0.5 / PVP 0	0.4 / 0	0.3 / 0	0.2 / 0	0.1 / 0
US$ Millions	35.64	28.51	21.38	14.26	7.13
Patent / PVP at U = 0.5	Patent 0.5 / PVP 0.25	0.4 / 0.2	0.3 / 0.15	0.2 / 0.1	0.1 / 0.05
US$ Millions	49.19	39.35	29.51	19.68	9.84
Patent / PVP at U = 1	Patent 0.5 / PVP 0.5	0.4 / 0.4	0.3 / 0.3	0.2 / 0.2	0.1 / 0.1
US$ Millions	62.74	50.19	37.64	25.09	12.55

61. The projections made in the new analysis are substantially lower than those in *Potential*, when allowance is made for the fact that the calculations in this paper have been made from a higher estimate for the world seed market (*Potential* estimated it at US$ 36.8 billion annually,[11] whereas the new analysis assumes a market worth US$ 44.8 billion).[12]

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[9] *Investigation of the preferences and behaviour of users of the SMTA, when making decisions to use the alternative payment options of Articles 6.7 and 6.11 of the SMTA*.
[10] These factors are discussed in more detail in paragraphs 31–47 of *Background*.
[11] *Potential*, p. 76.
[12] This estimate of the world seed market was prepared on the basis of FAOSTAT data, in the context of the

Moreover, the increased membership of the Treaty, and the fuller information on material available have been taken into account.

62. With these provisos, a number of observations may be made:

   a. Under the current SMTA, Article 6.7 provides for mandatory payments, effectively only for products marketed under patents, and Article 6.8 foresees voluntary payments. The figures from *Potential*, for voluntary payment are based on a notional rate equal to the rate for mandatory payment, that is, 0.77%. In the case of the revisited Article 6.7 and 6.11, however, the basis of voluntary payments falls away, leaving a substantially lower set of material with obligations to pay.

   b. Nonetheless, the projected income from patents is higher in the new analysis than in *Potential* (where all mandatory payment derived from patents), despite the effect of the Article 6.11 PVP rate capping the theoretical maximum at Parity Point.

   c. It should be stressed that, though the potential migration of Regulated products to PVP may to some extent compensate for the loss of "voluntary" payments, this is a very long-term possibility, that does not add to income for many years.

Figure 21. Projections of potential income at 2081, by *Potential* and the new analysis		
Potential, p. 143, tab. 3.4		**US$ Millions annually**
	Mandatory only	23.0
	Mandatory + 33% Voluntary	47.0
	Mandatory + 66% Voluntary	69.0
	Mandatory + 100% Voluntary	97.0
New Analysis		
	Patents	35.6
	PVP	7.0
		42.6
	US% Millions	
+ 10% Migration of Regulated	1.5	44.1
+ 30% Migration of Regulated	4.5	47.1
+ 50% Migration of Regulated	7.5	50.1
+ 70% Migration of Regulated	10.5	53.1
+100% Migration of Regulated	15.0	57.6

New Analysis	R	U	$\sigma_{6.11}(\mu_1)$	$\sigma_{6.11}(\mu_2)$	$\sigma_{6.7}(\mu_1)$	$\sigma_{6.7}(\mu_2)$
	1.54	0.26	0.5%	0.13%	0.77%	0.2%

63. It is important to stress, once more, that these are theoretical, maximum projections only, and that, when real world factors are considered, the actual sums that it may be possible to mobilise are likely to be considerably lower.