May 2018

Food and Agriculture Organization of the United Nations

The International Treaty ON PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE

**Items 3 and 3.1 of the Provisional Agenda**

**INTERNATIONAL TREATY ON PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE**

**THIRD MEETING OF THE SCIENTIFIC ADVISORY COMMITTEE ON THE GLOBAL INFORMATION SYSTEM**

**Rome, Italy, 21 – 22 June 2018**

# Report on the Operations and Implementation of the Programme of Work

## I. INTRODUCTION

1. At its Sixth Session, the Governing Body adopted Resolution 3/2015 containing a Vision and a Programme of Work on the Global Information System (Programme of Work). This document reports the progress made in the implementation of the Programme of Work since the second meeting of the Scientific Advisory Committee in 2017, with particular emphasis on the elements of guidance provided by the Governing Body at its Seventh Session.

2. The Vision provides that:

> *The Global Information System for PGRFA integrates and augments existing systems to create the global entry point to information and knowledge for strengthening the capacity for PGRFA conservation, management and utilization.*
>
> *The development of a truly effective Global Information System as foreseen in the International Treaty involves, inter alia: strengthening existing systems and, where gaps remain, establishing new systems and initiatives; promoting inter-connectivity among systems; and providing overarching mechanisms to ensure ready access to the information and services provided*

3. The Programme of Work is arranged in seven objectives, under the following headings:

Objective 1 - The web-based platform

Objective 2 – Access to sources of PGRFA and associated information

Objective 3 – Interoperability, scientific standards and tools

Objective 4 – Transparency on the rights and obligations of users

Objective 5 – Communication and multidisciplinary collaboration

Objective 6 – Capacity development and technology transfer

Objective 7 – Draft monitoring and assessment mechanism

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4. *Appendix 1* to this document contains a tracking table of the major issues discussed at the Second meeting of the Scientific Advisory Committee (SAC-GLIS-2), excluding partnerships,[1] and their corresponding references in the Report of the Seventh Session of the Governing Body.

5. Section II of this document contains an update on the support provided to users to make their plant genetic resources available through the Global Information System in relation to objectives 1, 2 and 3. In particular, it contains information on the development of documentation, the launch of the DOI Module, information on the first type of registrants and a methodology for the collection of feedback and the documentation of users' experiences.

6. Section III contains a proposal, based on existing systems and infrastructures, for the definition of entry points in GLIS and how to articulate them in both the Catalogue of sources of information and in the links and targets that are associated with the Digital Object Identifiers (DOIs). Section IV provides an overview of other ongoing collaborations at various levels.

7. Finally, Section IV, summarizes the major elements of advice to facilitate the discussion of the under Item 3.1 of the Provisional Agenda, *Experiences and Refining Guidelines in the Application and Use of Digital Object Identifiers.*

## II. MAKING PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE AVAILABLE IN THE GLOBAL INFORMATION SYSTEM

### Documentation and Outreach

8. Since the last meeting of the Scientific Advisory Committee, the Secretariat has made available online, the documents on the descriptors and the guidelines, and in May 2018, a booklet was published containing both documents in English, French and Spanish. The Arabic version is in currently under production.

9. The website of the International Treaty has been updated with several new or reviewed sections:

i. Selected documentation and links containing information on standards, on the consultations, surveys and meetings conducted for the development of the Digital Object Identifiers, videos and presentations on descriptors, background study papers on various topics, notifications and other useful links to partner systems and entry points including Genesys, the World Information and Early Warning System on Plant Genetic Resources for Food and Agriculture (WIEWS) and the European Search Catalogue for Plant Genetic Resources (EURISCO). [2]

ii. Outreach, training and coordination events;[3]

iii. Frequently Asked Questions on the Global Information System and on DOIs.[4]

10. The Secretariat has continued to coordinate, at technical level, with the priority partners identified by the Scientific Advisory Committee and the Governing Body. Contacts have been maintained with other institutions and projects interested in the early adoption of DOIs and in other services and activities in the Programme of Work of GLIS. More information on capacity building and on partnerships is available in document IT/SAC-GLIS-3/18/7, *Strengthening Partnerships, Collaboration and Capacity Building*.

### Technical Assistance to Users for the Adoption of Digital Object Identifiers (DOIs)

11. In October 2017, the Secretariat launched the DOI Module to further enhance users' capability to make their material visible in the GLIS through the assignation of DOIs.

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[1] The update on the activities on partnerships are described in document IT/SAC-GLIS-3/18/7

[2] http://www.fao.org/plant-treaty/areas-of-work/global-information-system/links/en/

[3] http://www.fao.org/plant-treaty/areas-of-work/global-information-system/externalmeetings/en/

[4] http://www.fao.org/plant-treaty/areas-of-work/global-information-system/faq/en/

12. This first module of the Portal is hosted in the FAO Headquarters under the system administration provided by the FAO Information Technology Division (CIO). Before the launch, extensive vulnerability checks were performed on the system to ensure compliance with FAO security policies and rules. The migration of the application to a new hosting environment has been recommended by CIO and the activity is expected to be scheduled before the end of the year.

13. By mid-May 2018, the Secretariat had assisted users in the assignation of 627,942 DOIs as follows:

i. Nine CGIAR centres: AfricaRice, Bioversity, CIAT, CIMMYT, CIP, ICARDA, IITA, ILRI, IRRI. ICRAF and ICRISAT, have indicated that they plan to complete the registration of their collections in 2018;

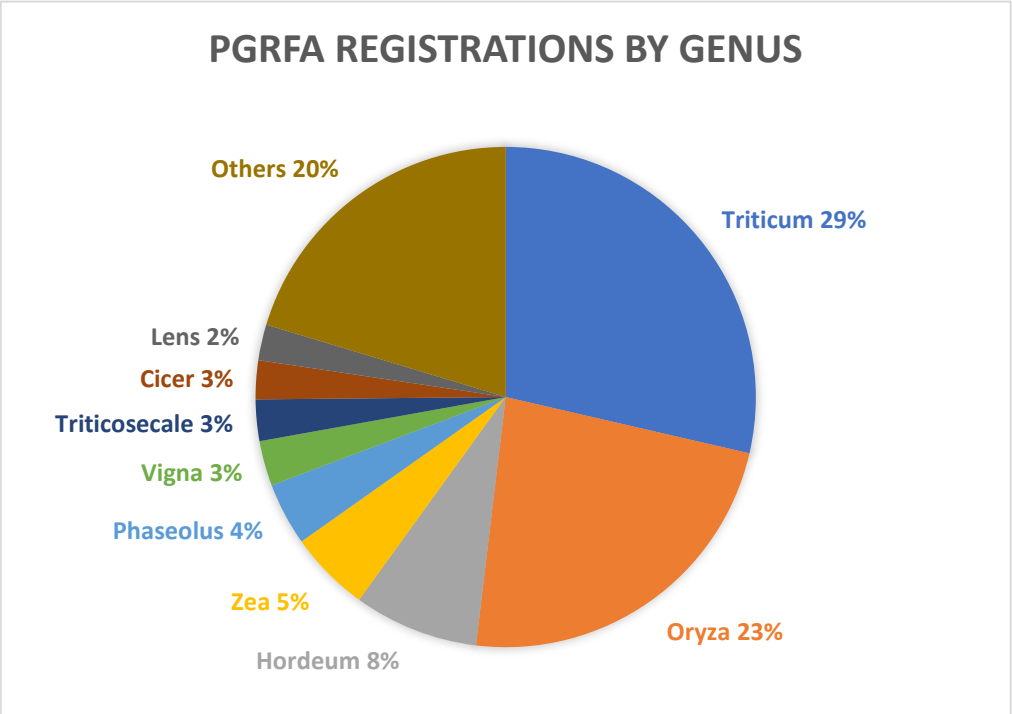
ii. Seven national genebanks from the Netherlands, Lebanon, India, Indonesia, Tunisia, Qatar and Bhutan;

iii. Two research centres: CATIE and The James Hutton Institute;

iv. Several genebanks and research institutions collaborating in characterization and evaluation projects with universities and stakeholders in various countries and locations (two projects coordinated from Italy and Saudi Arabia) have also obtained DOIs for their materials;

14. Other national and regional genebanks have been briefed on the process to register DOIs, as well as two of the projects funded by the Benefit-sharing Fund of the International Treaty.

15. The share of DOIs assigned by genus is illustrated in the following chart:




16. Half of DOI registrations have been performed using Excel tables through the upload function and the other half used the XML protocol. About 42% of the registration requests received through the XML protocol, was made using the Integration Toolkit. CGN and ICARDA implemented their own version of the XML protocol.

17. The DOI Module has made the development of entry points to the data stored in Genesys possible, as follows:

i. When a genebank registers or updates Genesys records with an associated DOI, Genesys sends a message to GLIS to add the link to its own page on the accession, facilitating access to detailed information stored in Genesys;

ii. GLIS uses the same message described above to identify accessions that may have been updated on Genesys. GLIS then queries Genesys to update its own descriptors associated to the DOI.

18. In this way, users do not need to report the same changes twice to Genesys and GLIS as the two systems synchronize themselves. At the time of preparation of this document, there are 480,406 DOIs registered in Genesys and the figure continues to grow as genebanks update their records in Genesys. The first DOI to register in Genesys was for an accession of the International Potato Center "CIP 700001".

In Genesys: https://www.genesys-pgr.org/10.18730/8T40


In GLIS: https://ssl.fao.org/glis/doi/10.18730/8T40


19. The Secretariat has also discussed with WIEWS on a procedure to link the material reported at accession level to GLIS. This connection is planned for the second semester of 2018.

20. The Secretariat participated at the 15th Steering Committee of European Cooperative Programme for Plant Genetic Resources (ECPGR) held in Greece in May 2018. At that meeting, ECPGR agreed to promote the adoption of DOIs through a note to the national coordinators of the Programme, explaining the benefits and the procedure to obtain the DOIs.

21. This process, which is based on the XML protocol, is possible thanks to a collaboration by which Eurisco will facilitate the registration of all regular accessions maintained in the genebanks and shared with its Catalogue. This process will generate synergy with the direct

support that Eurisco already provides to genebanks of the region for the documentation of their regular accessions and will be embedded in the current workflow.

**Milestones**

22. It is worth noting some of the milestones in the DOI adoption process since the DOI Module was launched. At the end of October 2017, we witnessed the first shipment of material with a DOI on it, next to the accession number, facilitating quick access to the passport information registered by the provider in GLIS.

23. In March 2018, 29 GLIS DOIs, associated to IRRI rice accessions were referenced in a publication. The paper is being published by Cambridge University Press in an upcoming issue of the Seed Science Research journal.

24. The following diagram illustrates the milestones in the advancement of the GLIS initiative since system launch in October 2017.

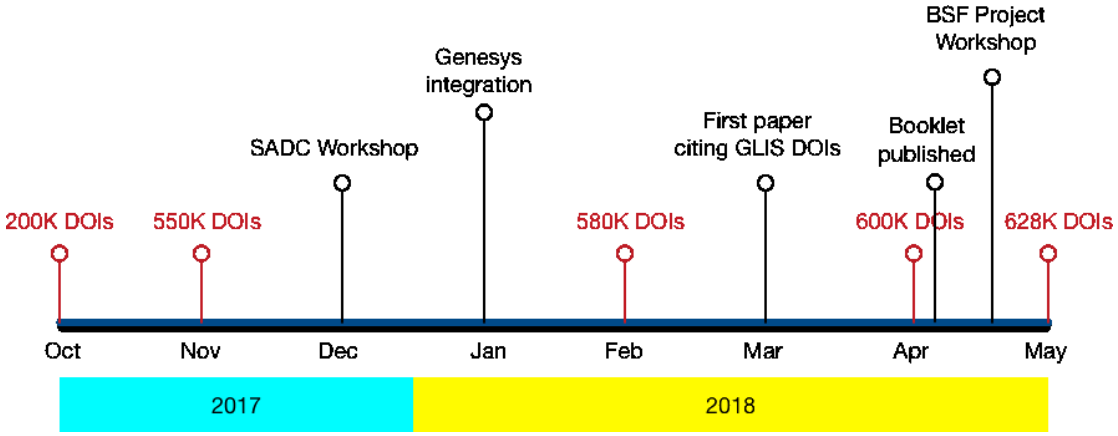



**Figure 1. Experiences and Feedback on DOI adoption**

25. Although the DOI Module was launched in October 2017, it may be premature to analyse the experiences accumulated with their assignation given the limited number of users and the lack of detailed information.

26. In the report of it Second meeting in 2017, the Committee indicated that a "broader consultation is desirable with the on-farm and *in situ* conservation communities, and with the broader GRFA community" for the promotion of the DOIs. In this context, the Secretariat is collaborating with several stakeholders and gathering information from *in situ* and on-farm communities, including preparing a note to improve the guidelines on the DOIs for *in situ and* on-farm communities. The Secretariat envisages consultations with experts and invites the Committee to provide the references to experts and suggestions for the review of the first draft, when done.

27. With the view that these experiences will help to improve future operations, the Secretariat has been collaborating with various types of users and has initiated gathering information and conducting interviews to better document this process and its various applications and experiences. In particular, it has developed a set of questions, as contained in *Appendix 2*, to conduct a review and facilitate the update of the Guidelines and improve the modalities for providing assistance to users. The Committee is invited to advise on those questions.

28. Regarding the review and improvement of the existing DOI case for *ex situ* material included in the Guidelines, the Secretariat has prepared a table below profiling some of the pioneer adopters of the DOIs for the selection of the user cases to document in detail. The table includes basic information on the use of DOIs and the interest it may have for the documentation of users´ experiences. It also contains some useful annotations based on the preliminary contacts.

| Type of user | Title or acronym | Research focus/notes |
|---|---|---|
| **National genebanks** | - CGN (the Netherlands)<br>- LARI (Lebanon)<br>- NBPGR (India)<br>- NGB (Tunisia) | Select two genebanks. It is proposed to select one from a developing country and one from a developed country |
| **CGIAR Centers** | - AfricaRice, Bioversity International, CIAT, CIMMYT, CIP, ICARDA, IITA, ILRI, and IRRI | Selection of two Centres. CIP has already volunteered to participate in the feedback process |
| **Benefit-sharing Fund projects** | - W3B-PR-18-Turkey<br><br>- W3B-PR-29-Indonesia: Multi-country Construction of a Test Platform for the Development and Allocation of Unique Identifiers to Rice Germplasm, linking the MLS information infrastructure and the DivSeek repository | Two benefit-sharing Fund projects. The focus of the first one is "Addressing the challenges of climate change for sustainable food security in Turkey, Iran and Morocco, through the creation and dissemination of an international database to promote the use of wheat genetic resources and increase genetic gains" (RESWHEATDATA). DOIs are used to identify wheat accessions held in various genebanks and link them to research and breeding records including phenotypic, genotypic and environmental data obtained from high-quality experimental replicated trials.<br><br>The research focus of the second project will be on how DOIs have been used to identify rice accessions in various national and international genebanks, collect information use of the use of the MLS toolkit, and useful data on the organization of training events with genebank staff. |
| **Multi-country evaluation project** | Bean_ADAPT Project - Università Politecnica delle Marche, Italy | The project is distributing improved bean varieties received from several holders with SMTAs to various locations, including the National Agricultural Research Organisation (Uganda), for field testing. DOIs associated to PGRFA in the different collections are related and will be used to generate links from the new research records back to the provider's genebanks. |
| **Research institute** | - CATIE<br>- The James Hutton Institute | It is proposed to document the use of DOIs in the Germinate 3 database. |
| **Regional Genebank Networks** | EURISCO | Document how DOIs are assigned in collaboration with the national coordinators of EURISCO via the XML protocol and how this information is shared with Genesys and WIEWS. |
| **Priority entry-point systems at global level** | - WIEWS<br>- GENESYS | It is proposed to document the collaboration with both systems, starting with Genesys. |

*Table I. List of systems and stakeholders for the documentation of experiences on the use of DOIs*

29. At the time of preparation of this document, the Secretariat is facilitating the screening of the fourth round of project proposals of the Benefit-sharing Fund. It is expected that any of the new projects with information components will be adopting DOIs. DOIs will help to monitor the outcomes and the success of some components of the projects.

**Quality Checks**

30. The quality of the information published is paramount and assistance for improving quality is one of the services data users regularly request. In the DOI Module quality checks have been put in place and carried out to address specific quality aspects and to minimise errors.

31. An attempt has been made to integrate a taxonomic spelling checker upon registration and or the editing inputs. An option to provide this function appears to be GlobalNames[5], which also provides a good API. A working example has been implemented that checks taxonomy with GlobalNames and returns diagnostic messages as appropriate, as an additional service to the users of the DOI Module.

32. The Secretariat has also received several suggestions to develop a DOI Quality Index to help users assess several aspects of the data they provide against a set of pre-defined parameters. A concept note in under development to apply a scoring algorithm to existing DOIs and report the results. The purpose is to identify areas where DOI descriptors can be improved and this index can be used to motivate registrants. The scoring algorithm needs to be refined and could benefit from further inputs and expert advice.

33. In the last quarter of 2017, a robust integration with Genesys, as described above, was implemented through the development of entry-points in GLIS. Additionally, the Global Crop Diversity Trust is including components on DOIs in training activities as well as promoting the registration of material in GLIS, in close collaboration with the Secretariat of the International Treaty.

## III. DEFINING AND CONNECTING TO ENTRY POINTS

34. In the design of the GLIS Portal, entry points must take into account users' needs and language. Objective 2 of the Programme of Work on GLIS request the System "*to provide a comprehensive overview and facilitate access to sources of PGRFA and associated information*" and, in particular "*to create an index of sources of information, knowledge and other materials*".

35. This is one of the functions to be included in the master plan for the GLIS Portal, for which a draft is contained in document IT/SAC-GLIS-3/18/5. The risk in developing catalogues is that they may end up in the form of lists that are difficult to use and update and, hence, little impact is achieved on the long-term.

36. Over the last two decades, FAO has gathered experience in the development of catalogues. Most recently, it has developed innovative mechanisms that on one hand present the content according to pre-defined entry points for specific communities and target groups, and on the other, allow for a collaborative and decentralized approach for their update and management.

37. One of the most recent and technically-sound experiences is the one gathered by the initiative Coherence in Information for Agricultural Research for Development (CIARD) and its Routemap to Information Nodes and Gateways (RING) [6]. RING is a global directory of datasets and data services organized in nodes which offers for specific groups and communities a sub-set of customized entry points. It allows information providers to register their services in various categories to facilitate the discovery of sources of agriculture-related information across the world. The overall aim of RING is to increase the visibility and use of open access tools for agricultural information management.

[5] See http://globalnames.org

[6] See http://ring.ciard.net

38. The Secretariat proposes to use the model and the existing technical infrastructure of RING to set up the catalogue of sources of information for the GLIS Portal, thus avoiding the development of its own infrastructure. A pilot phase is proposed during the second semester of 2018 for the setting up of a GLIS node in RING. This node would help to:

i. create the catalogue of information sources which can be dynamically searched using a community-specific classification and pre-defined entry points;

ii. get access to an existing pool of scientific and technical information and expose PGRFA related information and data sources to other agricultural information projects and portals;

iii. easily collaborate with other stakeholders on the update and enriching it, as required.

39. In this context, the pilot phase will also provide valuable functions, such as:

i. A repository of datasets that would otherwise not be made available on the Web to complement available options (e.g. Figshare, Dataverse, Dryad, PANGAEA).

ii. A dynamic mechanism to add value to the links and targets displayed in the DOIs, indicating to users of GLIS:

- who owns the database/system where a DOI is pointing to;
- contact details of the curator of the database/system;
- licensing information;
- proper citation for use in publications;
- formats and protocols that could be used by information agents to interact with the database/system.

40. Through the information made available through a node in RING, stakeholders can provide details on the technologies and protocols that agents can use to query linked systems.

41. Links associated to DOIs in GLIS are classified using a simple controlled vocabulary (keywords) describing the kind of information the user, or agent, will find at the corresponding link. For instance, the PGRFA holder's website will likely provide passport information with characterization and evaluation data also available in some cases while other systems may also provide pictures of the PGRFA. The controlled vocabulary used by GLIS is available for improvement and extension from interested stakeholders and will also be shared with RING to make the classification consistent across systems.

42. The Secretariat has developed a proposed list of keywords for the PGRFA domain contained in *Appendix 3*. The Scientific Advisory Committee is invited to provide advice on the initial selection of keywords.

## IV. OTHER COLLABORATIONS

### Germinate 3

43. Collaboration is being established with The James Hutton Institute to explore the connection of Germinate 3 to GLIS. Germinate 3 is an open source plant database infrastructure and application programming platform on which complex data from genetic resource collections can be stored, queried and visualized using common and reusable programming components. Germinate 3 utilises modern web and database standards to provide a common architecture and high-performance web-based user interface and analytics functionality across a wide variety of data types. Some of the data types include: passport, phenotypic, field trial, pedigree, genetic, climatic, geographic location data as well as user-submitted annotations[7]. This connection with Germinate 3 will facilitate the linkages to other types of PGRFA datasets in GLIS.

[7] https://ics.hutton.ac.uk/get-germinate/

**Information Technology Division (CIO) of FAO**

44. The collaboration with FAO's Information Technology Division (CIO) continues on two tracks:

i. Hosting of GLIS. CIO has recommended a new customized hosting environment to increase the capacity of GLIS to connect with external systems. The setting up of the new environment would require the migration of the application, most probably before the end of 2018.

ii. Integration Toolkit. An improved version has been planned to further facilitate its adoption by stakeholders in developing countries, incorporating feedback from early adopters in Asia, collected during the first semester of 2018.

**The Plant Genetic Resources Centre of the South African Development Community**

45. The Plant Genetic Resources Centre (SPGRC) of South African Development Community (SADC) has developed Web-SDIS[8], a web-based genebank management system that is being favourably received in the region. Thanks to the workshop organized by the Secretariat in the region in December 2017, with the financial support of the Government of Germany, collaboration with SPGRC has been established to advance in connection of Web-SDIS and GLIS. The collaboration will focus on the provision of support for the registration of accessions on GLIS, incorporating the use of DOIs in the Web-SDIS database and the update of GLIS descriptors as required. A future phase could focus on the generation of the Standard Material Transfer Agreements (SMTAs) and their reporting to Easy-SMTA, as this was one of the needs identified in the region.

**DataCite and Crossref**

46. The collaboration with DataCite continues on:

i. Registration on the Global DOI System of the DOIs assigned by GLIS;

ii. Testing of the Make Data Count initiative that focuses on usage metrics standards that could be used, in the GLIS context, to identify the most popular PGRFA;

iii. Following the Onyar initiative that aims at assigning global identifiers to organizations;

47. Efforts are under way, with Crossref and DataCite, to rationalize and simplify the procedure to establish a relationship between DOIs assigned to the PGRFA in GLIS and the DOI assigned to the publication where results on such PGRFA are presented. At the time of this writing, the procedure depends on the specific publishing service used by the authors which makes it difficult to provide coherent advice to GLIS stakeholders.

48. Thanks to the good offices and intermediation of the FAO’s Library, the Secretariat has also contacted one of the major editors of scientific agricultural publications to explore the ways in which the use of DOIs can be encouraged in their scientific journals.

[8] See http://sdis.spgrc.org.zm

## IV. ADVICE SOUGHT

22. The Committee is invited to provide advice and recommendations on the following points:

i. On the selection of systems and stakeholders to interact with for the documentation of experiences and feedback on the DOI adoption, on the basis of content in ***Table I*** above;

ii. On the review process for the DOI case for *in situ* and on farm material;

iii. On the list of questions presented in ***Appendix 2*** and on the focus of the research;

iv. On the list of keywords to be used for the classification of systems and sources for information in the GLIS Catalogue and for the links and targets of the DOIs as contained in ***Appendix 3***.

v. Additional feedback, comments and advice the Committee may wish to provide for the promotion of DOIs and the documentation of users' experiences.

***Appendix 1***

**Update on the Guidance of the Governing Body on Issues Previously Discussed by the Scientific Advisory Committee**

This tables present a list of the main issues of advice discussed at the Second meeting of the Scientific Advisory Committee (SAC-GLIS-2), excluding partnerships,[9] and their references in the Resolution of the Governing Body regarding the Programme of Work on the Global Information System of Article 17.

| | **SAC-GLIS-2- June 2017** | **GB7 – November 2017** |
|---|---|---|
| **Progress on the development of the web-based Platform to assign Digital Object Identifiers (DOIs)** | Noted progress.<br><br>Recommended broader consultation is desirable with the on-farm and *in situ* conservation communities | System launched. |
| **Excel tables and manual data entry for users registering DOIs in GLIS** | Priority was given to this option. | - |
| **Development and implementation of a Toolkit for DOIs assignation in support of BSF-funded project** | Noted progress. | - |
| **Facilitate the adoption of DOIs** | With a broad range of stakeholders.<br>In the future, the Committee may discuss mechanisms and processes to promote the participation of all PGRFA holders. | Priority to the promotion of DOIs. Underlined the importance of the provision of support by the Secretary to Contracting Parties and other relevant stakeholders in developing countries for the adoption of the DOI.<br>Guidelines through the development of training materials and capacity-strengthening workshops, including mentoring activities, at regional and national levels |
| **Explore further synergies and connections – define entry points** | With Genesys, GRIN-Global, WIEWS | Priority to entry points to:<br>i) PGRFA in ex situ collections documented in Genesys and FAO WIEWS;<br>ii) on farm management of PGRFA in the monitoring system of the Global Plan of Action; |

[9] The update on the activities on partnerships are described in document IT/SAC-GLIS-3/18/7

| | | |
|---|---|---|
| | | iii) Open research data from DivSeek contributions. |
| **Relationship with DivSeek** | - Memorandum of Understanding<br>- Could act as a collaborator | Requested the Secretary to invite the DivSeek Initiative to report on the development and activities of the Initiative for the biennium 2018-19 and submit a report |
| **Other issues for further discussion** | The needs of users regarding the documentation, exchange of information and knowledge associated to PGRFA for the conservation and sustainable use of on-farm and in situ germplasm. | - |
| **Functionalities of GLIS Portal** | Requested the Secretary to define priority needs, start small, incorporate learning and then build up. | Requested the Secretary to interact with a broad range of user categories in order to define through user cases the user-oriented entry points in the GLIS web-based Portal<br><br>Requested the Secretary to develop a Master Plan |
| **DOI Guidelines** | The Secretariat to consider any additional written comments on the Guidelines, within two weeks, since the adoption of this report for their publication. | Welcomed the voluntary use of the Digital Object Identifiers (DOIs) and the publication of the Descriptors and the Digital Object Identifiers Guidelines |
| **Genetic Sequence Data - Mandate** | Welcomed further guidance from the Governing Body. | Included in the terms of reference of the Committee the consideration of scientific and technical issues of relevance to genetic sequence information, as far as it is generated from the use of PGRFA and related to the implementation of GLIS; |
| **Genomic information inputs** | Suggested that the Governing Body invite Contracting and relevant stakeholders to provide views and information to on-going processes | Incorporated in the Report of the Governing Body. |
| **Elaboration of a legal disclaimer** | Endorsed the principles and criteria | Published in October after the revision of the FAO Legal Office |

***Appendix 2***

**Questions for the Documentation of Users' Experience on the Adoption of DOIs**

1) How did you register your collection on GLIS
   - Web form,
   - Your own implementation of the XML protocol,
   - Excel-based batch format,
   - Toolkit

2) Why did you choose this method?

3) Did you encounter any significant problem preparing the information for registration? If yes, please explain.

4) How was your experience with the actual registration?

3) Did you receive timely and effective support from the ITPGRFA Secretariat or the focal point? What would you improve?

4) Have you provided the descriptor "MLS Status" to notify the material that is available in the multilateral system?

5) Is your institution also reporting to the Governing Body on the transfer of material with the Standard Material Transfer Agreement?

6) Are you using the DOIs to link to the same material stored in other genebanks or collections?

7) Are you using the DOIs to link to other records like characterization of evaluation information? In your institutions or in an external database? In collaboration with other institutions or projects?

8) Are you integrating DOIs in your physical or information workflow, e.g. by adding them to seed bag labels or using them to quickly access information related to the material? Please explain

9) Are you promoting the adoption of DOIs with your partners or clients (material recipients and providers)? What could be improved? What kind of support would be appreciated most?

10) You registered DOIs for your collection that is (*in situ*, *ex situ*, breeding, on farm)

11) What is your assessment of the documentation available (descriptors, guidelines, FAQs, XML protocol, batch format, Toolkit)? What would you like to see improved and why?

12) Did you use the Web site to edit or resolve DOIs? If yes, how was your experience? What would you like to see improved and how?

12) Is there a specific function (or set of functions) you would like the GLIS portal to provide?

*Appendix 3*

**List of keywords for the links associated to GLIS DOIs**

This list of keywords has been elaborated by looking at the information sources and taking into considerations potential areas of interest. Stakeholders have been invited to provide suggestions for improvement and expansion of the list to better meet future needs.

| Code | Keyword |
|---|---|
| **1** | **Passport data** |
| 1.1 | Genealogy |
| 1.2 | Collection documents |
| **2** | **Characterization** |
| **3** | **Evaluation** |
| 3.1 | Chemical analysis |
| 3.2 | Abiotic stress |
| 3.3 | Biotic stress |
| 3.4 | Biochemical markers |
| 3.5 | Molecular markers |
| 3.6 | Cytological characters |
| 3.7 | Genomics |
| 3.8 | Phenomics |
| **4** | **Environments** |
| **5** | **Multimedia** |