



**COLLABORATION AGREEMENT
BETWEEN**

NP2021114

FORSCHUNGSZENTRUM JÜLICH GMBH, represented by its Board of Directors,
for: Institute of Bio- and Geosciences (IBG) -Bioinformatics (IBG-4), a publicly funded research
center and member of the Helmholtz Association, established at Wilhelm-Johnen Straße, 52428
Jülich, Germany,

AND

COMISIÓN NACIONAL PARA EL CONOCIMIENTO Y USO DE LA BIODIVERSIDAD (hereinafter
referred to as "**CONABIO**") a permanent interdepartmental commission of the government of
Mexico, with head office is located at Liga Periferico - Insurgentes Sur 4903, Alcaldía Tlalpan, Código
postal 14010, Ciudad de México, México.

Herein referred to jointly and severally as the "Parties" and "Party", as the context may reasonably
indicate or require.

RECOGNIZING THAT:

- a) The mission of JUELICH is to conduct scientific and technical research and development at
the interface between people, the environment and technologies, to take on other national
and international tasks in the field of basic and application-oriented research.

The Bioinformatics Department (IBG-4) of the Institute of Bio- and Geosciences works and
develops methods and algorithms to gain a basic understanding of high-dimensional data
and processes in the bioeconomy.

- b) IBG-4 focuses on knowledge management and data integration, classic bioinformatics and
machine learning,
- c) The mission of CONABIO is to promote, coordinate, support and carry out activities aimed
at increasing knowledge of biodiversity and its conservation and sustainable use for the
benefit of society; and
- d) On June 9 of 2020, Federal Ministry for Education and Research in Germany, grants an
amount of € 337,874.00 to JUELICH (three hundred thirty-seven thousand eight hundred
seventy-four Euros 00/100), for the implementation of the PROJECT "TEOSINTE - Extensive
sequencing and comparative genomics of a large number of Teosinte accessions with the aim
of Generate knowledge in order to cultivate corn in particular with regard to the Support
climate change.", hereafter "the PROJECT", submitted by JUELICH and CONABIO, see Annex
1.
- e) The Parties acknowledge the benefits that each may derive from their collaboration
hereunder towards the fulfilment of their respective missions.



THE PARTIES AGREE TO COLLABORATE UNDER THE FOLLOWING TERMS:

1. DEFINITIONS:

“Background”

means any data, know-how or information — whatever its form or nature (tangible or intangible), including any rights such as intellectual property rights — that:

- (a) is held by the Parties before they acceded to the Agreement, and
- (b) is Needed to implement the action or exploit the Results.

“Data”

The Background Data and Data Results.

“Fair and reasonable conditions”

Fair and reasonable conditions means appropriate conditions, including possible financial terms or royalty-free conditions, taking into account the specific circumstances of the request for access, for example the actual or potential value of the Results or Background to which access is requested and/or the scope, duration or other characteristics of the Exploitation envisaged.

“Implementation”

Implementation means the execution of the PROJECT.

This PROJECT will be implemented by CONABIO in collaboration with JUELICH.

CONABIO will collaborate with other Mexican universities or research centers for the PROJECT implementation subject to compliance with this agreement.

“Needed”

means: For the implementation of the PROJECT Access Rights are Needed if, without the grant of such Access Rights, carrying out the tasks assigned to the recipient Party would be technically or legally impossible, significantly delayed, or require significant additional financial or human resources.

“Material”

means the Teosinte samples and nucleic acids libraries. The Parties will not exchange germplasm in anytime of the implementation of the PROJECT.

“Results”

means any (tangible or intangible) output of the PROJECT such as data, knowledge or information — whatever its form or nature, whether it can be protected or not — that is generated in the PROJECT, as well as any rights attached to it, including intellectual property rights.

“Software”

Software means sequences of instructions to carry out a process in, or convertible into, a form executable by a computer and fixed in any tangible medium of expression.

“Teosinte DB”

A data warehouse as defined in Annex 1.



2. OBJECTIVE

The objective of this Collaboration Agreement is to establish the basis according to which the Parties will carry out the PROJECT titled "Extensive sequencing and comparative genomics of a large number of Teosinte accessions with the aim of generating knowledge in order to support maize breeding, especially with regard to climate change", hereafter called the PROJECT, in accordance with the provisions of Annex 1 and 2.

2.1 SPECIFIC OBJECTIVES OF THE PROJECT

The Parties agree that the specific Objectives of the PROJECT are as follows:

- a) Set up a TEOSINTE-database for data management.
- b) Perform Genome Wide Association Studies;
- c) Integrate and analyse data to make a phylogeny and select teosinte candidates for whole genome sequencing
- d) Perform whole genome and RNA sequencing of eight (8) teosinte candidates
- e) Perform comparative genomic analyses

3. PRINCIPLES OF COLLABORATION

1. The Parties will support each other in working toward the achievement of the Objective and the fulfilment of their respective missions, by building on elements of their respective programs and by pursuing effectiveness while avoiding unnecessary duplication of efforts.
2. To ensure the harmonious implementation of the Parties' collaboration and the successful achievement of the Objective of this Agreement, the Parties undertake actively to support each other in the performance of agreed tasks, activities and to take all reasonable steps to make the most effective use of the collaboration hereunder in furtherance of their respective missions.

The Parties will arrange and obtain all permits from Mexican authorities when needed to implement the PROJECT.

4. ROLES AND RESPONSIBILITIES OF THE PARTIES

A) CONABIO or in collaboration with other Mexican universities or research centers shall undertake:

1. Perform in time and form the activities of Annexes 1 and 2;
2. Provide the human and material resources necessary for the implementation of the PROJECT;
3. Define jointly with JUELICH the data models (formats) and associated validation filters used to store the data produced in the PROJECT;
4. Develop jointly with JUELICH two standardized access interfaces;
5. Provide a server to host the data administration platform. Including installation and maintenance of a file-sharing platform and a Wikilab installation;
6. Distinguish jointly with other Mexican universities or research centers habitats by climate according to best suited markers;
7. Carry out jointly with other Mexican universities or research centers the phylogeny of teosinte accessions;
8. Analyze the Results of Genotyping by sequencing and select eight (8) Teosinte candidates for subsequent analysis;
9. Phenotype eight (8) Teosintes;
10. Carry out the studies of wide association studies (GWAS);
11. Interpret the Results of GWAS;



12. Grow the selected eight (8) Teosinte candidates and harvest samples, especially of the six (6) plant organs from which RNA samples will be extracted. Provide expertise in analyzing and interpreting intermediate Results and guide subsequent steps on comparative genomics;
13. Provide genetic marker data needed to perform genome wide association studies (GWAS).
14. Distinguish habitats by climate according to best suited markers;
15. Provide expertise in analyzing and interpreting intermediate Results and guide on subsequent steps on comparative genomics;
16. Carry out the phylogeny of Teosinte accessions;
17. Carry out DNA and RNA extractions of six (6) plant organs.

B) JUELICH shall undertake:

1. Manage the amount of €337,874.00 (three hundred thirty-seven thousand eight hundred seventy-four Euros 00/100) for the implementation of the PROJECT, according to Budget of Annex 2;
2. Provide the human and material resources as necessary for the implementation of the PROJECT;
3. Carry out Oxford nanopore library preparation and whole genome sequencing.
4. Assisted by CONABIO, submit to genome assembly DNA sequencing results, in the context of Illumina sequencing;
5. Analyze Results of RNA sequencing assisted by CONABIO;
6. Carry out the comparative genomics, including transcriptome data;
7. Provide expertise in analyzing and interpreting intermediate Results and guide subsequent steps on comparative genomics;
8. To perform in time and form the activities of Annexes 1 and 2.

5. PROJECT SUPERVISORS

The following persons have been named to supervise the commitments acquired by the Parties involved and to agree upon other aspects related to the PROJECT throughout its development:

On behalf of JUELICH, the Dr. Asis Hallab will act as the responsible.

On behalf of CONABIO, the Dra. María Francisca José Acevedo Gasman, will act as the responsible.

6. OWNERSHIP OF RESULTS

6.1 The Parties agree that all rights concerning the Results created within the PROJECT will be allocated to the Party/Parties who created the Results.

6.2 Two or more Parties own Results jointly if:

- (a) they have jointly generated them and
- (b) it is not possible to:
 - (i) establish the respective contribution of each Party, or
 - (ii) separate them for the purpose of applying for, obtaining or maintaining their protection

The Parties agree that all rights related to the Results created within the PROJECT in collaboration with other Mexican universities or research centers of Mexico, will also belong to them, therefore such institutions will also be copyright holders.



- each of the joint owners shall be entitled to use their jointly owned Results for non-commercial research and teaching activities on a royalty-free basis, while informing the other joint owner(s). Non-commercial research activities means use for academic/teaching/scientific purposes, or mere internal use, and
 - excludes use in contract research (= rendering a research service against payment to a customer, using the joint Result), even when the charge is mere cost reimbursement without profit;
 - excludes use of Results for royalty bearing activities (such as licensing) or other activities leading to monetary benefits (e.g. use in developing, creating or marketing a product or process or creating and providing a service or use in standardisation activities);
 - includes use in further (funded or unfunded) cooperative research projects. However where such use leads to a grant of further user rights to others (e.g. project partners) for royalty-bearing or other activities leading to monetary benefits, such further user rights shall not be included in the category of non-commercial research activities under this bullet point, and
- each of the joint owners will be able to use the Joint Results, create derived works and make them available to the public as each sees fit, without exclusivity and duly crediting the authors, and without commercial purposes, nor patenting.

The Parties agree that prior to the end of the PROJECT to negotiate a separate agreement regarding the exploitation of the joint Results.

7. RIGHTS FOR TEOSINTE DB

The owners of the Joint Results on TEOSINTE DB agree to use TEOSINTE DB without any commercial purposes.

CONABIO and JUELICH hereby agree to publish their jointly the created software Result for TEOSINTE DB under Controlled License Terms GPLv3.

8. DISSEMINATION OF ANOTHER PARTY'S UNPUBLISHED BACKGROUND

A Party shall not include in any dissemination activity another Party's Background without obtaining the owning Party's prior written approval, unless they are already published.

9. COOPERATION OBLIGATIONS

The Parties undertake to cooperate to allow the timely submission, examination, publication and defence of any dissertation or thesis for a degree that includes their Results or Background subject to the confidentiality and publication provisions agreed in this Agreement.

10. BACKGROUND INCLUDED

The Parties have identified and agreed on the Background for the PROJECT and have also, where relevant, informed each other that Access to specific Background is subject to legal restrictions or limits. Anything not identified in Annex 3 shall not be the object of Access Right obligations regarding Background.

General Principles

Each Party shall implement its tasks in accordance with the PROJECT Plan and shall bear sole responsibility for ensuring that its acts within the PROJECT do not knowingly infringe third party property rights, nor any legal provision on genetic resources.

Any Access Rights granted expressly exclude any rights to sublicense unless expressly stated otherwise.

Access Rights shall be free of any administrative transfer costs and are granted on a non-exclusive basis.



Results and Background shall be used only for the purposes for which Access Rights to it have been granted.

11. ACCESS RIGHTS FOR IMPLEMENTATION

Access Rights to Results and Background Needed for the performance of the own work of a Party under the PROJECT shall be granted on a royalty-free basis, unless otherwise agreed.

Digital access via Internet to TEOSINTE DB shall be accessible for every Party during the PROJECT implementation and for one (1) year after the end of the PROJECT, depending on budget sufficiency.

All data described in Material and data created during the PROJECT must grant write and read access to the Parties.

Should TEOSINTE DB be made inaccessible, CONABIO shall grant JUELICH access to the raw files via download from another server for at least 30 calendar days.

12. NON-DISCLOSURE OF INFORMATION

All information in whatever form or mode of communication, which is disclosed by a Party (the "Disclosing Party") to any other Party (the "Recipient") in connection with the PROJECT during its implementation and which has been explicitly marked as "confidential" at the time of disclosure, or when disclosed orally has been identified as confidential at the time of disclosure and has been confirmed and designated in writing within 15 calendar days from oral disclosure at the latest as confidential information by the Disclosing Party, is "Confidential Information".

The Recipients hereby undertake in addition and without prejudice to any commitment on non-disclosure, for a period of 4 years after the end of the PROJECT:

- Not to use Confidential Information otherwise than for the purpose for which it was disclosed;
- not to disclose Confidential Information without the prior written consent by the Disclosing Party;
- to ensure that internal distribution of Confidential Information by a Recipient shall take place on a strict need-to-know basis; and
- to return to the Disclosing Party, or destroy, on request all Confidential Information that has been disclosed to the Recipients including all copies thereof and to delete all information stored in a machine readable form to the extent practically possible. The Recipients may keep a copy to the extent it is required to keep, archive or store such Confidential Information because of compliance with applicable laws and regulations or for the proof of on-going obligations provided that the Recipient comply with the confidentiality obligations herein contained with respect to such copy for as long as the copy is retained.

The recipients shall be responsible for the fulfilment of the above obligations on the part of their employees or third parties involved in the PROJECT and shall ensure that they remain so obliged, as far as legally possible, during and after the end of the PROJECT and/or after the termination of the contractual relationship with the employee or third party.

The above shall not apply for disclosure or use of Confidential Information, if and in so far as the Recipient can show that:

- a) the Confidential Information has become or becomes publicly available by means other than a breach of the Recipient's confidentiality obligations;
- b) the Disclosing Party subsequently informs the Recipient that the Confidential Information is no longer confidential;



- c) the Confidential Information is communicated to the Recipient without any obligation of confidentiality by a third party who is to the best knowledge of the Recipient in lawful possession thereof and under no obligation of confidentiality to the Disclosing Party;
- d) the Confidential Information, at any time, was developed by the Recipient completely independently of any such disclosure by the Disclosing Party;
- e) the Confidential Information was already known to the Recipient prior to disclosure, or
- f) the Recipient is required to disclose the Confidential Information in order to comply with applicable laws or regulations or with a court or administrative order

The Recipient shall apply the same degree of care with regard to the Confidential Information disclosed within the scope of the PROJECT as with its own confidential and/or proprietary information, but in no case less than reasonable care.

Each Party shall promptly advise the other Party in writing of any unauthorised disclosure, misappropriation or misuse of Confidential Information after it becomes aware of such unauthorised disclosure, misappropriation or misuse.

If any Party becomes aware that it will be required, or is likely to be required, to disclose Confidential Information in order to comply with applicable laws or regulations or with a court or administrative order, it shall, to the extent it is lawfully able to do so, prior to any such disclosure

- notify the Disclosing Party, and
- comply with the Disclosing Party's reasonable instructions to protect the confidentiality of the information.

13. MODIFICATIONS

This Agreement will only be able to be modified by mutual agreement between the Parties.

14. TERM

This Agreement shall be deemed to be effective from the date of its signature by all the Parties and will continue until December 15th 2023.

15. FORCE MAJEURE

Force Majeure as used herein shall mean acts laws or regulations, industrial disturbances, civil disturbances, explosions and any other similar event of equivalent force not caused by nor within the control of other Party and which neither Party is able to overcome. As soon as possible after the occurrence of any event constituting Force Majeure, and if any of the Parties is thereby rendered unable, wholly or in part, to perform its obligations and meet its responsibilities under this Collaboration Agreement, shall give notice and full particulars thereof in writing to the other Party . In this event, the following provisions shall apply:

- (a) The obligations and responsibilities under this Agreement shall be suspended to the extent of its inability to perform them and for as long as such inability continues.
- (b) The term of this Collaboration Agreement shall be extended for a period equal to the period of suspension taking, however, into account any special conditions which may cause the time for completion of the PROJECT be different from the period of suspension.
- (c) If any of the Parties is rendered permanently unable, wholly or in part, by reason of Force Majeure, to perform its obligations and meet its responsibilities under this Collaboration Agreement, CONABIO or JUELICH shall have the right to terminate this Agreement

**16. EARLY TERMINATION**

Either Party may at any time terminate this Agreement when circumstances of general interest or of any nature arise that prevent its continuation, upon prior Notice to the other Parties, whom will agree on the corresponding conditions to its termination.

17. NO WARRANTIES

In respect of any information or materials (incl. Results and Background) supplied by one Party to another under the PROJECT, no warranty or representation of any kind is made, given or implied as to the sufficiency or fitness for purpose nor as to the absence of any infringement of any proprietary rights of third parties.

Therefore,

- the recipient Party shall in all cases be entirely and solely liable for the use to which it puts such information and materials, and
- no Party granting Access Rights shall be liable in case of infringement of proprietary rights of a third party resulting from any other Party (or its Affiliated Entities) exercising its Access Rights.

18. LIMITATIONS OF CONTRACTUAL LIABILITY

No Party shall be responsible to any other Party for any indirect or consequential loss or similar damage such as, but not limited to, loss of profit, loss of revenue or loss of contracts, provided such damage was not caused by a wilful act or by gross negligence.

For any remaining contractual liability, a Party's aggregate liability towards the other Parties collectively shall be limited to once the Party's share of the total costs of the PROJECT as identified in Annex 1 provided such damage was not caused by a wilful act or gross negligence or such damage results in death or injury to natural persons.

The terms of this Agreement shall not be construed to amend or limit any Party's statutory liability.

19. USE OF NAMES, LOGOS OR TRADEMARKS

Nothing in this Agreement shall be construed as conferring rights to use in advertising, publicity or otherwise the name of the Parties or any of their logos or trademarks without their prior written approval.

20. NO REPRESENTATION, PARTNERSHIP OR AGENCY

No Party shall be entitled to act or to make legally binding declarations on behalf of any other Party or of the Agreement. Nothing in this Agreement shall be deemed to constitute a joint venture, agency, partnership, interest grouping or any other kind of formal business grouping or entity between the Parties.

21. MANDATORY NATIONAL LAW

Nothing in this Agreement shall be deemed to require a Party to breach any mandatory statutory law under which the Party is operating.

22. TRANSPARENCY

The Parties agree that this Agreement, the information and personal data contained herein be public and open to allow CONABIO to be transparent with information related to their operations and activities that perform, this in compliance with their policies accountability of the use of public and



private resources; as well as with principles of transparency, proactive transparency and open government policies outlined in legislation applicable to the subject.

23. LANGUAGE

This Agreement is drawn up in English, which language shall govern all documents, notices, meetings, arbitral proceedings and processes relative thereto.

24. DISPUTE RESOLUTION

Amicable Settlement:

The Parties shall use their best efforts to settle amicably any dispute, controversy or claim arising out of, or relating to this Agreement or the breach, termination or invalidity thereof.

Any dispute, controversy or claim arising under, out of or relating to this contract and any subsequent amendments of this contract, including, without limitation, its formation, validity, binding effect, interpretation, performance, breach or termination, as well as non-contractual claims, shall be submitted to mediation in accordance with the WIPO Mediation Rules. The place of mediation shall be Brussels unless otherwise agreed upon. The language to be used in the mediation shall be English unless otherwise agreed upon.

In witness whereof, the undersigned, being duly authorised to do so, have executed this Agreement, in the English language in two (2) counterparts,



On behalf of **Forschungszentrum Jülich GmbH**

Jülich,

10. MAI 2021

ppa. Immo Wetcke
Head of External Funding Management

i.V. Prof. Björn Usadel
Director of the Institute of Bio- and
Geosciences - Bioinformatics (IBG-4)

On behalf of **CONABIO**

Ciudad de México,

José Aristeo Sarukhán Kermez,
National Coordinator of CONABIO

Annex 1

The project plan: The following the work packages (WP) are revised and the resulting work assigned to the respective participating partners. Each work package includes milestones (M).

Participating partners

- “JUELICH” - Forschungszentrum Jülich GmbH represented by its Board of Directors,
for: Institute of Bio- and Geosciences (IBG) -Bioinformatics (IBG-4)
- “CONABIO” - CONABIO Comisión Nacional para el Conocimiento y Uso de la
Biodiversidad or in collaboration with other Mexican universities or research
centers.

Milestones

M 1.1 Setup a TEOSINTE-database

This milestone completes WP 1.1. At the end of month three data models will have been defined to structure, validate, and administer data collected for the ca. 4,000 teosinte accessions. A graphical and a programmatic user interface will provide standardized data access. Validations are defined for each data model to ensure only valid and concise data is uploaded. User accounts are provided for each participating partner.

Achieved: End of month 3

M 1.2 Setup file sharing platform

This milestone completes WP 1.2. At the end of month three a file sharing platform will be setup and made accessible for all partners. A Wikilab installation enables the sharing of programming code and keeps track of software versions to ensure reproducibility.

Achieved: End of month 3

M 1.3 Setup a Wikilab installation

This milestone completes WP 1.3. At the end of month three a wikilab installation is planned to have been setup. User accounts will be provided for all participating partners. Program code will be managed within the Wikilab installation, which thus serves as work organization platform, code distribution and sharing tool, and ensures backups are made of all programmatic work.

Achieved: End of month 3

M 2.1 GWAS of climate and resistance

This milestone completes WP 2.1. Identify those genetic loci contributing significantly to climate adaptation and resistance. Standard GWAS analyses will be executed on the data already generated by our partners. Results will be uploaded into the Teosinte-Database.

Achieved: End of month 5

M 2.2 Distinguish habitats by climate

Using results from WP 2.1 machine learning approaches are applied to identify those loci that best distinguish habitat by climate. The resulting identified loci, along with their significance scores, will be stored in the Teosinte-Database.

Achieved: End of month 9

M 3.1 Phylogeny of teosinte accessions

This milestone completes work package WP 3.1. Using the genotyping by sequencing (GBS) data a robust and trustworthy phylogeny of the 4,000 teosinte candidates is reconstructed. Its robustness is ensured by the application of various tree building methods that are joined in supertree and phylogenetic network approaches.

Achieved: End of month 12

M 3.2 Select eight teosinte candidates

This milestone completes work package WP 3.2. Using results from WP 3.1, 2.1, and 2.2. the 4,000 teosinte candidates are analyzed and eight are selected that represent best the taxonomy geographic, climatic, and genetic distribution. These candidates will be submitted subsequently to whole genome and transcriptome sequencing.

Achieved: End of month 14

M 4.1.1 DNA extraction and library generation

This milestone is part of work package WP 4.1. First, individuals of the selected teosinte-candidates are grown in greenhouse facilities and DNA is extracted. Libraries are prepared for Oxford nanopore sequencing and Illumina sequencing.

Achieved: End of month 16

M 4.1.2 Whole genome sequencing

This milestone is part of work package WP 4.1. The libraries prepared for Oxford nanopore sequencing are sequenced. The same is done with the libraries prepared for Illumina sequencing, with the exception that sequencing is done by an external company.

Achieved: End of month 18

M 4.1.3 Genome assembly

This milestone is part of work package WP 4.1. The whole genome sequencing results from Oxford nanopore and Illumina platforms are submitted to genome assembly. The results will be shared in the file-sharing-platform established in WP 1.2.

Achieved: End of month 25

M 4.2.1 RNA extraction and library generation

This milestone is part of work package WP 4.2. First, individuals of the selected teosinte-candidates are grown in greenhouse facilities. RNA is extracted from six different plant organs of each individual. The extracted material is used for sequencing library preparation.

Achieved: End of month 17

M 4.2.1 Transcriptome analysis

This milestone is part of work package WP 4.2. The results obtained from RNA-Seq in WP 4.2 are analyzed and expression counts for each gene in each tissue sample are obtained. The results are uploaded into the Teosinte-Database established in WP 1.1.

Achieved: End of month 25

M 5.1 Detection of gene orthologs / paralogs, species tree reconstruction

This milestone is part of work package WP 5. Gene orthologs and paralogs are identified. Subsequently concatenated alignments of single-copy orthologs are used to reconstruct the species, i.e. accession tree. Results are made available in the file-sharing platform established in WP 1.2.

Achieved: End of month 28

M 5.2 Gene family reconstruction and identification of per species family expansion and contraction

This milestone is part of work package WP 5. Gene families are reconstructed by markov clustering pairwise sequence similarity scores. Reconstructed families are analyzed to detect species (accession) specific and significant gene expansion or contraction. Results are made available in the file-sharing platform established in WP 1.2.

Achieved: End of month 29

M 5.3 Phylogeny based identification of positive selection

This milestone is part of work package WP 5. Phylogenies and coding sequence alignments of the gene families are submitted to positive selection analysis using HyPhy. Results are made available on the file-sharing platform established in WP 1.2

Achieved: End of month 31

M 5.4 Analysis of Expression Vector-Space

This milestone is part of work package WP 5. Expression assessed for each gene in the six examined tissues is translated into a six dimensional expression vector space. Vector analysis is used to identify genes with significant divergence from background single-copy ortholog expression. Results are made available on the file-sharing platform established in WP 1.2.

Achieved: End of month 32

M 5.5 Gene function annotation, Function Diversification, and Enrichments

This milestone is part of work package WP 5. The functions of proteins contained in the teosinte and, if required, the reference maize proteomes are predicted using different established tools. Expanded and contracted gene families are analyzed for divergent protein functions. A similar analysis is carried out for gene families with significant divergent gene expression. Subsequently, within gene families that are either expanded, contracted, positively selected, or show divergent gene expression enriched protein functions are identified. Results are made available on the file sharing platform established in WP 1.2.

Achieved: End of month 33

Work assignments

Work is assigned to each participating partner in the context of each work package.



WP 1 data management

Within WP 1, data management, JUELICH and CONABIO jointly will define the data models (formats) and associated validation filters used to store the data produced in the TEOSINTE project. Based on these data model definitions two standardized access interfaces are developed, one graphical in the web browser and another programmatic interface in the form of a GraphQL web-server. These interfaces are developed jointly by JUELICH and CONABIO. Phenotyping and accession related data, climatic and geographic data will be put into the defined formats and uploaded, i.e. validated by CONABIO. Genotyping by sequencing will be put into defined formats and uploaded, i.e. validated by CONABIO.

CONABIO will furthermore handle administration tasks and provide a server to host the data administration platform. This includes installation and maintenance of a file-sharing platform and a Wikilab installation.

WP 2 Genome trait association

CONABIO in collaboration with other Mexican universities or research centers provides the phenotyping and genetic marker data needed to perform genome wide association studies (GWAS). Subsequently habitats will be distinguished by climate according to best suited markers. This will be carried out by CONABIO and JUELICH.

WP 3 Integrate and analyse results, select candidates

Phylogeny of teosinte accessions will be carried out by CONABIO in collaboration with other Mexican universities or research centers with feedback from JUELICH interpreting results. All participating partners will analyze the results produced in WP one and two and select eight Teosinte candidates for subsequent analysis. These candidates will best represent genetic, phenotypic variation in the context of habitat.

WP 4 DNA and RNA sequencing

CONABIO in collaboration with other Mexican universities or research centers will grow the selected eight Teosinte candidates and harvest samples, especially of the six plant organs from which RNA samples will be extracted. Then will carry out DNA and RNA extraction. JUELICH will carry out Oxford nanopore library preparation and whole genome sequencing. DNA sequencing results, in the context of Illumina sequencing provided by third party laboratories, will be submitted to genome assembly by JUELICH, and CONABIO will assist. RNA seq results will be analyzed by JUELICH, and CONABIO will assist.

WP 5 Comparative genomics

Comparative genomics, including transcriptome data, will be carried out by JUELICH. Partners CONABIO and Mexican universities or research centers provide expertise in analyzing and interpreting intermediate results and guide subsequent steps.

WP 6 publications

All participating partners will write articles to publish the results produced within the TEOSINTE project.

Workload per partner

Workload is measured in months a single person would work on the respective task.

Work-Package	Description	Workload in person-months	
		JUELICH	CONABIO
WP 1.1	Teosinte-DB	6	6
WP 1.2	File-Sharing platform	0	1
WP 1.3	Wikilab installation	1	1
WP 2.1	GWAS of climate and resistance traits	0	11
WP 2.2	Distinguish habitats by climate	0	8
WP 3.1	Phylogeny of teosinte accessions	2	6
WP 3.2	Select eight teosinte candidates	1	1
WP 4.1	Whole genome sequencing	9	3
WP 4.2	RNA Sequencing	9	3
WP 5	Comparative genomics	11	9
WP 6	Publications	6	6

Annex 2

Project budget:

Personal € 207,000.00

One trained Bioinformatician or Computer Science PhD student. The student is necessary to conduct the work on sequence and evolutionary analysis as well as on the database work. This additional work can not be payed by core funding.

Travel €6,000.00

Travel costs to visit the Mexican partner and to collect sample material of the chosen lines at least once a year

Consumables and Equipment € 180,000.00:

Funds to cover whole genome and RNA sequencing costs for eight selected candidate lines

Total: € 337,874.00

The above stated amount funds only the work of JUELICH.

Project activity calendar

Objectives	Months	Year 1				Year 2				Year 3			
		1-3	4-6	7-9	10-12	13-15	16-18	19-21	22-24	25-27	28-30	31-33	34-36
WP 1 Teosinte-DB (JUELICH and CONABIO)													
1.1 capture data of 4,000 teosinte variants	x												
1.2 provide a Seafile file-sharing-platform	x												
1.3 Provide a Gitlab and Wiki InstallationWP	x												
WP 2 Genome Trait Association (CONABIO in collaboration with other Mexican universities or research centers)													
2.1 GWAS on GBS data, repeat on whole genome data		x	x										
2.2 Climate genome associationWP		x	x										
WP 3 Integrate and analyse results (JUELICH and CONABIO in collaboration with other Mexican universities or research centers)													

3.1 Phylogeny on GSB loci, and loci correlated with traits of interest					x	x											
3.2 Select eight teosinte candidates for WGS, RNA-Seq, and comparative genomics							x	x									
WP 4 Whole genome and RNA sequencing (JUELICH and CONABIO in collaboration with other Mexican universities or research centers)																	
4.1 Whole Genome Sequencing (Oxford Nanopore)									x	x							
4.2 RNA-Seq of leaf, stem, and root samples (three replicates)									x	x							
WP 5 Comparative Genomics (JUELICH and CONABIO in collaboration with other Mexican universities or research centers)																	
Apply previously developed pipeline on data from WP 4													x	x	x		
WP 6 Publish results (JUELICH and CONABIO in collaboration with other Mexican universities or research centers)																	
Publish ScienceDb with Teosinte data (WP 1)				x	x	x											
Publish loci associated with climate and resistance traits (WP 3)								x	x	x							
Publish teosinte genomes, phylogeny, and resistance and climate traits (WP 5)														x	x	x	

ANNEX 3
DATA BACKGROUND

JUELICH DATA BACKGROUND

Describe Background	Specific limitations and/or conditions for implementation	Specific limitations and/or conditions for Exploitation
Node Java Script	Subject to the terms and conditions of MIT license.	Subject to the terms and conditions of MIT license.
Postgers	Subject to the terms and conditions of PostgreSQL license.	Subject to the terms and conditions of PostgreSQL license.

CONABIO in collaboration with other Mexican universities or research centers DATA BACKGROUND

Describe Background	Specific limitations and/or conditions for implementation	Specific limitations and/or conditions for Exploitation
4,465 samples (tissue and DNA) of teosinte individuals, comprising and describing seven teosinte species of 276 teosinte populations (accesions)	Only the samples needed for the fulfilment of the project would be shared as described in the project proposal	the Parties agree that prior to the end of the Project the Parties will negotiate a separate agreement regarding the exploitation of the joint Results.
Climatic habitat description for each of the 276 accesions	This is unpublished data	the Parties agree that prior to the end of the Project the Parties will negotiate a separate agreement regarding the exploitation of the joint Results.
Genotyping-by-sequencing data for each of the 4,465 individuals	This is unpublished data	the Parties agree that prior to the end of the Project the Parties will negotiate a separate agreement regarding the exploitation of the joint Results.
Phenotypic data of each of the 4,465 individuals	This is unpublished data	the Parties agree that prior to the end of the Project the Parties will negotiate a separate agreement regarding the exploitation of the joint Results.

