Scaling-up Biofortification to 30 Countries:

The Impossible Science of Country Prioritization

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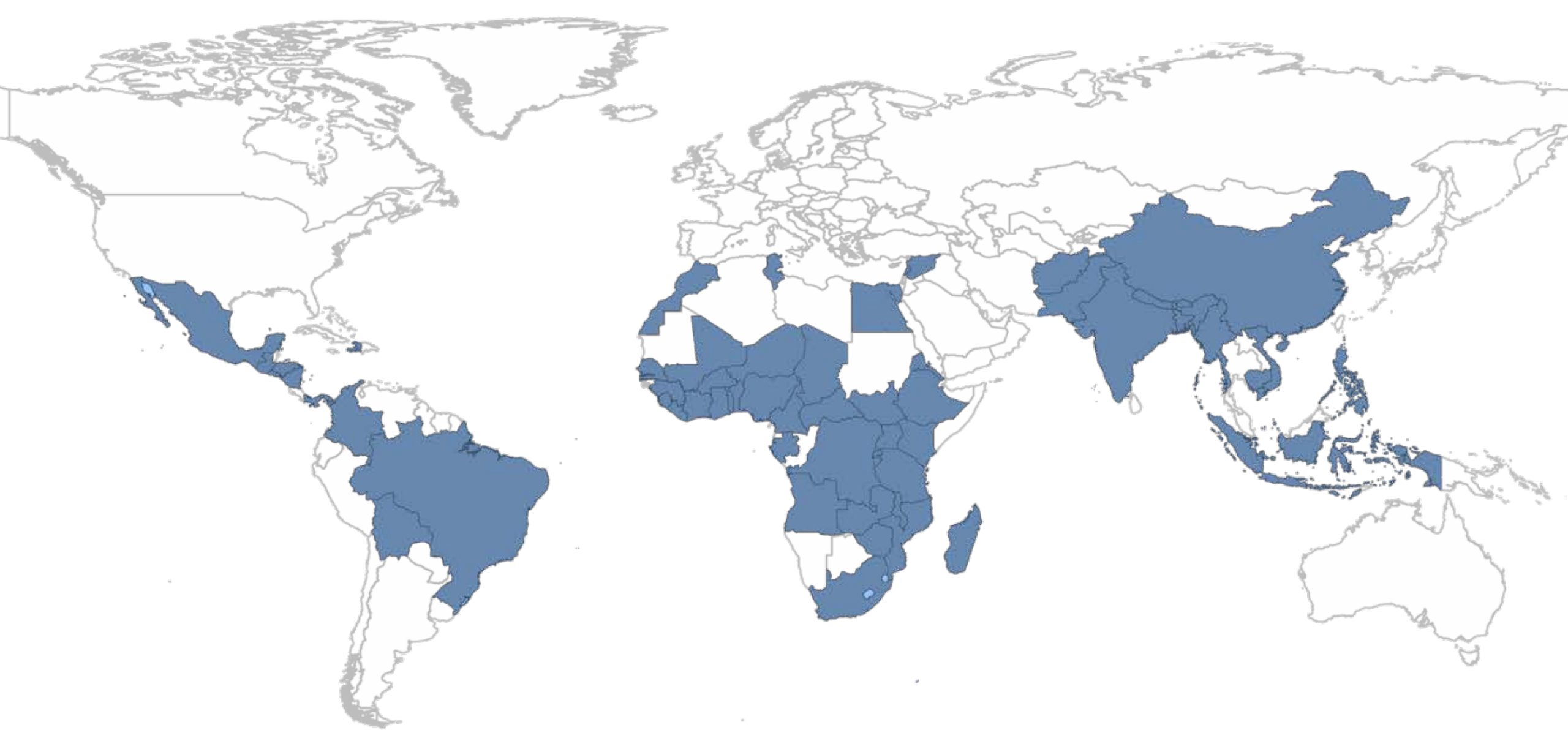
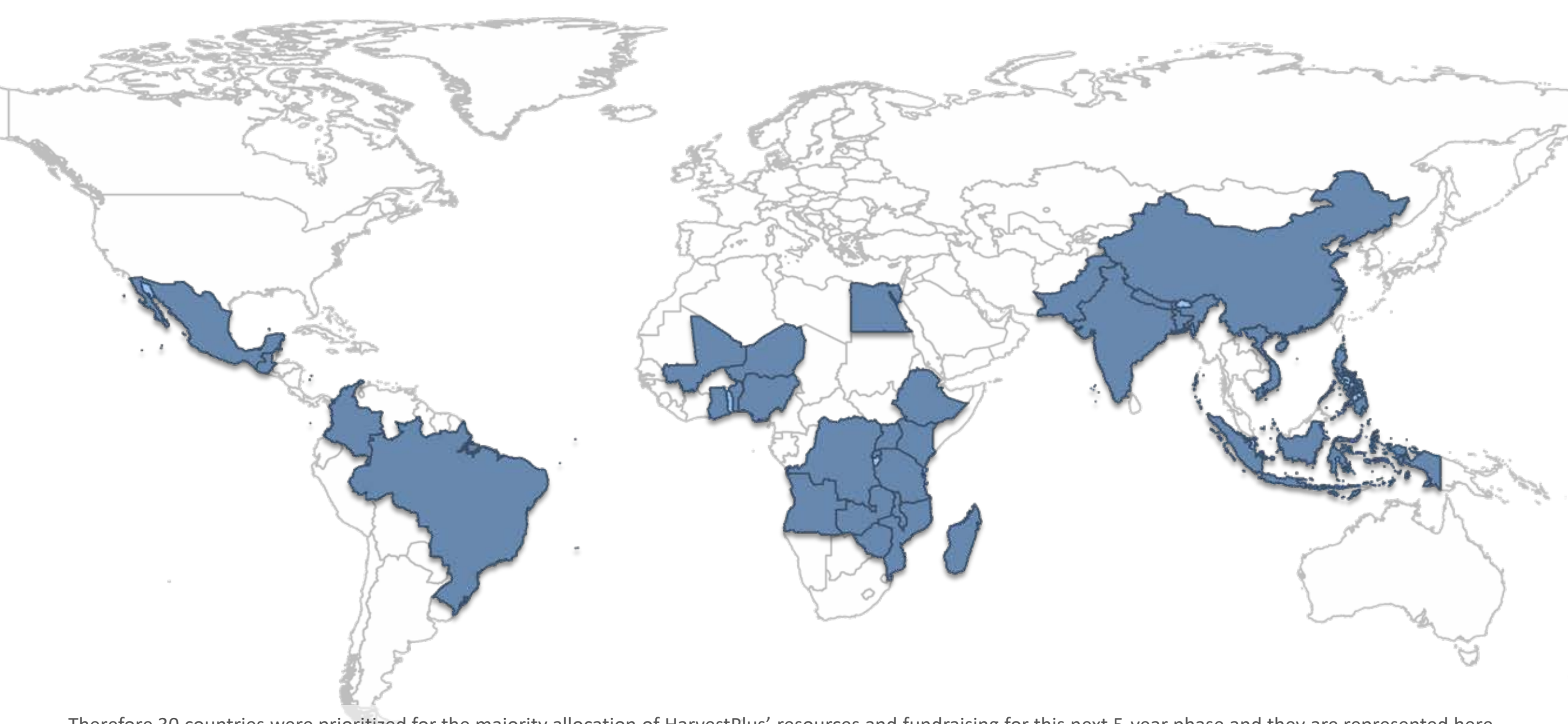
Better Crops • Better Nutrition

CGIAR RESEARCH PROGRAM ON Agriculture for Nutrition and Health

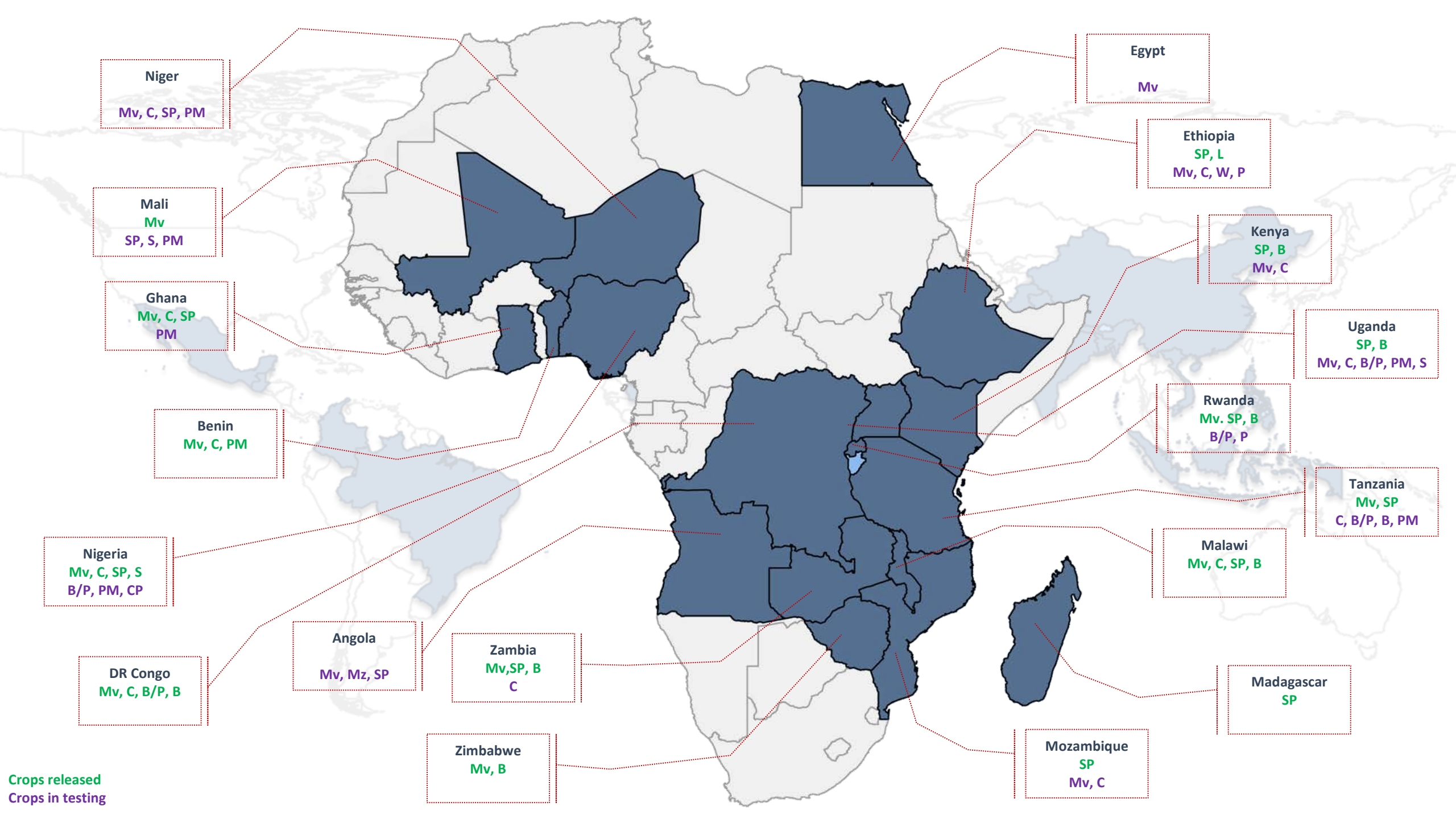
LED BY IFPRI

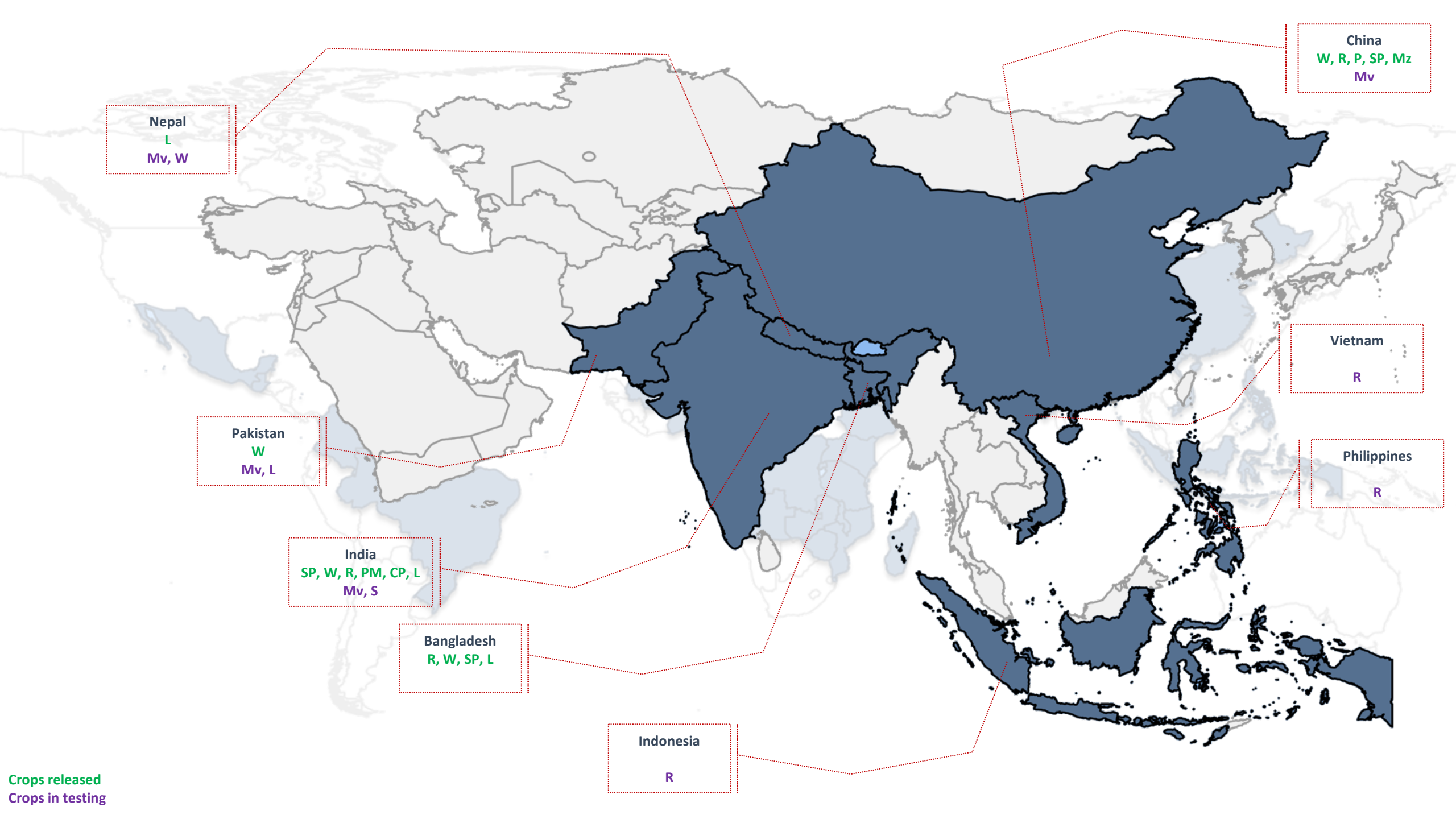


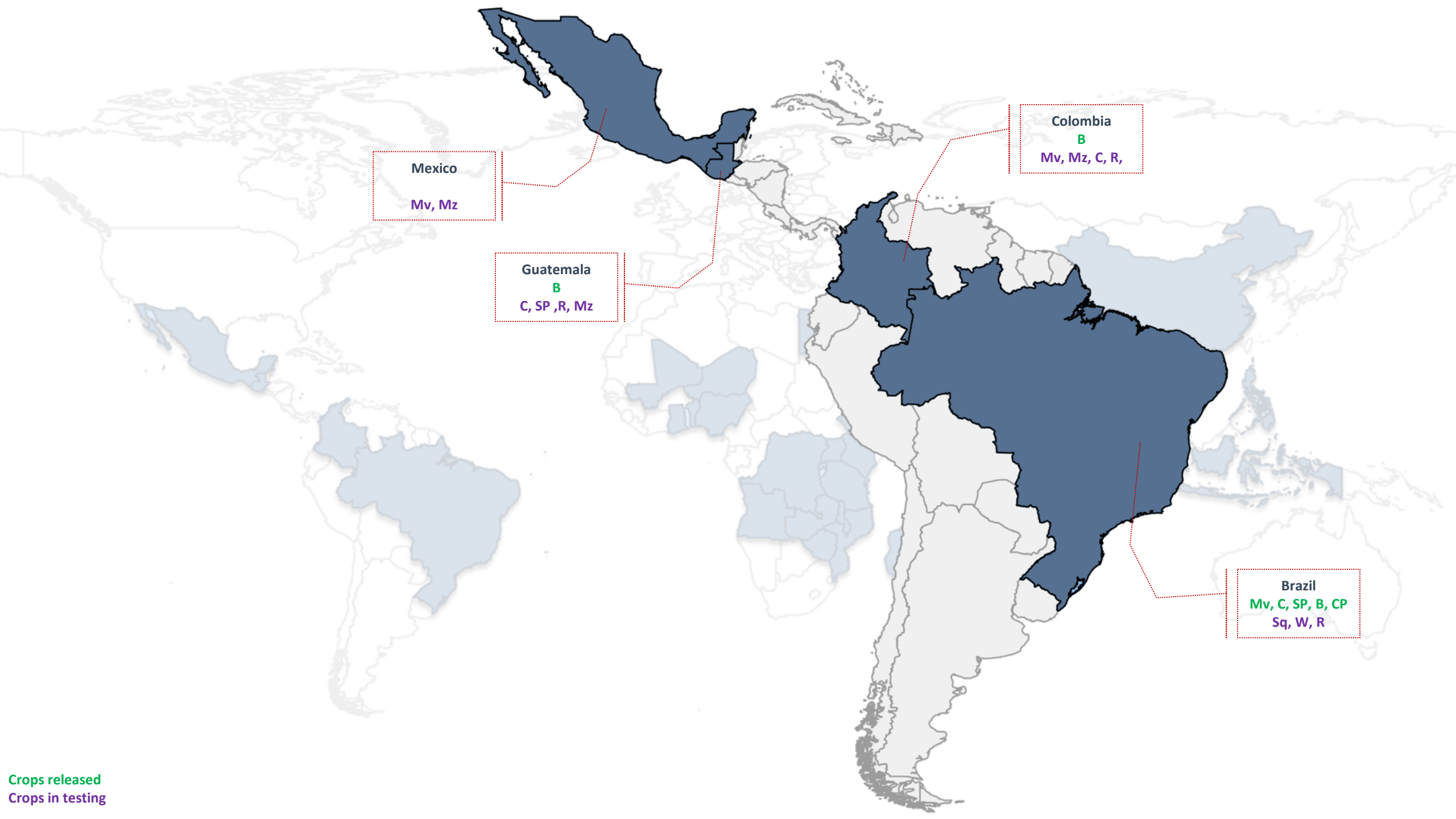
- Roughly 60 countries currently have biofortified crops in the pipeline, in testing, or that have already been released
- H+ is now moving from 8 priority countries to a larger set of focus countries to scale its activities
- However, to successfully scale biofortification activities it was decided that a tradeoff is required and that H+ cannot focus immediately in all 60 countries (and counting).
- HarvestPlus must focus its resources and work with countries in a phased approach, specifically as the number of countries investing in biofortification grows



- Therefore 30 countries were prioritized for the majority allocation of HarvestPlus' resources and fundraising for this next 5-year phase and they are represented here
- In Africa we are focusing on 18 countries; the dominant crops are maize, cassava, and sweet potato; additionally pearl millet is important in West Africa, and additionally crops like beans and banana are important in South/Eastern Africa
- In Asia we are focusing on 8 countries- rice and wheat are the dominant crops with the greatest emphasis on zinc deficiency; vitamin A /iron deficiencies also important
- In LAC we are focusing on 4 countries- maize, rice and beans are the dominant crops and in areas with large agroecological variation such as in Brazil, there is potential to address MN-deficiency with many different biofortified crops


Niger
Mv, C, SP, PM
Mali
Mv
SP, S, PM
Ghana
Mv, C, SP
PM
Benin
Mv, C, PM
Nigeria
Mv, C, SP, S
B/P, PM, CP
DR Congo
Mv, C, B/P, B
Angola
Mv, Mz, SP
Zambia
Mv,SP, B
C
Zimbabwe
Mv, B
Egypt
Mv
Ethiopia
SP, L
Mv, C, W, P
Kenya
SP, B
Mv, C
Uganda
SP, B
Mv, C, B/P, PM, S
Rwanda
Mv. SP, B
B/P, P
Tanzania
Mv, SP
C, B/P, B, PM
Malawi
Mv, C, SP, B
Madagascar
SP
Mozambique
SP
Mv, C
Crops released
Crops in testing


China
W, R, P, SP, Mz
Mv
Nepal
L
Mv, W
Vietnam
R
Pakistan
W
Mv, L
Philippines
R
India
SP, W, R, PM, CP, L
Mv, S
Bangladesh
R, W, SP, L
Indonesia
R
Crops released
Crops in testing



Crops released
Crops in testing

- For non-prioritized countries: HarvestPlus is currently overseeing and/or funding testing of biofortified varieties for eventual release and will continue to do so
- HarvestPlus is committed to setting aside 10% of its operational budget for those countries that are not on the list but may realize significant benefit from the introduction/scaling up of biofortification
- HarvestPlus is ready and willing to provide technical assistance/know how/manuals/guidelines to the UN system, international CSOs and financial institutions (e.g., WFP, World Vision, World Bank and the African Development Bank) for them to introduce and scale up biofortification in all countries

Overview of Prioritization Process

- Development, feedback, revision
  - Process began with the development of initial criteria by the Leadership team
  - Criteria include, where HarvestPlus already has some level of the following: operations, partnerships, varieties tested and/or released, demand from the government, easy transferability of varieties, planting material, and delivery infrastructure. These are in addition to high MN need and conditions for cost-effectiveness
  - Leadership Team then gathered feedback from other team members including PAC members and other collaborators
  - Revised some of the methods and criteria employed
  - Role of the Strategy and Policy Research Unit in prioritization: produce and/or apply a number of metrics that will inform the final decision-making process by the Leadership Team
  - Develop systematic process applying a set of revised tools (indices) and additional criteria
- Apply revised tools/criteria
  - > **Biofortification Priority Index (BPI)**
  - > **Multicrop Index (MCI)**
  - > **Hunger and Nutrition Commitment Index (HANCI)***
  - > **Crop readiness**
- Final decision by Leadership

*Developed by the Institute of Development Studies, UK

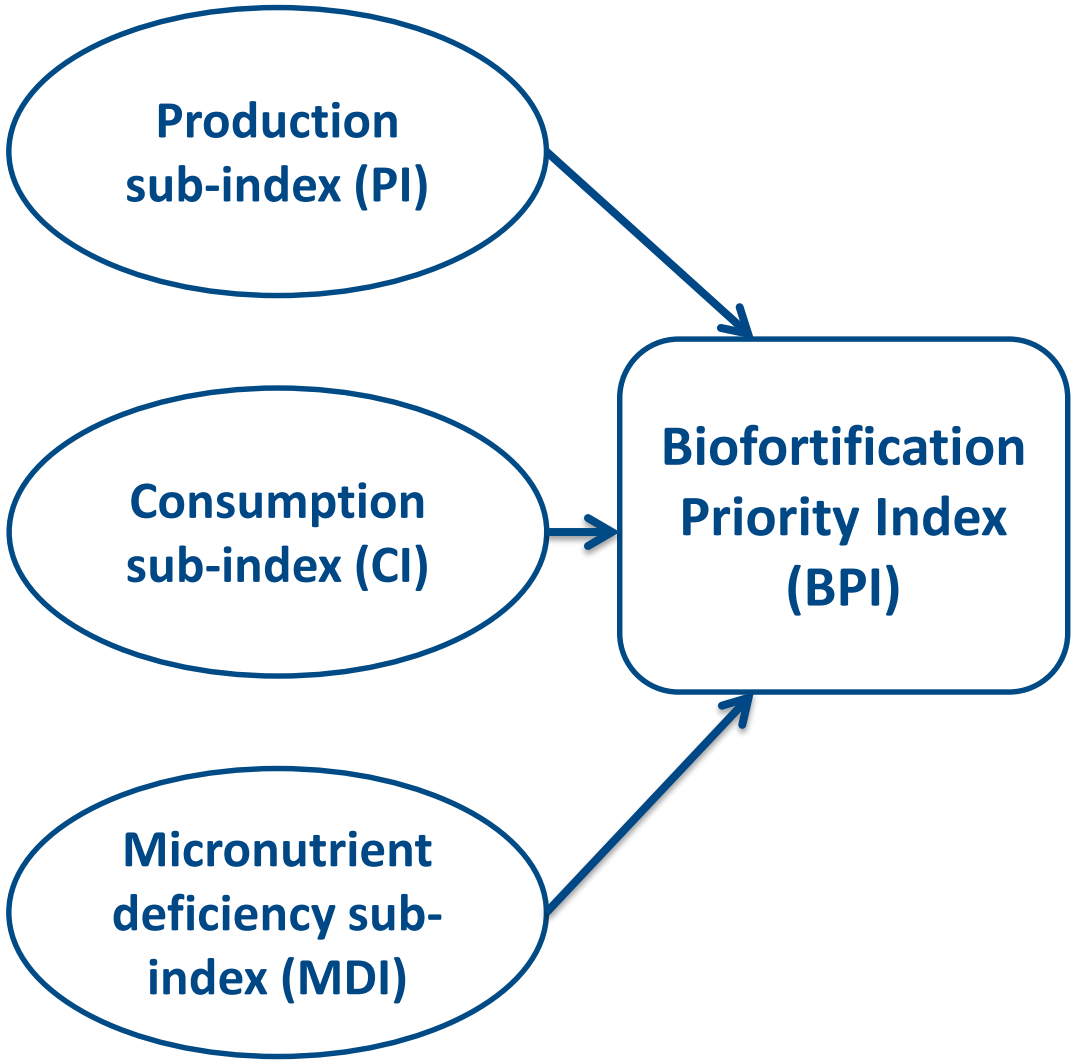
Objective of Index application

To utilize a set of **indexes to identify countries** with high potential to **address** significant micronutrient **intake gaps** within country through **domestic production** of biofortified crops (targeted delivery) and that also exhibit **favorable conditions for implementation**

BIOFORTIFICATION PRIORITY INDEX

Conditions for biofortification investments

1. Produce the biofortifiable crop
2. Consume much of the biofortifiable crop on a per capita basis
3. Have a high level of micronutrient deficiency



Production sub-index (PI)

Measures the intensity of biofortifiable crop production

- Variables:
  - Per capita area harvested (m^2/capita)
  - Share of cultivated land area allocated to crop (%)
  - Export share (%)
- Country level data from FAO

Production Sub-index =

[1 – export share] x
[(0.5 x per capita area harvested) +
(0.5 x % land area allocated to crop)]

Consumption sub-index (CI)

Measures the magnitude of per-capita consumption of biofortifiable crop which is supplied by domestic production

- Variables:
  - Consumption per capita (kg/cap/year)
  - Import share (%)
- Country level data from FAO

Consumption Sub-index =

Consumption per capita x (1-Import Share*)

***Import share = Imports/(Production + Imports - Exports)**

Vitamin A deficiency sub-index

Describes the extent of Vitamin A deficiency

- Variables:
  - Proportion of preschool-age children with serum retinol less than 0.7µmol/l
  - Age-standardized DALYs per 100,000 inhabitants by VAD
- Country level data from WHO

Vitamin A Deficiency Sub-index =

(0.5 x Prop children with retinol < 0.70 umol/l)

+

(0.5 x Age-standardized DALYs)

Iron deficiency sub-index

Describes the extent of Iron deficiency

- Variables:
  - Proportion of preschool-age children with Hb < 110 g/dl
  - Age-standardized DALYs per 100,000 inhabitants by IDA
- Country level data from WHO

Iron Deficiency Sub-index =

(0.5 x Prop children with Hb < 110 g/l)

+

(0.5 x Age-standardized DALYs)

Zinc deficiency sub-index

Describes the extent of Zinc deficiency

- Variables:
  - Percentage of population at risk of inadequate zinc intake
  - Prevalence of stunting among children 6-59 months (%)
- Country level data from iZinc and WHO

Zinc Deficiency Sub-index =

(0.5 x % population at risk of inadequate zinc intake)

+

(0.5 x Prevalence of stunting)

Biofortification Priority Index (BPI)

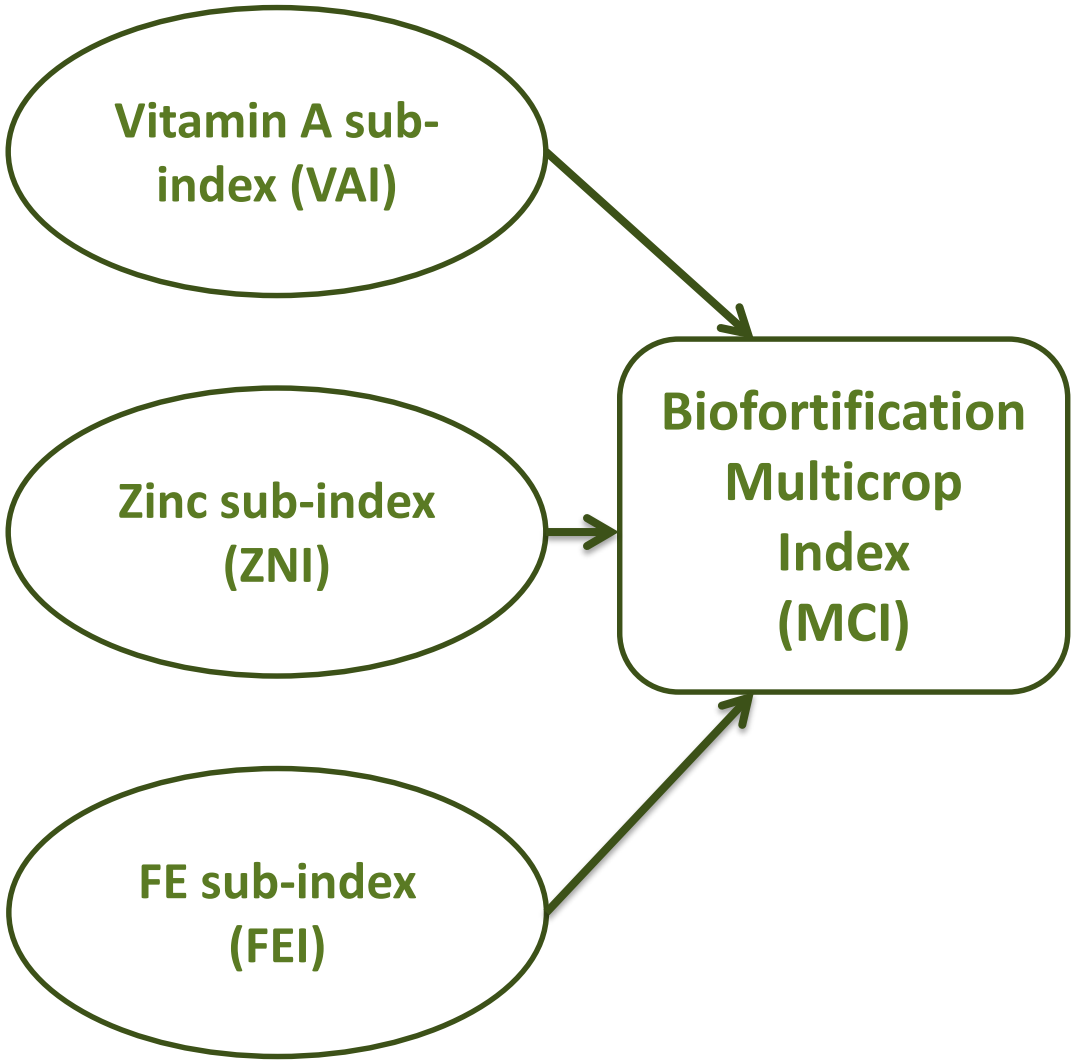
$$\text{BPI Score} = \sqrt{\left(\sqrt{\text{PI} \times \text{CI}}\right) \times \text{MDI}}$$

BPI: http://www.harvestplus.org/knowledge-market/BPI

BIOFORTIFICATION MULTICROP INDEX

Conditions for biofortification investments

1. Consume VA biofortifiable crops/have high level of VA deficiency
2. Consume ZN biofortifiable crops/have high level of ZN deficiency
3. Consume FE biofortifiable crops/have high level of FE deficiency



Vitamin A sub-index (VAI)

Describes the potential to address VAD through per-capita consumption of domestically produced biofortifiable crops

- Variables:
  - NVAD: Net per capita VA from all biofortifiable VA crops
  - VAD1: Proportion of PSAC with serum retinol < 0.7µmol/l
  - VAD2: Proportion of preg wmn with serum retinol <0.70 µmol/l)
- Country level data from FAO and WHO

$$\text{Vitamin A Sub-index} = \sqrt{\left(\text{NVAD} * \sqrt{(\text{VAD1} * \text{VAD2})}\right)}$$

Zinc sub-index (ZNI)

Describes the potential to address ZND through per-capita consumption of domestically produced biofortifiable crops

- Variables:
  - NZND: Net per capita ZN from all biofortifiable ZN crops
  - ZND: Prevalence of stunting among children 6-59 months (%)
- Country level data from FAO, World Bank and WHO

$$\text{Zinc Sub-index} = \sqrt{(\text{NZND} * \text{ZND})}$$

Iron sub-index (FEI)

Describes the potential to address ID through per-capita consumption of domestically produced biofortifiable crops

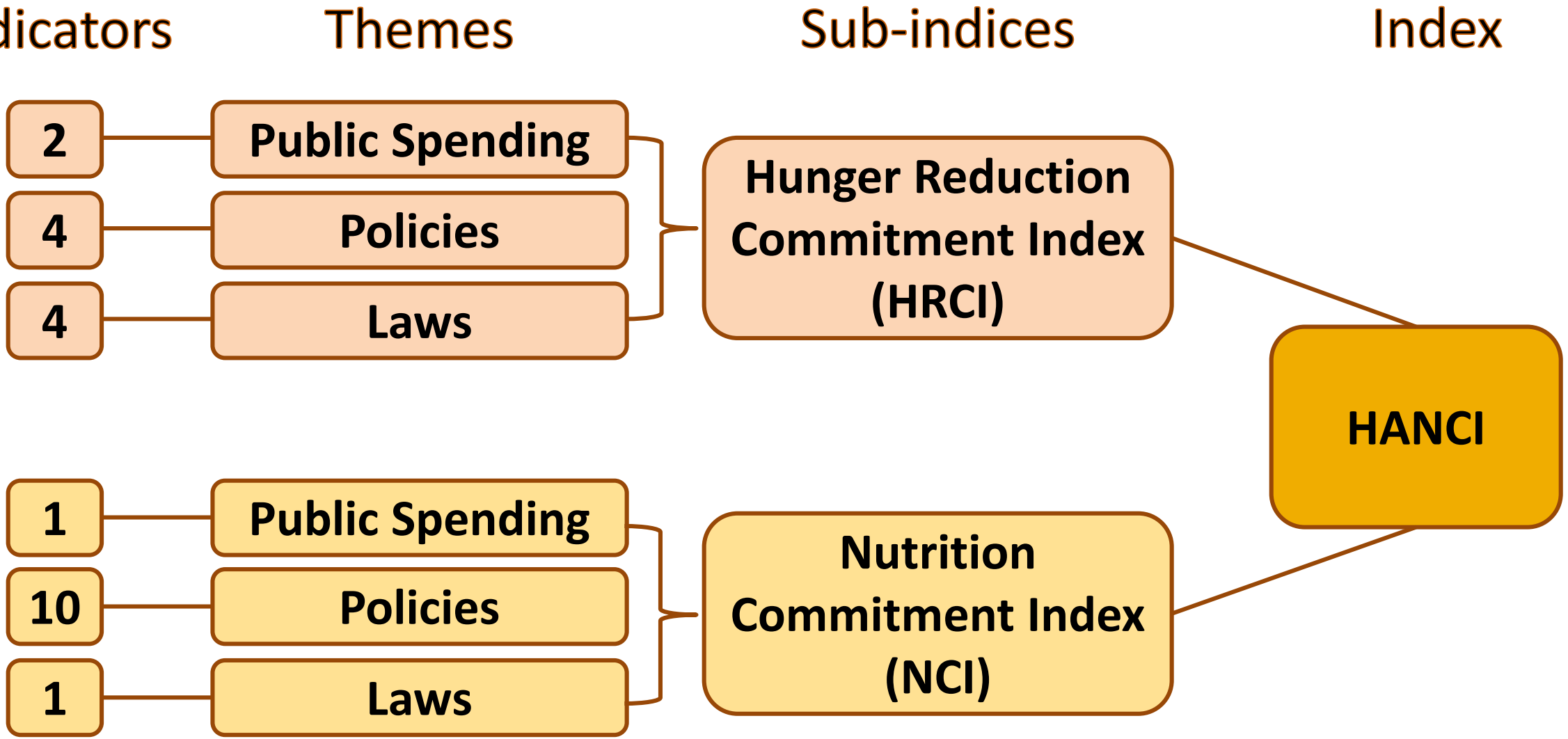
- Variables:
  - NFED: Net per capita FE from all biofortifiable FE crops
  - FED1: Proportion of preschool-age children with Hb < 110 g/dl
  - FED2: Proportion of non-preg wmn with Hb < 110 g/dl
- Country level data from FAO, World Bank and WHO

$$\text{Iron Sub-index} = \sqrt{\left(\text{NFED} * \sqrt{(\text{FED1} * \text{FED2})}\right)}$$

Biofortification Multicrop Index (MCI)

$$\text{MCI Score} = \frac{(\text{VAI}+\text{ZNI}+\text{FEI})}{3}$$

HANCI



HANCI: http://www.hancindex.org/

Crop Readiness

— Rank sorting based on number of crops released or in testing

> Number of primary crops in release

> Number of secondary crops in release

> Number of primary crops in testing

> Number of secondary crops in testing

Population weighting

— To provide a score with equal weighting of the index and population:

> The population of countries were rescaled

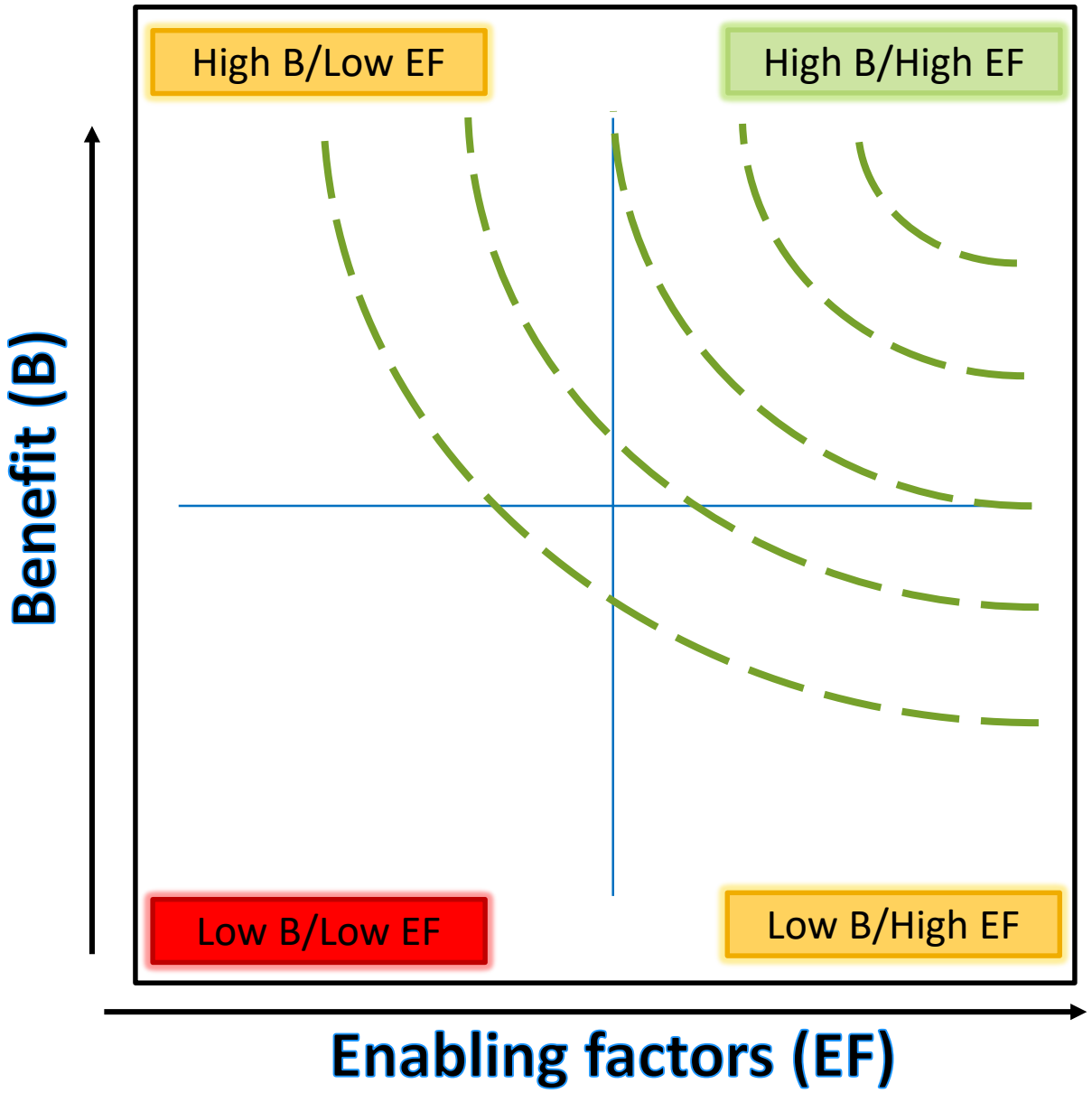
- Called PI and ranges between 0 and 100

> Weighed index was calculated as:

- $Index_{weighted} = (MCI + PI)/2$

Schematic for GAIN/PAIN scoring

- This is a schematic of the grid system we used to plot country values.
- It was based on countries' overall benefit ("gain")- as estimated using the BPI and MCI- which was plotted on the y-axis; and based on the enabling factors for implementation ("pain")- as estimated using the HANCI index and the crop readiness- which were plotted on the x-axis.
- The upper right quadrant represented both high benefit and high enabling factors and therefore the most prioritized; once plotted, countries were flagged using a sweeping fashion as shown.



Methodology: application of index

1. Estimate the **benefit**
   - First we estimated the benefit: we evaluated countries based on a composite of single-crop BPIs and re-ranked them by taking the top countries for each single crop BPI for each of 7 priority crops (rice, wheat, maize, cassava, sweet potato, beans, pearl millet); from that list, we combined their BPI values across all crops and re-ranked them
2. Estimate the **enabling factors**
   - Next, we estimated the enabling factors by creating a composite of crop readiness and HANCI. Using the HANCI and Crop readiness rankings, we normalized these values between 0 and 100, added their ranks and rescaled them between 0 and 100.
3. Plot on **4-quadrant grid**
   - Plotted on 4-quadrant grid to identify top candidates and flagged these
4. Conduct **sensitivity analyses**
   - We then conducted additional scorings (sensitivity analyses) of the benefit based on MCI and population weighting. Using the MCI values we plotted countries under 3 different conditions based 1) only on considering the 7 primary crops; 2) on all potential biofortifiable crops (12); and 3) based only on crops in testing and release;
   - This gave us 4 different sets of scorings, all without weighting for population differences. To take population into account, we weighted all benefit indices by the population index and recalculated an additional set of 4 grids for a total of 8.
5. **Flag countries** for review
   - Using these results, we flagged countries that appeared in the top 25 of each grid and the number of conditions that they appeared under.
6. Apply additional **intangible criteria**
   - We compared these results to our initial lists to consider any countries that were not initially included
7. Present to **Leadership Team**
   - They were evaluated based on additional criteria and presented to Leadership Team for the final decisions/selections

Limitations

— There is no perfect index

— Important drawbacks to using MCI alone

> No account of costs

> Probability of delivery success

> Number of crops introduced

— BPI and MCI do not account for within country variation

— Additional criteria need to be taken into account

Additional Criteria

— Existing operations

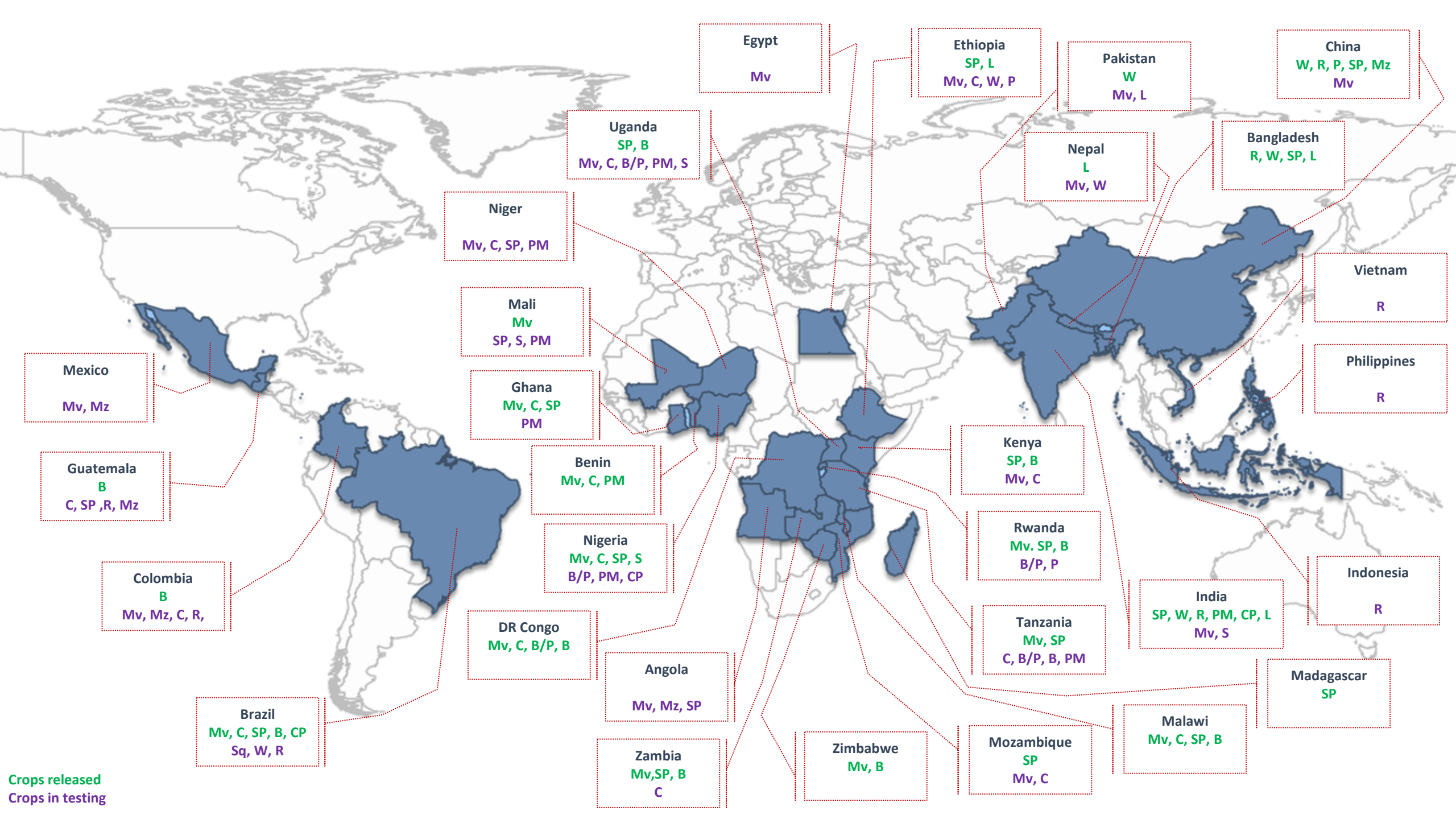
— Partnerships

— Varietal pipeline/planting material

— Demand from the government

— Regional importance

— Delivery infrastructure


Egypt
Mv
Ethiopia
SP, L
Mv, C, W, P
Pakistan
W
Mv, L
China
W, R, P, SP, Mz
Mv
Uganda
SP, B
Mv, C, B/P, PM, S
Nepal
L
Mv, W
Bangladesh
R, W, SP, L
Niger
Mv, C, SP, PM
Vietnam
R
Mali
Mv
SP, S, PM
Mexico
Mv, Mz
Philippines
R
Ghana
Mv, C, SP
PM
Kenya
SP, B
Mv, C
Guatemala
B
C, SP ,R, Mz
Benin
Mv, C, PM
Rwanda
Mv. SP, B
B/P, P
Nigeria
Mv, C, SP, S
B/P, PM, CP
Indonesia
R
Colombia
B
Mv, Mz, C, R,
India
SP, W, R, PM, CP, L
Mv, S
Tanzania
Mv, SP
C, B/P, B, PM
DR Congo
Mv, C, B/P, B
Madagascar
SP
Angola
Mv, Mz, SP
Malawi
Mv, C, SP, B
Brazil
Mv, C, SP, B, CP
Sq, W, R
Zambia
Mv,SP, B
C
Zimbabwe
Mv, B
Mozambique
SP
Mv, C
Crops released
Crops in testing

Why isn’t country X on the list?

- There isn’t one obvious staple crop that can generate significant domestic impact if biofortified
- There are no suitable biofortified varieties that can be released in the next 5 years
- The country is too difficult to operate in due to natural or political reasons
- It is almost impossible to find funding to operate in the country

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