

Conserving Plant Genetic Resources for Global Climate Resilience and Food Security

Assistant Professor Dr Chutchamas Kanchana-udomkan

Tropical Vegetable Research Center, Department of Horticulture,
Faculty of Agriculture at Kamphaeng Saen, Kasetsart University



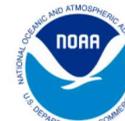
Food Security and Climate Change

- Weather patterns influenced by global warming
 - Heat waves → Extreme weather
 - Heavy rainfall → Flood
 - Droughts → Salinity
- Greenhouse gas emissions from global food system



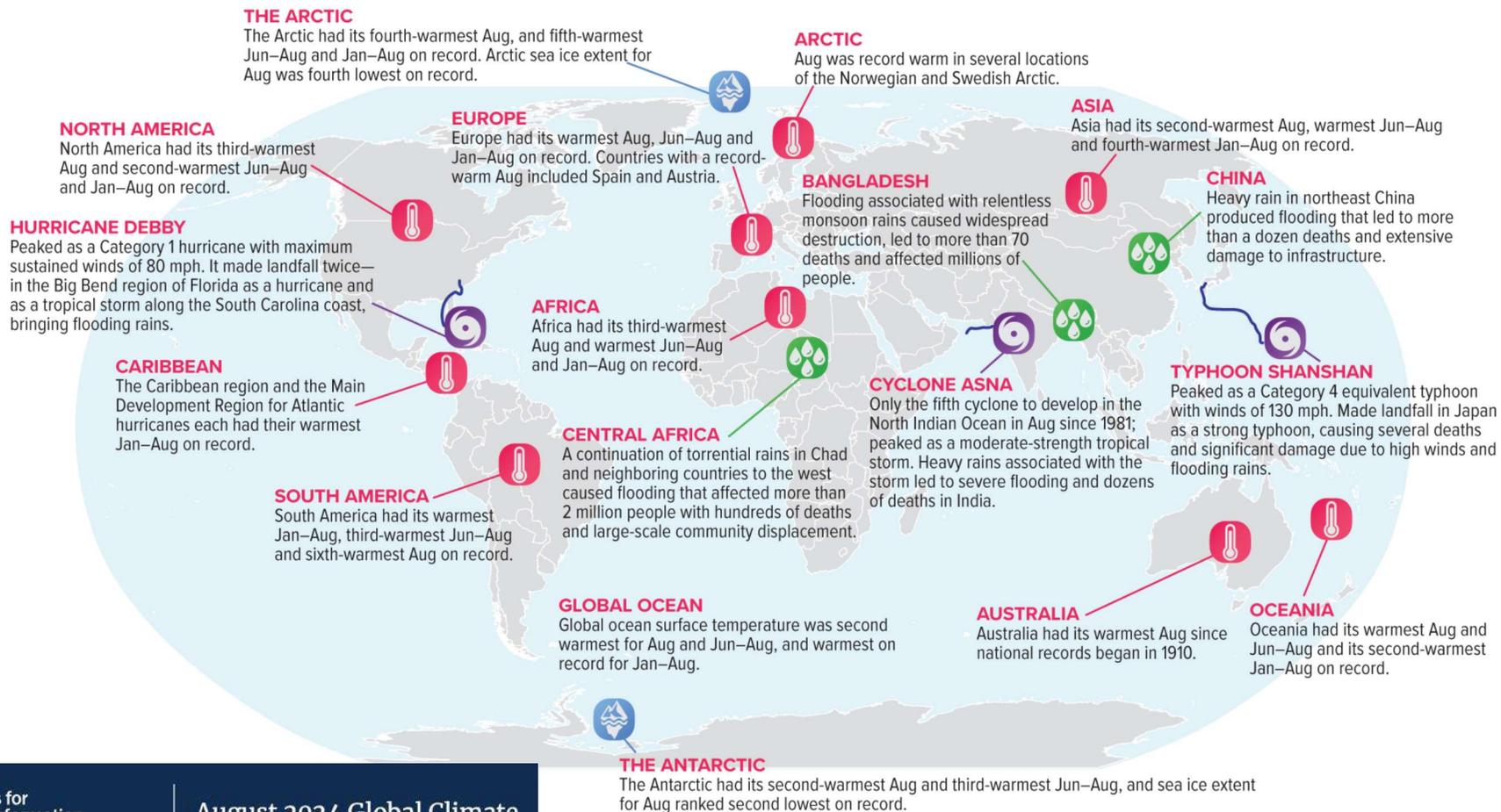
Source: Bangkok Post, 28 Aug 2024

Selected Significant Climate Anomalies and Events: August 2024



GLOBAL AVERAGE TEMPERATURE

Aug 2024 global surface temperature ranked warmest since global records began in 1850, making it the 15th consecutive record-warm month.



Food Security and Climate Change

- Global food insecurity:
 - Quantity and quality
 - Crop diversity lost



<https://eos.com/blog/monoculture-farming/>

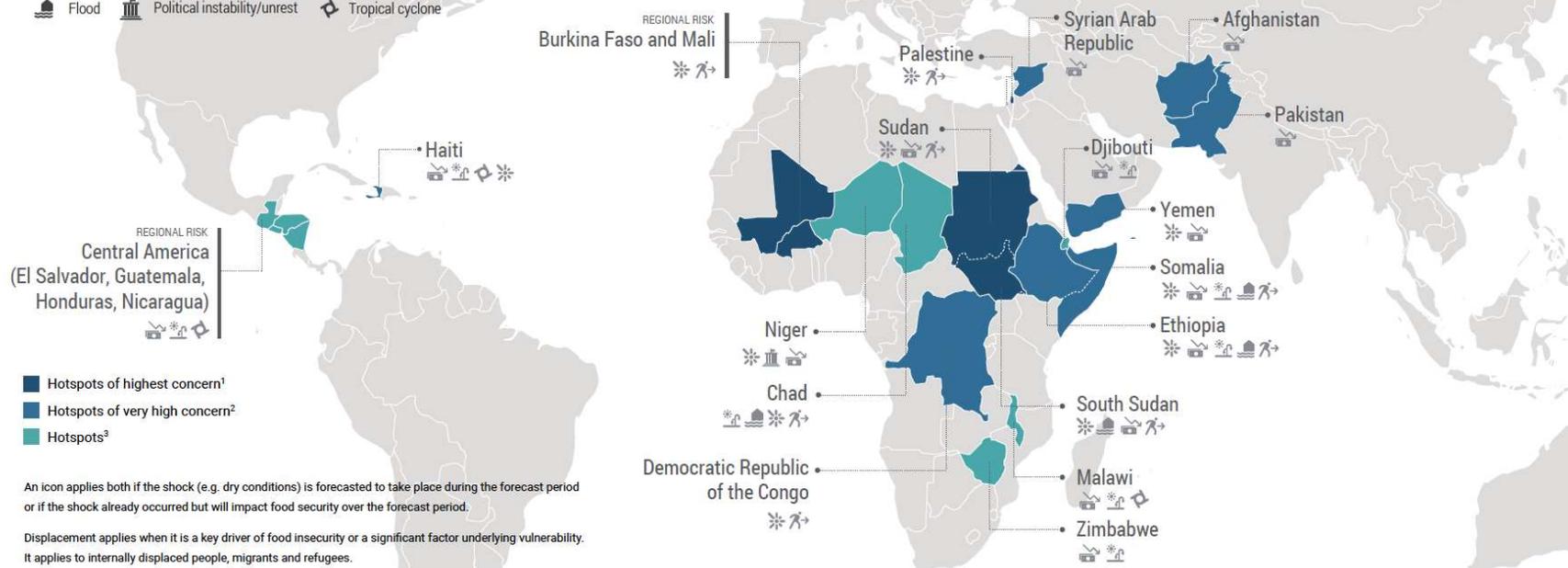


lack of crop diversity

Early warning hunger hotspots November 2023 to April 2024

Key drivers and aggravating factors

-  Conflict/insecurity
-  Displacement
-  Dry conditions
-  Economic shocks
-  Flood
-  Political instability/unrest
-  Tropical cyclone



- Hotspots of highest concern¹
- Hotspots of very high concern²
- Hotspots³

An icon applies both if the shock (e.g. dry conditions) is forecasted to take place during the forecast period or if the shock already occurred but will impact food security over the forecast period.

Displacement applies when it is a key driver of food insecurity or a significant factor underlying vulnerability. It applies to internally displaced people, migrants and refugees.

¹ This category includes hotspots already with populations in Catastrophe (Integrated Food Security Phase Classification [IPC]/Cadre Harmonisé [CH] Phase 5), as well as hotspots at risk of deterioration towards catastrophic conditions. At risk are those hotspots where an extremely vulnerable population in Emergency (IPC/CH Phase 4) is facing severe aggravating factors – especially access constraints – that indicate a further deterioration and possible occurrence of catastrophic conditions in the outlook period. Per definition, this category also includes hotspots with Famine or Risk of Famine.

² These are hotspots with sizeable populations – over 500 000 people – estimated or projected to be in Emergency (IPC/CH Phase 4) levels of acute food insecurity or identified as severely acute food insecure as per WFP's Consolidated Approach for Reporting Indicators of Food Security (CARI) or remote CARI (rCARI) methodology; or hotspots with more than 10 percent of the population analysed in Emergency (IPC/CH Phase 4) or severely acute food insecure, and at least 50 percent of the population analysed. In the included countries/territories, life-threatening conditions are expected to further intensify in the outlook period.

³ Other countries/territories, in which acute food insecurity is likely to deteriorate further during the outlook period, and which were identified as hunger hotspots.

Source of data: FAO and WFP. 2023. *Hunger Hotspots analysis (November 2023 to April 2024)*. Rome. <https://doi.org/10.4060/cc8419en>. Source of map: United Nations. 2020. *Map of the World*. [Cited 9 October 2023]. www.un.org/geospatial/content/map-world

The boundaries and names shown and the designations used on these map(s) in this information product do not imply the expression of any opinion whatsoever on the part of FAO and WFP concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers and boundaries. Dashed lines on maps represent approximate border lines for which there may not yet be full agreement. Dotted line represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the parties. Final boundary between the Sudan and South Sudan has not yet been determined. Final status of the Abyei area is not yet determined.

IPC/CH acute food insecurity phase description and response objectives

PHASE	TECHNICAL DESCRIPTION	PRIORITY RESPONSE OBJECTIVE
1 None/Minimal	Households are able to meet essential food and non-food needs without engaging in atypical and unsustainable strategies to access food and income.	Resilience building and disaster risk reduction.
2 Stressed	Households have minimally adequate food consumption but are unable to afford some essential non-food expenditures without engaging in stress-coping strategies.	Disaster risk reduction and protection of livelihoods.
3 Crisis	Households either: <ul style="list-style-type: none"> • Have food consumption gaps that are reflected by high or above-usual acute malnutrition; OR • Are marginally able to meet minimum food needs but only by depleting essential livelihood assets or through crisis-coping strategies. 	URGENT ACTION REQUIRED to protect livelihoods and reduce food consumption gaps.
4 Emergency	Some households either: <ul style="list-style-type: none"> • Have large food consumption gaps which are reflected in very high acute malnutrition and excess mortality; OR • Are able to mitigate large food consumption gaps but only by employing emergency livelihood strategies and asset liquidation. 	URGENT ACTION REQUIRED to save lives and livelihoods.
5 Catastrophe/ Famine*	Households have an extreme lack of food and/or other basic needs even after full employment of coping strategies. Starvation, death, destitution and extremely critical acute malnutrition levels are evident. (For Famine classification, area needs to have extreme critical levels of acute malnutrition and mortality).	URGENT ACTION REQUIRED to revert/prevent widespread death and total collapse of livelihoods.

* Some households can be in Catastrophe (IPC/CH Phase 5) even if areas are not classified as Famine (IPC/CH Phase 5). Given the severity and implications of classifying Famine, specific IPC protocols have been developed, and special considerations are identified in the IPC Technical Manual 3.1 (see pp. 24–25 for more details on criteria: https://www.ipcinfo.org/ipc/technical/manual_en).

The classification of areas in Famine Likely is permitted when all IPC protocols for Famine classification are met, except for the existence of reliable evidence for all three outcomes – food consumption or livelihood change, global acute malnutrition (GAM), and crude death rate. Areas can be classified as Famine Likely if minimally adequate evidence available indicates that a Famine may be occurring or will occur. Famine and Famine Likely are equally severe, the only difference is the amount of reliable evidence available to support the statement.

Hidden hunger

- 26.4% of population ~
2 billions people
worldwide
- 38 millions children
under 5 were
overweight (2019)
- Half are in Asia

Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture



Fig. 1. UN sustainable development goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture. Adapted from⁽¹²⁾.

The Svalbard Seed Vault, a facility for safety duplication of plant genetic resources

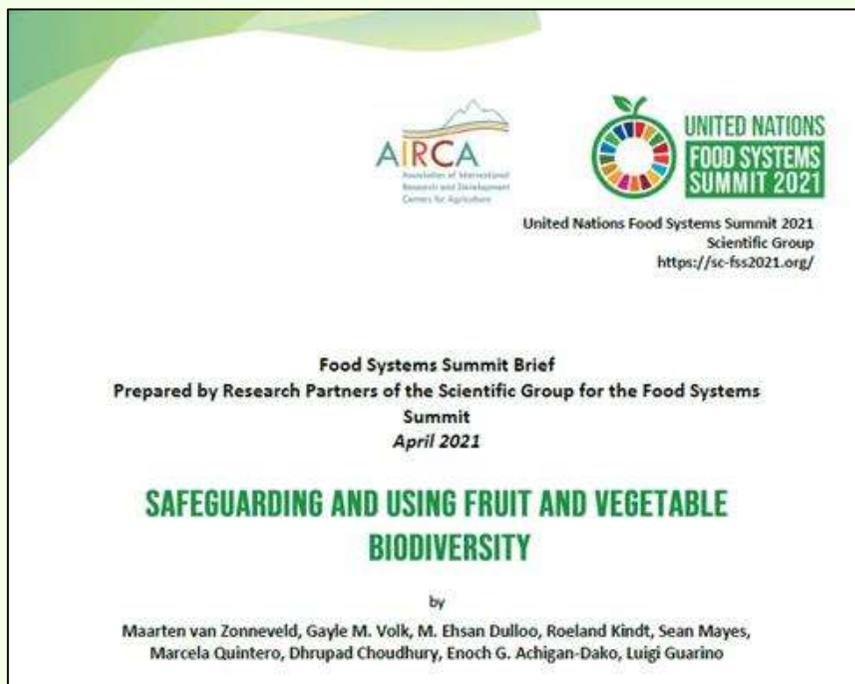


Traditional vegetables and crop wild relatives of vegetables are threatened and poorly conserved

- Abundance of 76% of the wild fruits and vegetables declines (Schunko et al. 2022)
- 25% of the about 1,100 recognized vegetables is still not conserved ex situ (Meldrum et al. 2018)
- 65% of eggplant wild relatives are poorly or not conserved ex situ (Syfert et al. 2016)
- 25% of mung bean wild relatives are poorly conserved ex situ (van Zonneveld et al. 2019)



A global call to save, store, and share vegetable and fruit biodiversity



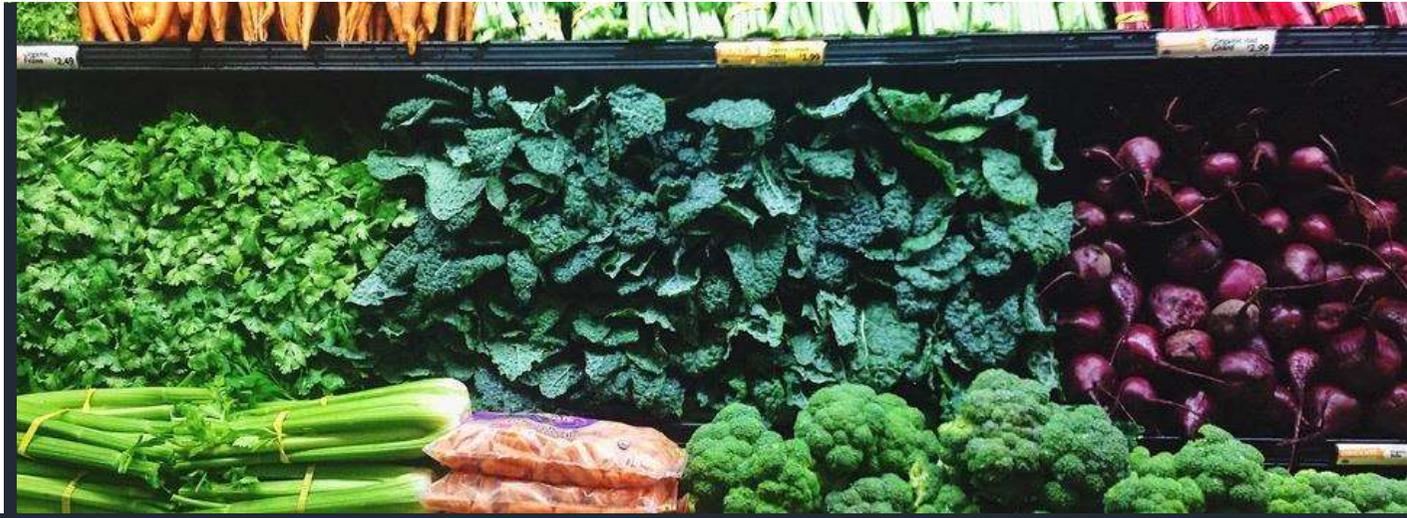
- Loss of vegetable and fruit biodiversity leads to less crop options and variation for breeding
- Zero hunger by 2030 - Sustainable Development Goals
- Large Investment needed in a Global Rescue Plan

<https://hdl.handle.net/20.500.11811/9141>

van Zonneveld et al. (2021)

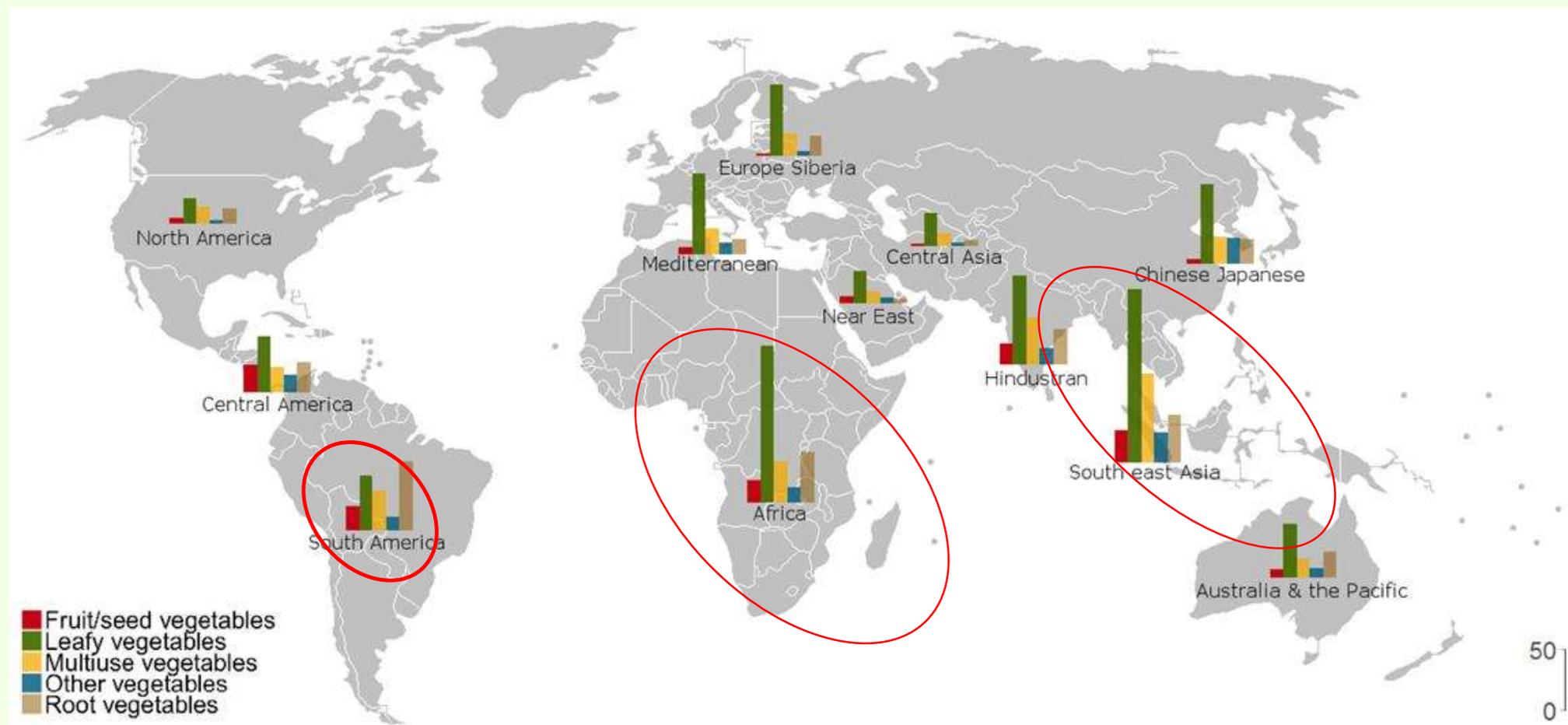


Securing the base for resilient and healthy food systems



- There are >1,000 vegetable species, but <10% of genebank accessions globally are vegetables.
- Vegetable biodiversity is declining rapidly
- We need to save this vegetable heritage before it is lost forever.

Global vegetable biodiversity hotspots



Meldrum *et al.* (2018)

Development of the African Vegetable Biodiversity Rescue Plan

Developed in a demand-driven process.



Endorsed by the African Union Commission in April 2024



Launched at the 2024 Africa Food System Forum and part of VACS.



- Rescue, conservation, and use started with support of the Taiwan Africa Vegetable Initiative from 2021 to 2024.
- Now, to expand action and secure African vegetable biodiversity continent-wide.

TAsVI – Taiwan Asia Vegetable Initiative

- strengthen international collaboration
- rescue and safeguard vegetable biodiversity in Asia for climate resilient and healthy food systems
- repatriate seed of more than 3,000 accessions of unique and lost vegetable varieties collected in the 1990s and 2000s by national genebanks and the World Vegetable Center back to their home countries: Malaysia, the Philippines, Thailand and Viet Nam.



Rescue, conservation, and use of Southeast Asian Vegetable Biodiversity

- TASVI supports regional collaboration in Southeast Asia.
- Seed homecoming ceremonies in Thailand, Philippines, Vietnam and Malaysia.
- International Symposium on Southeast Asian Vegetable Biodiversity in December.



TAsVI – Thailand activities



125 acc.



100 acc.



69 acc.



17 acc.



11 acc.



11 acc.



71 acc.



12 acc.



Bottleneck for genetic exchange

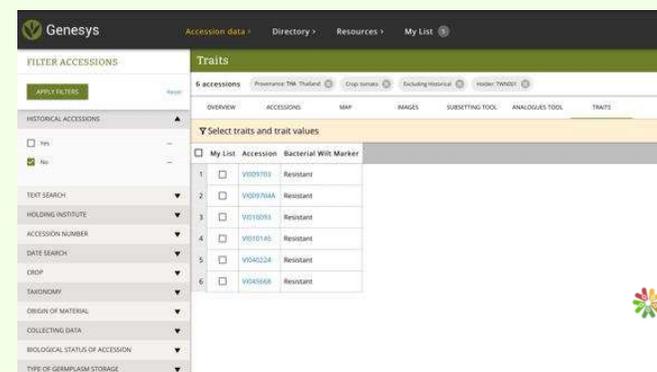
- Data accessibility
- Data sharing
- Seed sharing → ownership
- International protocol
- Country policy
- Collaboration?? can we really share??

Data Management Workshop for Genebank

- International standard for germplasm management
- Grin Global Community Edition
- Genesys system



Disease	QTL	Marker	<i>S. pimpinellifolium</i>	<i>S. peruvianum</i>	<i>S. habrochaites</i>	<i>S. pennellii</i>	<i>S. chilense</i>
Tomato spotted wilt virus	TSWV	Sw5	5	32	18	29	11
Fusarium wilt	I2	I2OH	83	59	15	30	1
Root knot nematode	Mi-1	Mi-23	0	33	1	0	1
Late blight	Ph2	UF-Ph2-1	15	1	0	1	0
Late blight	Ph3	Gsm1	19	2	2	0	0
Tomato yellow leaf curl virus	TY1/3	TY1/3	1	75	8	3	11
Tomato yellow leaf curl virus	TY2	P1-16	1	35	44	34	5
Tobacco osaic virus	Tm2	NCTm-019	1	27	41	33	2
Bacterial wilt	BWr12	SLM12-10	13	3	0	0	0
Bacterial wilt	BWr12	SLM12-2	66	4	2	1	0
			159	84	46	36	11





Tomato Evaluation

65 accessions from TAsVI

- 54 traits:
 - 5- Seedlings traits
 - 9 – Plant traits
 - 10 – Inflorescen traits
 - 30 – Fruit traits
- DNA marker data from Genesys system
 - Bacterial wilt
 - Fusarium wilt
 - Late blight
 - Tomato Mosaic Virus
 - Tomato Spotted Wilt Virus
 - Tomato Yellow Leaf Curl Virus



Next steps

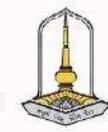
- Implement the Africa Vegetable Biodiversity Rescue Plan → Requires 12.5M USD annually for 10 years.
- Expand towards a Global Vegetable Biodiversity Rescue Plan → Requires 25M USD annually for 10 years.
- Engage with a larger community to make this a reality and secure the base for nutritious food.



TVRC partners



APSA



BIOTEC
a member of NSTDA

NSTDA



CORNELL
UNIVERSITY



Griffith
UNIVERSITY
Queensland, Australia



agresearch
āta mātai, mātai whetū



International Treaty
on Plant Genetic Resources
for Food and Agriculture



Royal Botanic Gardens
Kew



CROP
TRUST



Queensland
Government

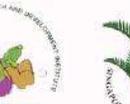
Margot Forde
Genebank
from AgResearch



WAGENINGEN
UNIVERSITY & RESEARCH



SANN
INTERNATIONAL COLLEGE
STRIVING FOR EXCELLENCE



Future Directions and Innovation

1. The future of germplasm conservation
2. Role of AI, big data, and machine learning in analyzing genetic diversity and climate patterns
3. Building resilient food systems: What the next 20 years may look like?

Take home message

- Crop diversity, conservation is everyone's responsibility
- Collaboration is a key to success but how to build it?
- Need for climate-adaptive breeding and crop protection
- Final thoughts on the critical role of the seed technology community in ensuring food security for future generations

Acknowledgement

