MERCY CORPS | AGRIFIN

DCSA: TOTAL ADDRESSABLE MARKET

November 2022

BILL & MELINDA GATES foundation

Context: ADF2 support for DCSA solutions will be informed through an assessment undertaken for priority countries

Assessment

For ADF2 priority countries of Nigeria, Ethiopia and Kenya:

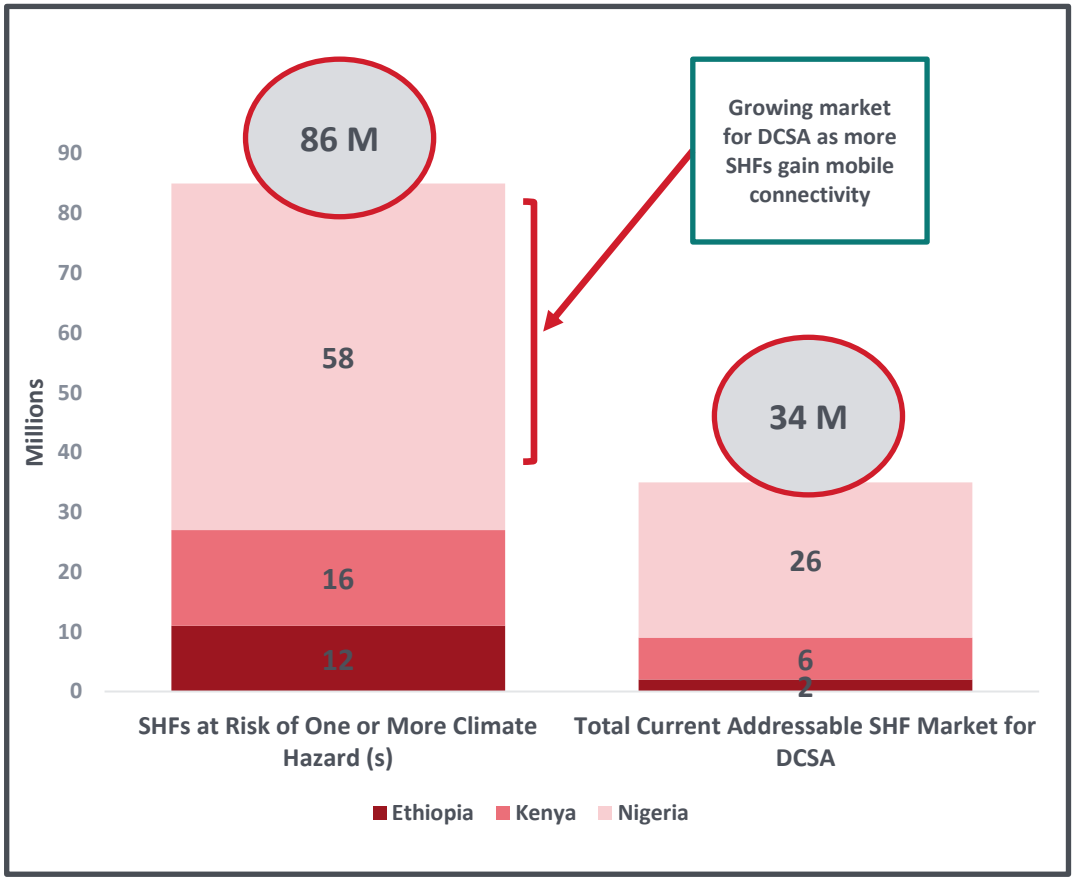
1. **What is the TAM (total addressable market) for DCSA in the three countries?** *Climate vulnerability + ability to adopt a digital solution*
2. **Which crops/livestock are most vulnerable to climate impacts? Which crops/livestock are projected to increase or decrease in suitability under climate change?**
3. **Which DCSA solutions are most relevant for SHFs of different crops/livestock under different climate hazards?**

Resources

1. Modelling for climate hazards and crop suitability by the **Alliance of Bioversity and CIAT**. Future scenario created based on an ensemble of 5 CMIP5 GCMs at 2050 (RCP 8.5) compared with the *current time period. Crop suitability based on the Ecocrop model.* *https://cgspace.cgiar.org/handle/10568/113289. Hazard layers modeled based on* https://cgspace.cgiar.org/handle/10568/115166.
2. TAM calculation by **AgThrive** based on # of SHFs facing climate hazards x rural mobile penetration. *Rural mobile penetration estimated using GSMA methodology (urban penetration is 1.3 x rural penetration)*.

MERCY CORPS

Total Addressable Market for DCSA: Ethiopia, Kenya and Nigeria



*Climate hazards: climate variability, drought, flood, dry conditions, thermal stress
**SHFs who need and can use DCSA calculated as # of SHFs at risk of climate hazards x rural mobile penetration

Total Addressable Market for DCSA services in Ethiopia, Kenya and Nigeria **= 34 M SHFs**

Opportunities for DCSA are **larger** in **Kenya and Nigeria** due to climate hazards + higher mobile usage among farmers.

The **TAM for DCSA will grow as mobile connectivity for SHFs grows.** The number of SHFs facing climate hazards far exceeds the number who can currently access digital solutions.

Sources: AgThrive analysis; Alliance of Bioversity and CIAT analysis. Hazard layers modeled by Alliance Bioversity-CIAT scientists using this methodology: https://cgspace.cgiar.org/handle/10568/115166

MERCY CORPS

Top Climate Hazards: Ethiopia, Kenya and Nigeria

Top 5 Climate Hazards	SHFs at Risk Millions (% of SHFs)		
	Ethiopia	Kenya	Nigeria
Climate variability	4 (7)	10 (54)	0.2 (0.3)
Drought	4 (7)	8 (41)	0 (0)
Dry conditions	5 (9)	6 (30)	4 (8)
Thermal stress	4 (8)	5 (25)	58 (100)
Flood	1 (2)	2 (13)	2 (4)

- **100% of SHFs** in **Nigeria** have experienced **thermal stress** and are likely to experience it in the future
- **Climate variability** impacts **over half of SHFs in Kenya;** most farmers experience this as increasing frequency of drought and dry conditions
- **SHFs in Ethiopia face a range of climate hazards**

Sources: AgThrive analysis; Alliance of Bioversity and CIAT analysis. Hazard layers modeled by Alliance Bioversity-CIAT scientists using this methodology: https://cgspace.cgiar.org/handle/10568/115166

MERCY CORPS

Kenya: Majority of SHFs face climate hazards with variability affecting the most people

Top 5 Climate Hazards	SHFs at Risk (millions)
Climate variability	10
Drought	8
Dry conditions	6
Thermal stress	5
Flood	2

More than half of SHFs face climate variability mostly in the form of increasing but unpredictable drought and dry conditions.

15 M SHFs have experienced and will continue to face two or more climate hazards.

What does this mean for SHFs?

A **majority of farmers** in Kenya are **at risk of climate variability**. Farmers may experience variable onset and poor distribution of rains making it difficult to plan and execute a successful growing season, especially in rainfed systems. Climate variability also means more frequent extreme events such as drought and flooding.

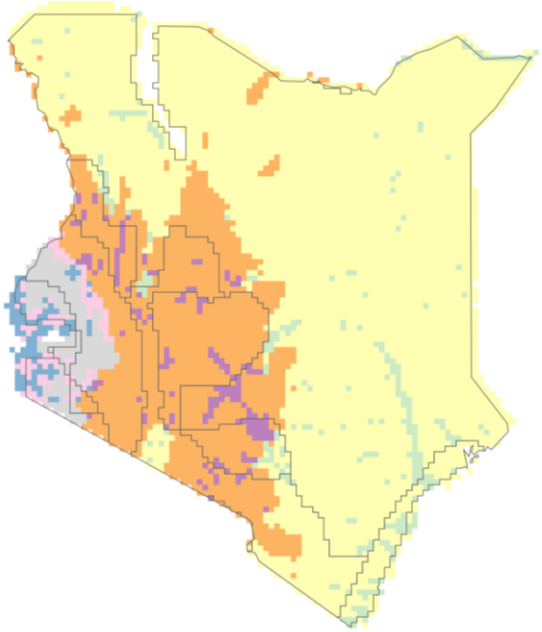
For most farmers, climate variability will lead to **increased risk of drought**, reducing yields, leading to crop loss and shifting the suitability of crops for different cropping systems.

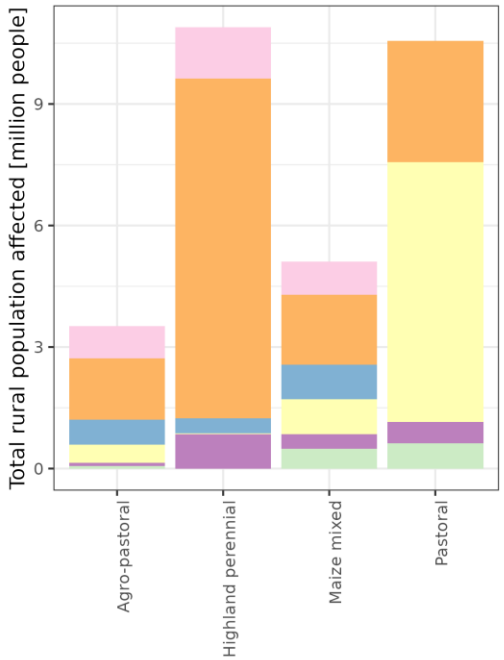
For some farmers, climate variability will mean **increased flooding episodes**, destroying crops and exacerbating soil erosion.

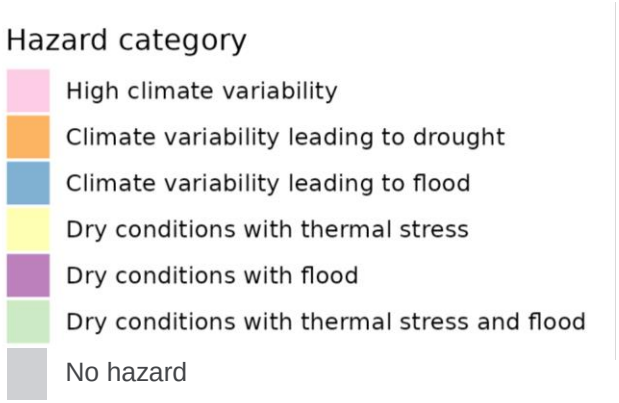
Many farmers not experiencing drought will contend with **increasingly dry conditions and thermal stress**, causing water and heat stress for crops and livestock, reducing productivity and at times leading to complete crop failure and high morbidity for livestock.

Kenya: Production system risks

Production System Risks

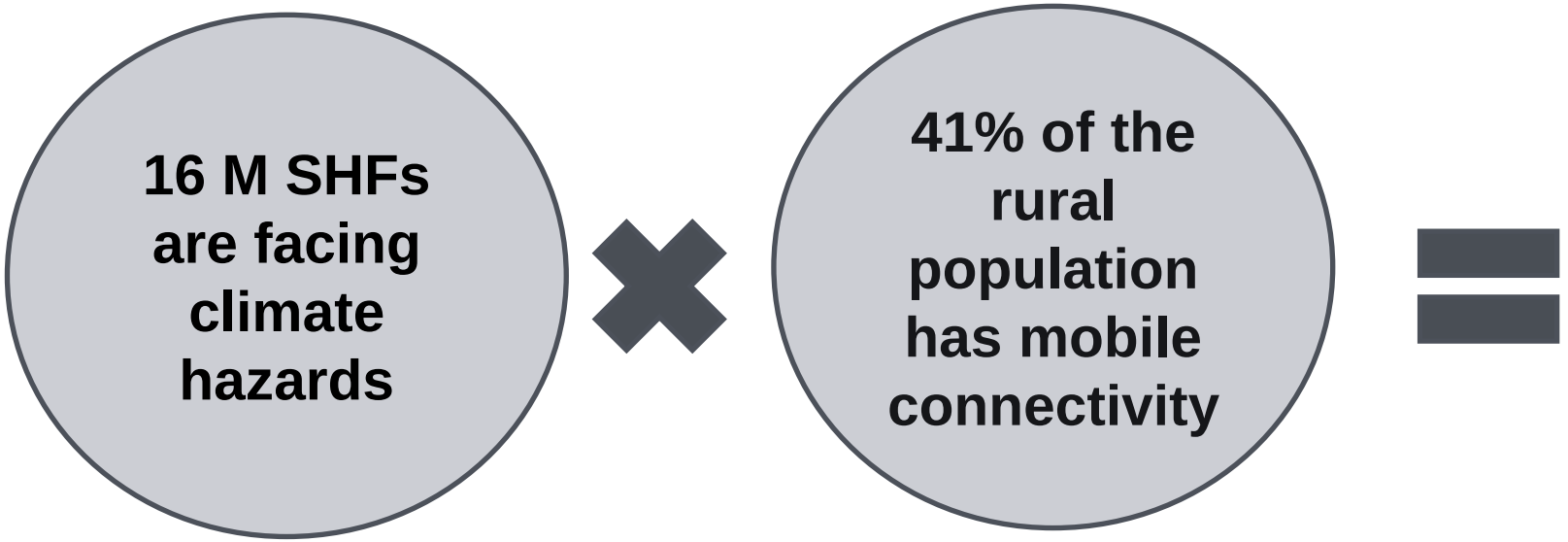






Production System	SHFs at risk	Main Climate Hazard(s)	Impact for Farmers
Highland perennial	**6 M**	**Climate variability leading to drought**	Difficult to manage growing season with unpredictable onset and poor distribution of rains. Crop failure and livestock mortality in drought episodes. Shifting crop and variety suitability. Primary perennial crop may fail.
Pastoral	**6 M**	**Dry conditions with thermal stress**; climate variability leading to drought	Decreased availability of feed and water for livestock; more time and distance covered to find resources. Heat stress for animals leading to low output. High morbidity/mortality of animals. Low prices.
Maize mixed	**3 M**	**Climate variability leading to drought**; high variability, variability leading to flooding, dry conditions + thermal stress	Difficult to manage growing season with unpredictable onset and poor distribution of rains. Crop failure and livestock mortality in drought episodes. Shifting crop and variety suitability. Food crops may fail.
Agro-pastoral	**2 M**	**Climate variability leading to drought**; high variability	Difficult to manage growing season with unpredictable onset and poor distribution of rains. Decreased yields. Shifting crop and variety suitability. Decreased availability of feed and water for livestock; high livestock morbidity/mortality.

Kenya: Total Addressable Market for DCSA



6.6 M SHFs in Kenya need and have the ability to utilize DCSA

More than 9 M SHFs facing climate hazards cannot access DCSA; as mobile connectivity and digital literacy grow the TAM will increase

Sources: AgThrive analysis; Alliance of Bioversity and CIAT analysis. Hazard layers modeled by Alliance Bioversity-CIAT scientists using this methodology: https://cgspace.cgiar.org/handle/10568/115166

Kenya: Value Chain Opportunities for DCSA

Analysis of Importance of Value Chains x Level of Climate Change Risks and Opportunities

*Identified as national priorities through CSA Country Profile development https://ccafs.cgiar.org/resources/publications/climate-smart-agriculture-kenya

** Climate risk: Amount of decrease (ha) in future suitability of area where crop is currently grown (Ecocrop model)

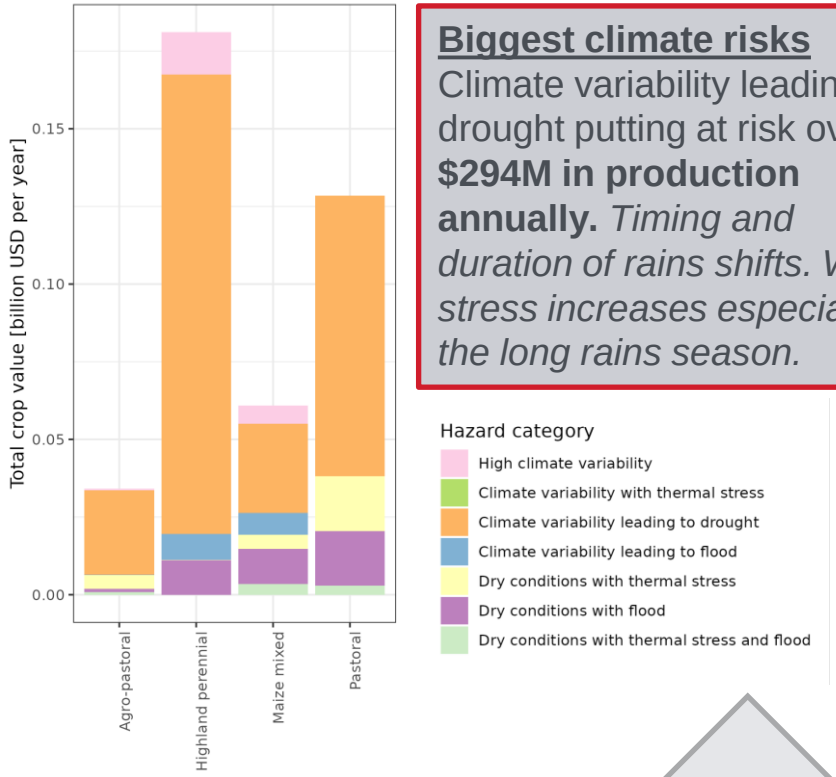
*** Climate Opportunity: Amount of increase (ha) in suitability of crop land for producing this crop (Ecocrop model)

Sources: AgThrive analysis; FAO Stat (11/2022);; Alliance of Bioversity-CIAT analysis using Ecocrop

MERCY CORPS

Kenya Example 1: DCSA Opportunities Beans x Climate Hazards

Beans



Biggest climate risks

Climate variability leading to drought putting at risk over **$294M in production annually.** *Timing and duration of rains shifts. Water stress increases especially in the long rains season.*

Future Change in Land Suitability (2050)

-- **Risk: 56% of current bean cropland will decline in suitability for bean production.** *Farmers currently growing beans in some areas need support to diversify to other crops.*

\+ **Opportunity: 5.7 M ha of crop land will increase in suitability for bean production.** *Farmers in newly suitable areas can start bean production.*

DCSA Solutions

+Weather forecasting and advisory for cropping timeline and climate smart practices +Early drought warning +Bundled advisory, credit, insurance and input access for adapted varietals and practices +Bundled advisory, credit and input and market access for new bean producers

57% of current bean cropland will **decrease in suitability**

5.7 M ha become more **suitable for bean production** creating opportunities for expanding where beans are grown

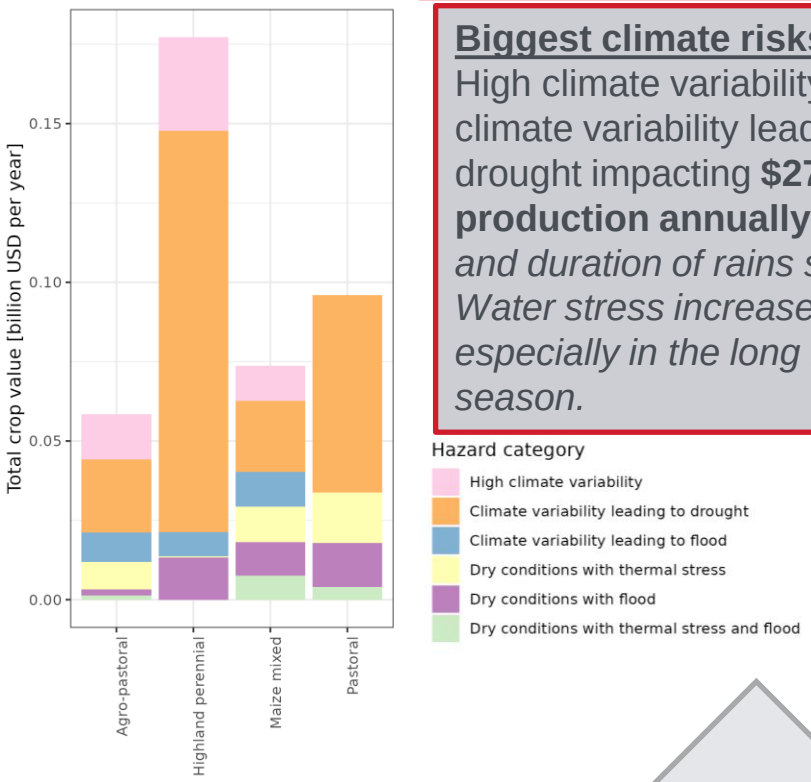
Number of bean farmers who could benefit from and utilize DCSA:

675,000 SHF HHs

MERCY CORPS

Kenya Example 2: DCSA Opportunities Maize x Climate Hazards

Beans



Biggest climate risks

High climate variability + climate variability leading to drought impacting **$278M in production annually**. *Timing and duration of rains shifts. Water stress increases especially in the long rains season.*

Future Change in Land Suitability (2050)

-- **Risk: Almost 12% of current maize cropland will become less suitable.** *Many maize farmers can continue producing maize with CSA practices.*

\+ **Opportunity: Over 3.5 M ha of crop land will increase in suitability for maize production.** *Some areas may become more promising for maize production.*

DCSA Solutions

+Weather forecasting and advisory for cropping timeline and climate smart practices **+**Early drought warning **+**Bundled advisory, credit and input access for drought and thermo tolerant varietals and practices **+**Bundled advisory, credit, insurance, input and market access for diversification including irrigation for high value crops

12% of current maize cropland will **decrease in suitability**

Over 3.5 M ha become more **suitable for maize production** creating opportunities for expanding where maize is **grown**

Number of maize farmers who could potentially adopt DCSA:

2.2 M SHFs HHs

MERCY CORPS

Ethiopia: Most at-risk SHFs are facing multiple climate hazards

Top 5 Climate Hazards	SHFs at Risk (millions)
Dry conditions	4.7
Thermal stress	4.1
Climate variability	3.8
Drought	3.8
Flood	1.2

More than 20 M Ethiopians in rural areas (>20% of the rural pop) are at risk of climate hazards.

12 M+ SHFs are facing climate hazards; 70% of these farmers are facing multiple hazards.

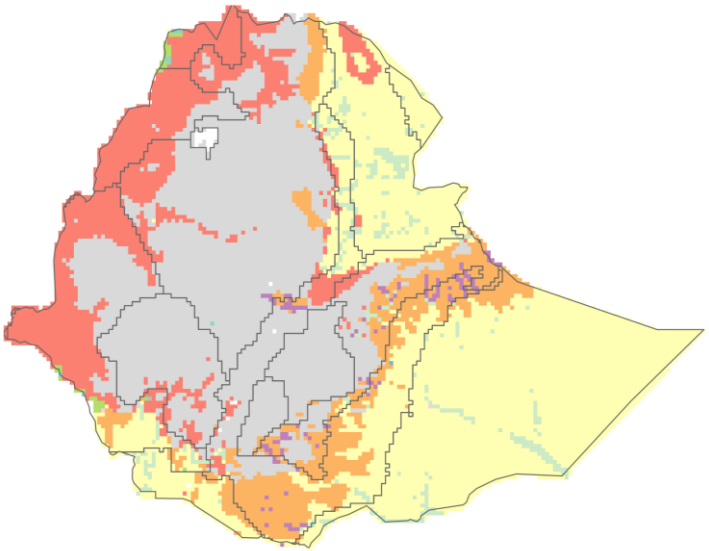
What does this mean for SHFs?

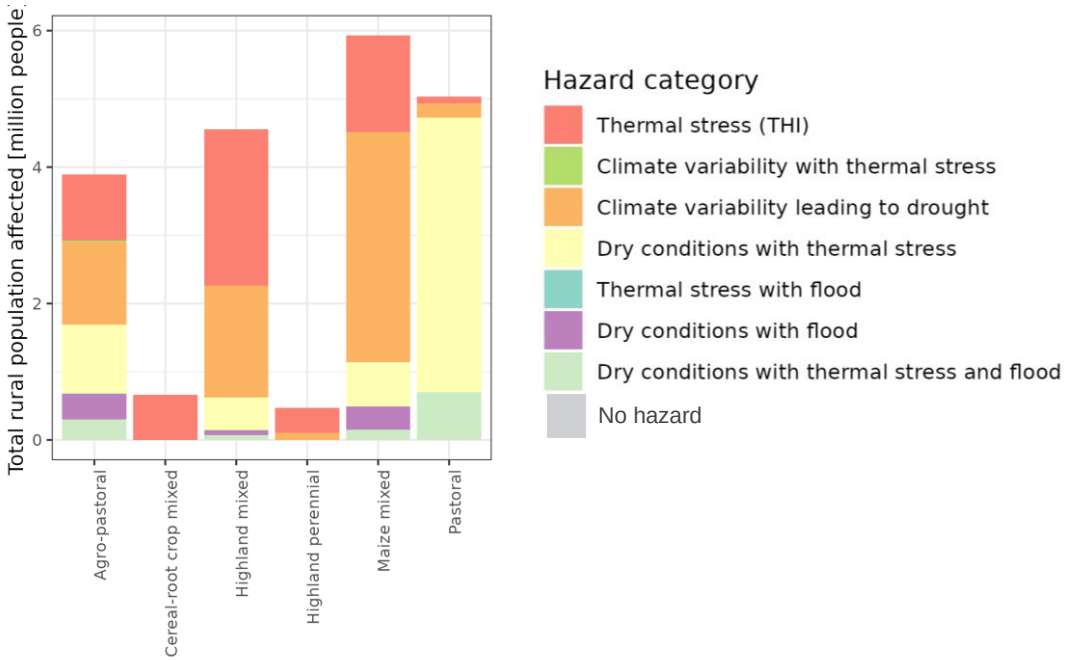
The most widespread climate risk in Ethiopia is **climate variability leading to drought**. Farmers may experience variable onset and poor distribution of rains making it difficult to plan and execute a successful growing season, especially in rainfed systems. More frequent droughts will lead to crop loss and water scarcity. Good information about weather patterns, timely planting and adapted varietals (drought tolerant, early maturing) will be important.

Many SHFs will also experience **thermal stress**, which impacts crops, livestock and the health of farm workers. Livestock productivity could decline as livestock face increased disease pressure and fertility challenges. Shade and water access are critical. Crops susceptible to heat stress will decline in productivity as temperatures rise. Adaptive management practices and appropriate varietals are important. Farm workers will need to manage their exposure to more extreme temperatures while they manage their farms.

Ethiopia: Production system risks

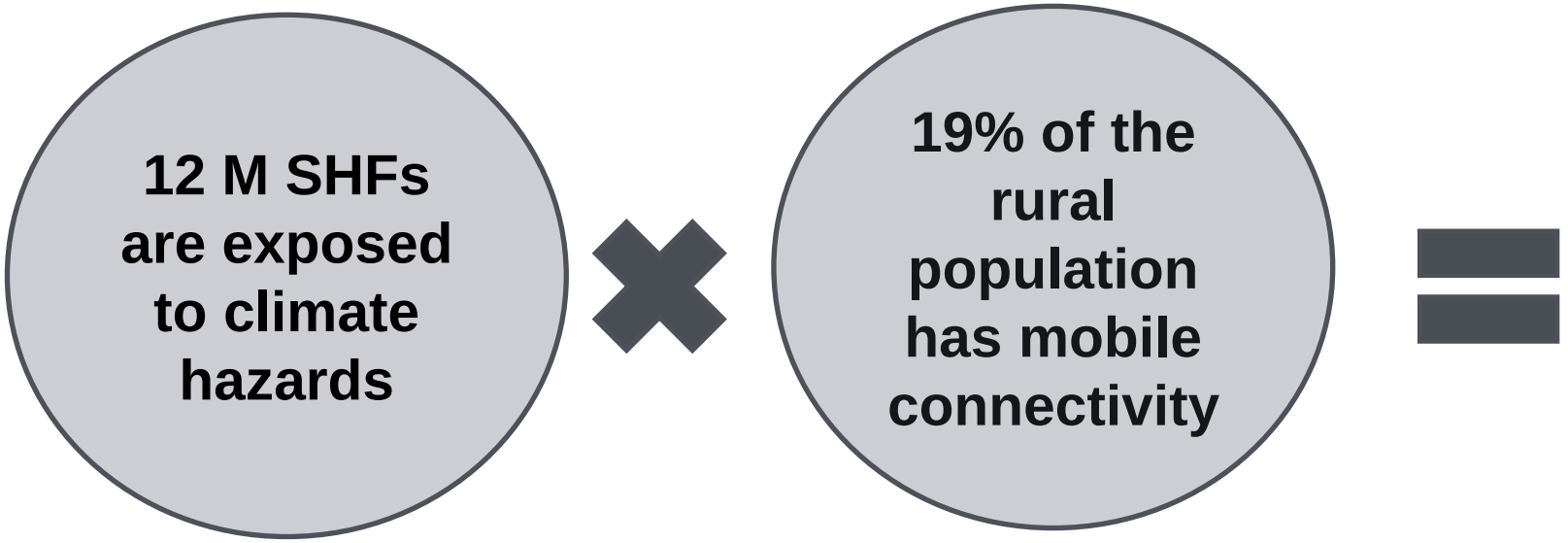
Production System Risks





Production System	SHFs at risk	Main Climate Hazards	Impact for Farmers
Maize mixed	**3.4 M**	**Climate variability leading to drought.** Thermal stress.	Difficult to manage the growing season with variable onset and poor distribution of rains. Reduced productivity of crops and livestock. Need for adapted varietals and breeds and possible shift to new crops/livestock.
Highland perennial	**2.9 M**	**Thermal stress**	Reduced productivity of perennial crop. Need for adaptive management practices including shade and irrigation. Need for thermo-tolerant varieties.
Pastoral	**2.9 M**	**Dry conditions with thermal stress**	Decreased availability of feed and water for livestock; more time and distance covered to find resources. Heat stress for animals leading to low output. High morbidity/mortality of animals. Low prices.
Agro pastoral	**2.2 M**	**Climate variability leading to drought.** Dry conditions + thermal stress. Thermal stress	Difficult to manage growing season with unpredictable onset and poor distribution of rains. Decreased yields. Shifting crop and variety suitability. Decreased availability of feed and water for livestock; increased mortality.
Cereal-root crop	**0.4 M**	**Thermal stress**	Reduced productivity of crop and livestock + heat stress risk for humans. Adaptation through planting date shifts and variety selection.

Ethiopia: Total Addressable Market for DCSA



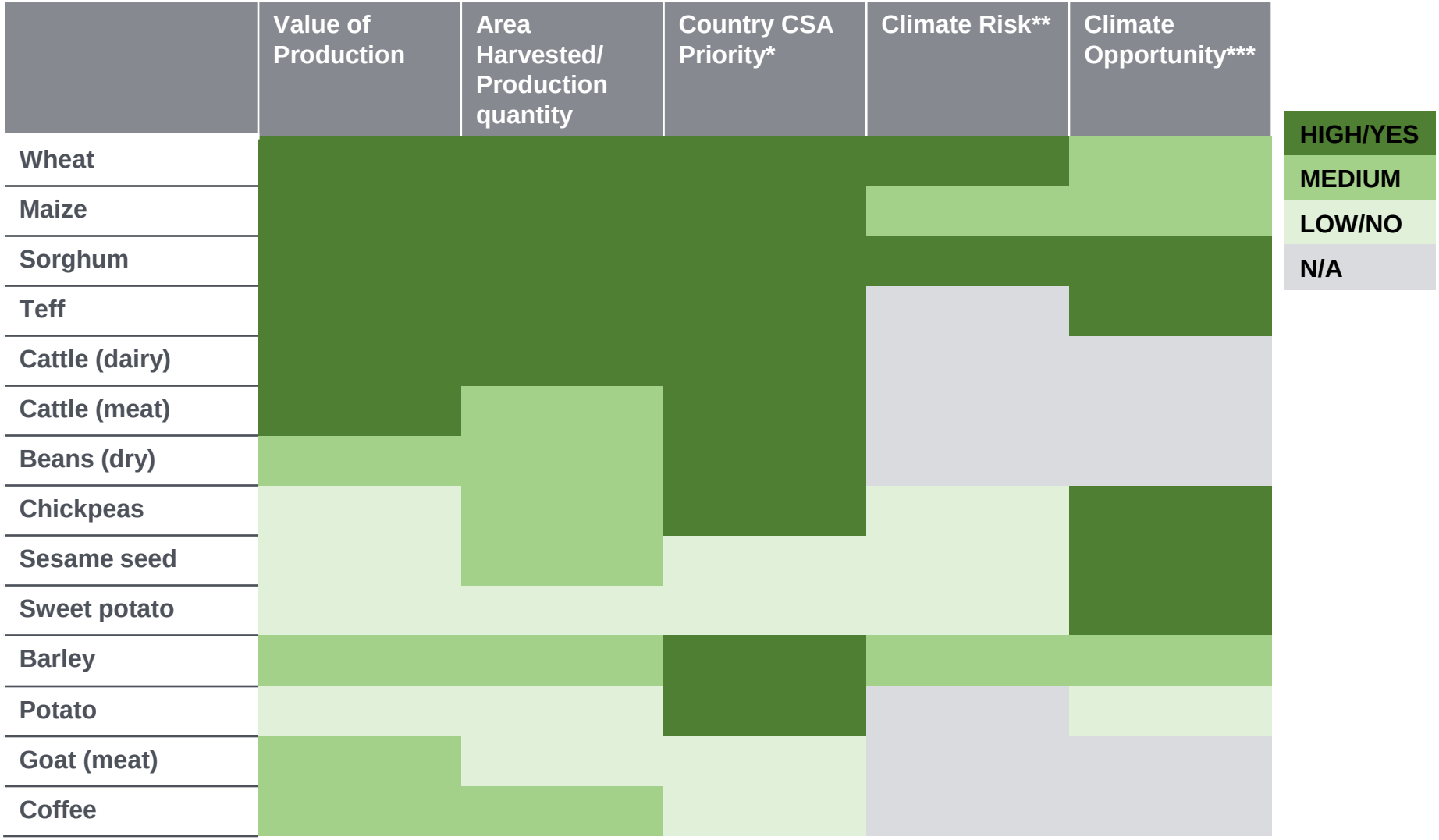
2.3 M SHFs in Ethiopia need and have the ability to utilize DCSA

9.6 M SHFs facing climate hazards cannot access DCSA; as mobile connectivity and digital literacy grow the TAM will increase

Sources: AgThrive analysis; Alliance of Bioversity and CIAT analysis. Hazard layers modeled by Alliance Bioversity-CIAT scientists using this methodology: https://cgspace.cgiar.org/handle/10568/115166

Ethiopia: Value Chain Opportunities for DCSA

Analysis of Importance of Value Chains x Level of Climate Change Risk and Opportunity



*Identified as national priorities through CSA Country Profile development https://ccafs.cgiar.org/resources/publications/climate-smart-agriculture-Ethiopia

** Climate risk: Amount of decrease (ha) in future suitability of area where crop is currently grown (Ecocrop model)

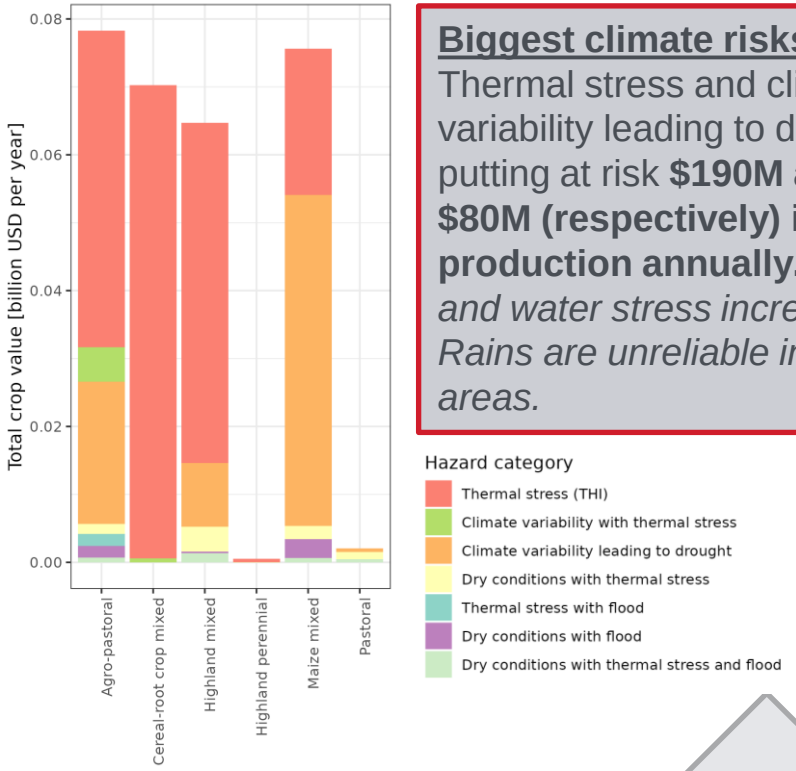
*** Climate Opportunity: Amount of increase (ha) in suitability of crop land for producing this crop (Ecocrop model)

MERCY CORPS

Sources: AgThrive analysis; FAO Stat (11/2022); Alliance of Bioversity-CIAT analysis using Ecocrop

Ethiopia Example 1: DCSA Opportunities Sorghum x Climate Hazards

Beans



Biggest climate risks

Thermal stress and climate variability leading to drought putting at risk **$190M and $80M (respectively) in production annually.** *Heat and water stress increase. Rains are unreliable in some areas.*

Future Change in Land Suitability (2050)

-- **Risk: 83% of current sorghum cropland will decline in suitability for sorghum production.** *Farmers need adapted varieties and practices and/or will need to shift out of sorghum production.*

+ **Opportunity: Over 20 M ha of crop land will increase in suitability for sorghum production.** *Farmers in newly suitable areas can start sorghum production.*

DCSA Solutions

+Weather forecasting and advisory for cropping timeline and climate smart practices +Early drought warning +Bundled advisory, credit, insurance and input access for adapted varietals and practices +Bundled advisory, credit and input and market access for new sorghum producers

83% of current sorghum cropland will **decrease in suitability**

Over 20 M ha become more **suitable for sorghum production** creating opportunities for expanding where sorghum is grown

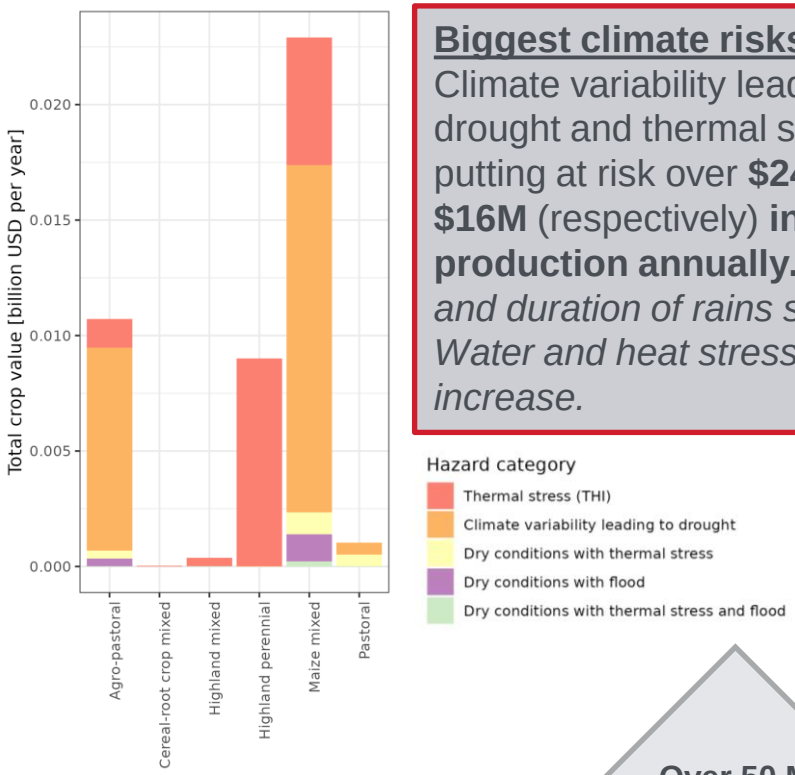
Number of sorghum farmers who could benefit from and utilize DCSA:

900,000 SHF HHs

MERCY CORPS

Ethiopia Example 2: DCSA Opportunities Sweet Potato x Climate Hazards

Beans



Biggest climate risks

Climate variability leading to drought and thermal stress putting at risk over **$24M and $16M** (respectively) **in production annually.** *Timing and duration of rains shifts. Water and heat stress increase.*

Future Change in Land Suitability (2050)

-- **Risk: Almost 12% of current sweet potato cropland will decline in suitability for sweet potato production.** *Farmers need climate smart practices.*

\+ **Opportunity: Over 50 M ha of crop land increases in suitability for sweet potato production.** *Farmers in newly suitable areas can start sweet potato production.*

DCSA Solutions

+Weather forecasting and advisory for cropping timeline and climate smart practices +Early drought warning +Bundled advisory, credit, insurance and input access for adapted varietals and practices +Bundled advisory, credit and input and market access for new sweet potato producers

Almost 12% of current sweet potato cropland will **decrease in suitability**

Over 50 M ha become more **suitable for sweet potato production** creating opportunities for expanding where they are grown

Number of sweet potato farmers who could benefit from and utilize DCSA:

320,000 SHF HHs

MERCY CORPS

Nigeria: All SHFs face thermal stress for livestock, crops and themselves

Top Climate Hazards	SHFs at Risk (millions)
Thermal stress	58
Dry conditions	4
Flood	2
Climate variability	0.2

All Nigerians in rural areas are at risk of thermal stress, the top climate hazard in the country.

8+ M are at risk of two+ hazards.

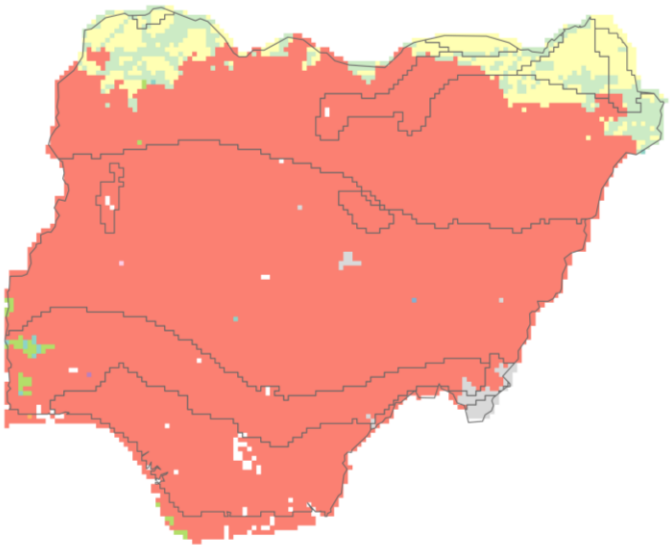
What does this mean for SHFs?

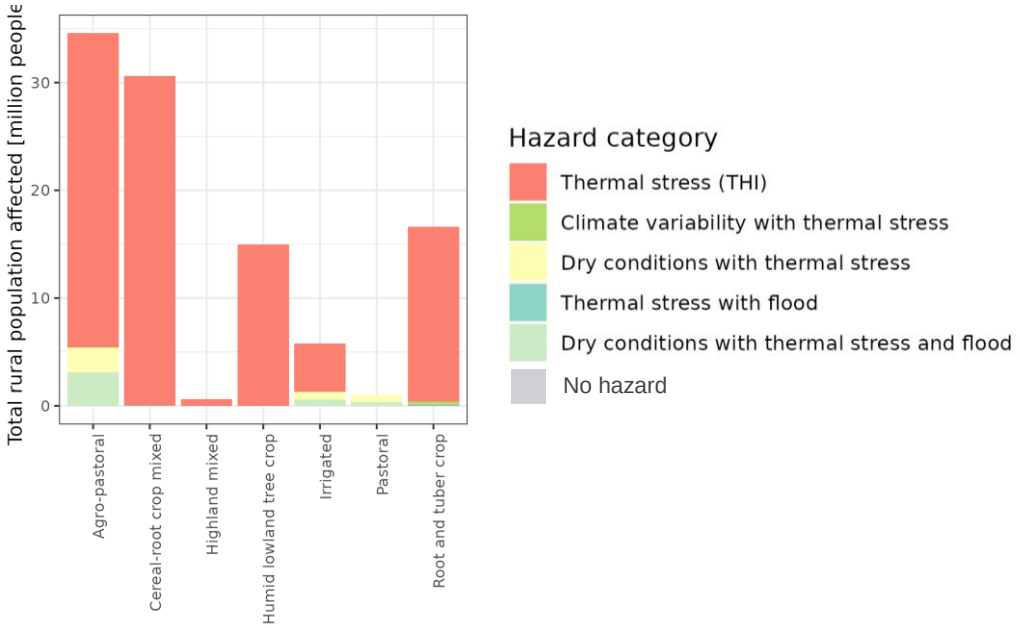
All farmers in Nigeria have experienced and are at current risk of **thermal stress**, which can include high temperatures and high humidity. **Heat stress affects crops, livestock and farm workers.**

- Livestock production will face reduced productivity, reduced animal welfare, reduced fertility, increased susceptibility to disease and sometimes increased mortality. Different livestock species will fair differently; improved dairy breeds are most at risk.
- Crop farmers could face significant reductions in growth and yield caused by different impacts during the plant's life cycle including plant dehydration (increased evapotranspiration), failure to pollenate and reduced photosynthetic productivity. Crops and varietals with better thermal tolerance will become important.
- SHFs rely almost exclusively on manual labor. Farm workers could see negative impacts to their health from working under high heat and humidity conditions especially if they don't take precautions to drink water and rest in the shade. In extreme cases heat stress can lead to death.

Nigeria: Production system risks

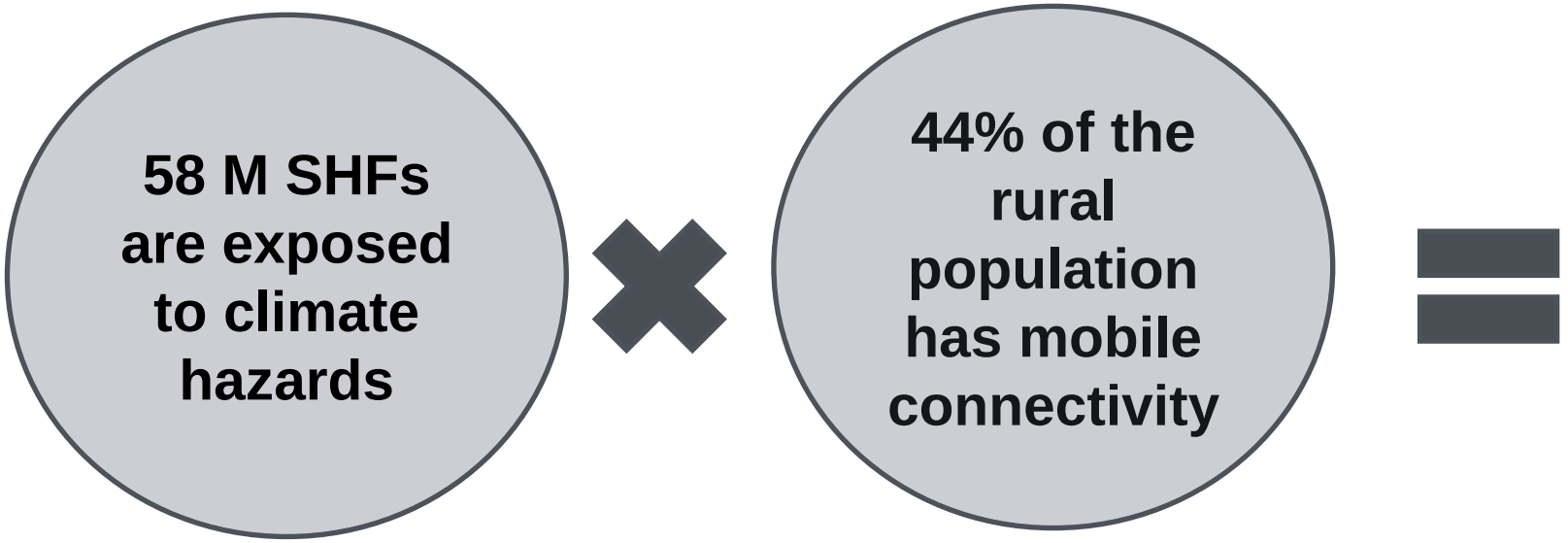
Production System Risks





Production System	SHFs at risk	Climate Hazards	Impact for Farmers
Agro pastoral	**19**	**Thermal stress** combined with dry conditions and occasionally flood	Reduced productivity of crops/livestock + heat stress risk for humans. Need for thermos tolerant varietals and changes in agronomic practices. Need to shelter livestock and select tolerant breeds.
Cereal-root crop	**17**	**Thermal stress**	Reduced productivity of crop and livestock + heat stress risk for humans. Adaptation through planting date shifts and variety selection.
Root and tuber crop	**9**	**Thermal stress**	Reduced productivity of crops + heat stress risk for humans. Can be a resilient system if SHFs adapt through planting date shifts, variety selection and adaptive practices (e.g. no till).
Humid lowland tree crop	**8**	**Thermal stress**	Cash crops at risk of low productivity. Need to increase shade. Diversification could be an important strategy.
Pastoral	**0.6**	**Dry conditions with thermal stress**	Heat stress for livestock. Reduced water availability. Conflict could increase.
Highland mixed	**0.3**	**Thermal stress**	Reduced crop productivity. Varietal selection and water management are key.

Nigeria: Total Addressable Market for DCSA



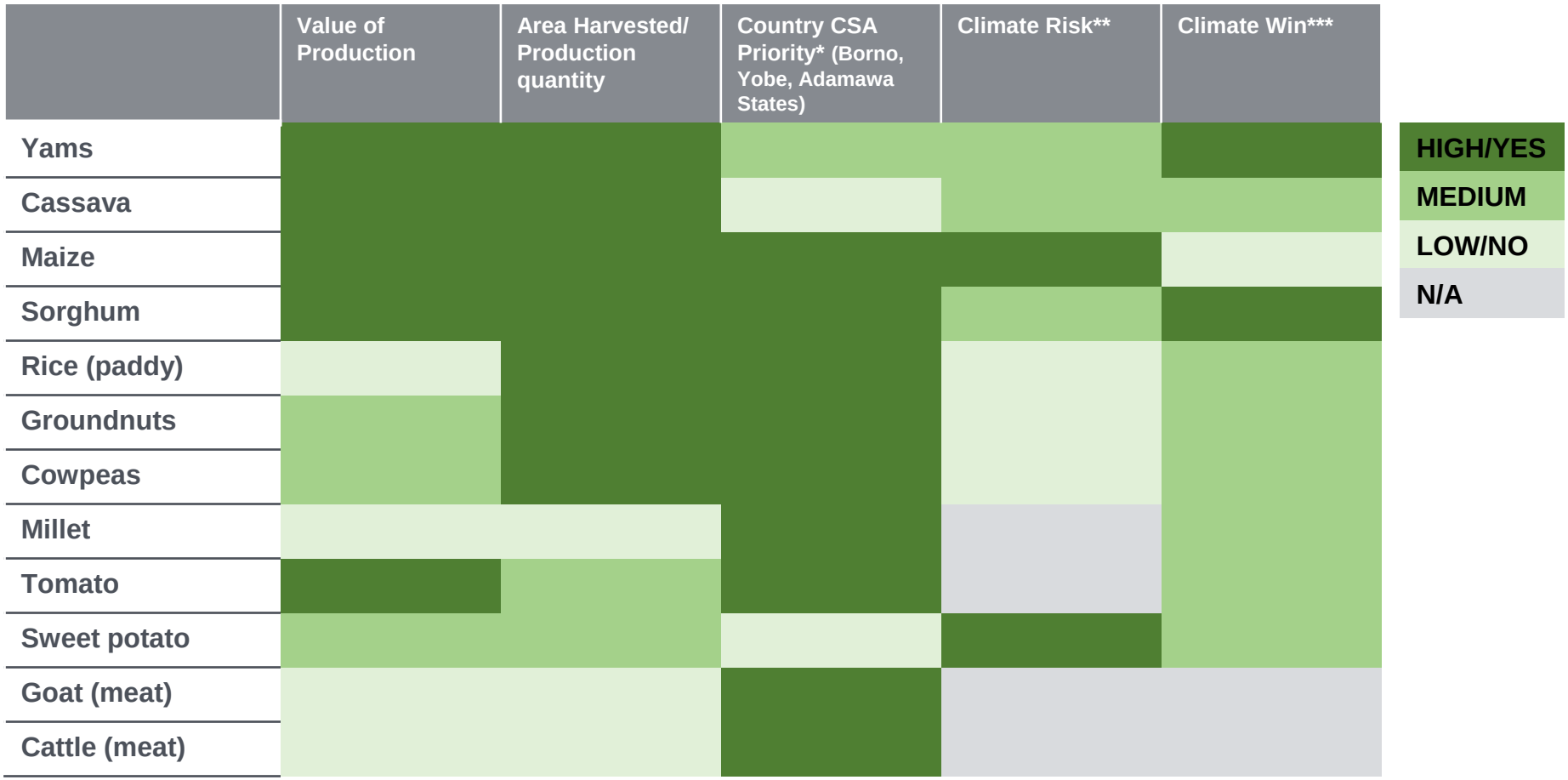
Almost 26 M SHFs in Nigeria need and have the ability to utilize DCSA

~32 M SHFs facing climate hazards cannot access DCSA; as mobile connectivity and digital literacy grow the TAM will increase

Sources: AgThrive analysis; Alliance of Bioversity and CIAT analysis. Hazard layers modeled by Alliance Bioversity-CIAT scientists using this methodology: https://cgspace.cgiar.org/handle/10568/115166

Nigeria: Value Chain Opportunities for DCSA

Analysis of Importance of Value Chains x Level of Climate Change Risk and Opportunity



*Identified as national priorities through CSA Country Profile development https://ccafs.cgiar.org/resources/publications/climate-smart-agriculture-yobe-state-nigeria; https://ccafs.cgiar.org/resources/publications/climate-smart-agriculture-borno-state-Nigeria; https://ccafs.cgiar.org/resources/publications/climate-smart-agriculture-adamawa-state-Nigeria

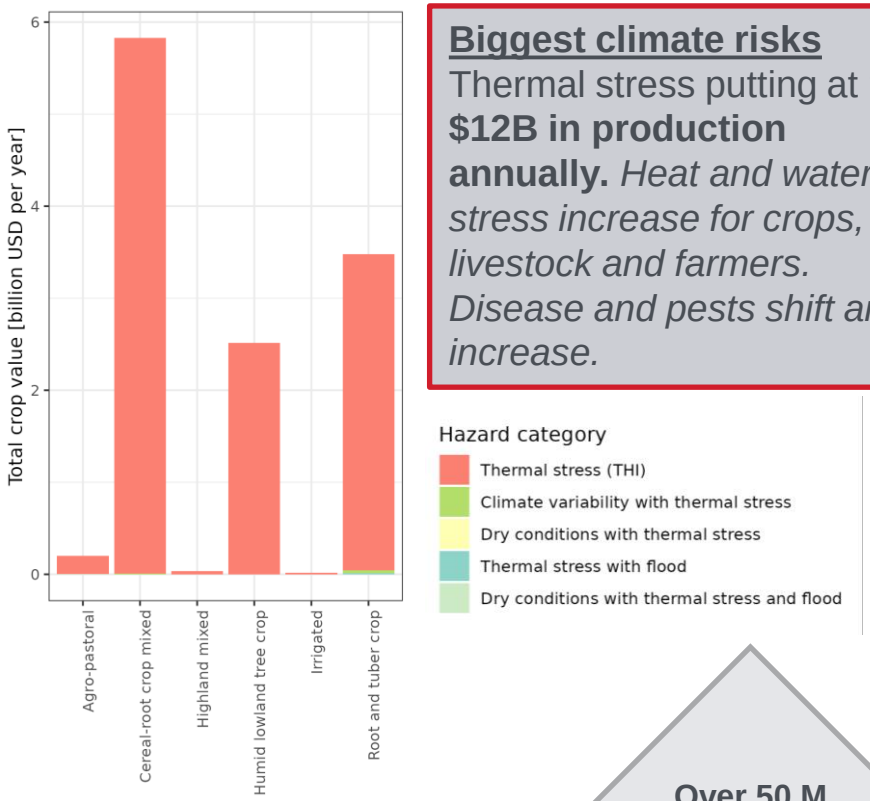
** Climate risk: Amount of decrease (ha) in future suitability of area where crop is currently grown (Ecocrop model)

*** Climate Opportunity: Amount of increase (ha) in suitability of crop land for producing this crop (Ecocrop model)

Sources: AgThrive analysis; FAO Stat (11/2022);; Alliance of Bioversity-CIAT analysis using Ecocrop

Nigeria Example 21: DCSA Opportunities Yams x Climate Hazards

Beans



Biggest climate risks
Thermal stress putting at risk **$12B in production annually.** *Heat and water stress increase for crops, livestock and farmers. Disease and pests shift and increase.*

Future Change in Land Suitability (2050)
-- **Risk: Minimal current yam cropland will decline in suitability for yam production.** *Farmers need climate smart practices but can continue producing yam.*

+ **Opportunity: Over 50 M ha of crop land increases in suitability for yam production.** *Farmers in newly suitable areas can start yam production.*

DCSA Solutions

+Pest and disease early warning
+Advisory for climate smart practices
+Bundled advisory, credit, insurance and input access for adapted varietals and practices +Bundled advisory, credit and input access for new yam producers

Minimal current yam cropland will **decrease in suitability**

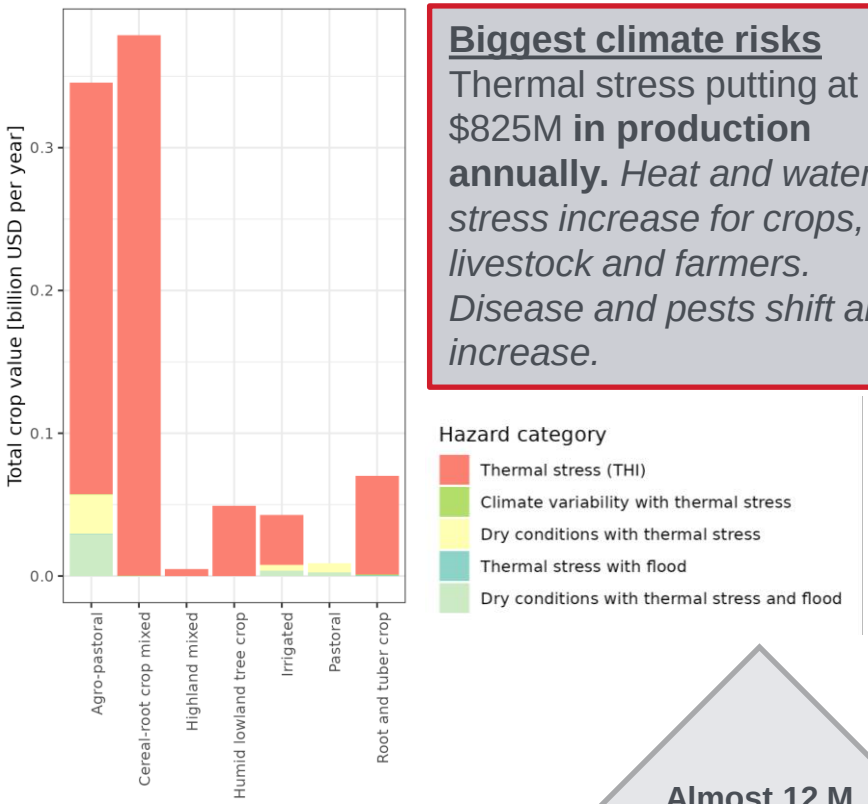
Over 50 M ha become more **suitable for yam production** creating opportunities for expanding where yams are grown

Number of yam farmers who could benefit from and utilize DCSA:
5.4 M SHF HHs

MERCY CORPS

Nigeria Example 2: DCSA Opportunities Cowpeas x Climate Hazards

Beans



Biggest climate risks
Thermal stress putting at risk $825M **in production annually.** *Heat and water stress increase for crops, livestock and farmers. Disease and pests shift and increase.*

Future Change in Land Suitability (2050)
-- **Risk: Minimal current cowpea cropland will decline in suitability for cowpea production.** *Farmers need climate smart practices.*

+ **Opportunity: Almost 12 M ha of crop land not under cowpea production will increase in suitability.** F*armers in newly suitable areas can start cowpea production.*

DCSA Solutions

+Pest and disease early warning
+Advisory for climate smart practices
+Bundled advisory, credit, insurance and input access for adapted varietals and practices +Bundled advisory, credit and input access for new cowpea producers +Postharvest innovations

Minimal current cowpea cropland will **decrease in suitability**

Almost 12 M ha become more **suitable for cowpea production** creating opportunities for expanding where cowpeas are grown

Number of cowpea farmers who could benefit from and utilize DCSA:
TBD

MERCY CORPS

MERCY CORPS | AGRIFIN

Victoria Clause
Digital Climate Smart Agriculture Manager
vclause@mercycorps.org

Kristin Girvetz
Senior Consultant
kristin@agthriveadvisors.com

Alliance of Bioversity and CIAT
Climate Action Team
Evan Girvetz, Principal Scientist
Ani Ghosh, Senior Scientist
Beatrice Wanjiku Githu, Scientist

Appendix

Climate Hazard Definitions

Production System	System Definition
Climate variability	Coefficient of variation of annual mean rainfall (15–30% highly variable, >30% extremely variable), derived from the CHIRPS dataset (Funk et al., 2015)
Thermal stress	Having thermal heat stress (ThI, projected for 2030 under an 8.5 RCP scenario), equal or higher than 79 units (see Thornton et al., 2021)
Flood	Risk of flooding shown in UNEP-GRID dataset, in which flooding risk is ranked from 0 (no risk) to 5 (extreme) (UNEP/DEWA/GRID-Europe, 2011)
Drought	Risk of drought defined as having more than 24 days without rain per month on average
Composite categories	Composite categories were created when two or more hazards take place at the same place/pixel

Sources: Funk, C., Peterson, P., Landsfeld, M., Pedreros, D., Verdin, J., Shukla, S., Husak, G., Rowland, J., Harrison, L., Hoell, A., Michaelsen, J., 2015. The climate hazards infrared precipitation with stations—a new environmental record for monitoring extremes. Sci. Data 2, 150066. https://doi.org/10.1038/sdata.2015.66
Thornton, P., Nelson, G., Mayberry, D., Herrero, M., 2021. Increases in extreme heat stress in domesticated livestock species during the twenty-first century. Glob. Chang. Biol. gcb.15825. https://doi.org/10.1111/gcb.15825

MERCY CORPS

SSA Farming System Definitions

Production System	System Definition
Agro-pastoral	Mixed crop-livestock farming found in semi-arid areas with low access to services. Livelihoods include sorghum, millet, cattle, shoats, pulses, sesame, poultry, off-farm work.
Arid pastoral-oasis	Extensive pastoralism and scattered oasis farming associated with sparsely settled arid zones across Africa, generally with very poor access to services. Livelihoods include date palms, cattle, small ruminants and off-farm work, irrigated crops and vegetables.
Cereal-root crop mixed	Mixed farming with medium-high access to services dominated by at least two starchy staples (typically maize and sorghum) alongside roots and tubers (typically cassava) found in the subhumid savannah zone in West and Central Africa. Other livelihood sources include legumes, cattle and off-farm work.
Highland mixed	Highland mixed farming above 1700 m dominated by wheat and barley, found predominantly in subhumid north-east Africa with pockets in Southern, West and North Africa. Other livelihood sources include teff, peas, lentils, broad beans, rape, potatoes, sheep, goats, cattle, poultry and off-farm work.
Highland perennial	Mixed farming in the humid highlands. Dominant perennial crop (banana, tea, coffee) and good market access. Livelihoods include diversified cropping including maize, cassava, sweet potato, beans, cereals, livestock and poultry and off-farm work.
Humid lowland tree crop	Lowland farming dominated by tree crops (> 25% cash income from cocoa, coffee, oil palm or rubber) found in humid areas of West and Central Africa with good access to services. Other livelihood sources include citrus, yams, cassava, maize and off farm work.
Irrigated	Large-scale irrigation schemes associated with large rivers across Africa. Often located in semi-arid and arid areas but with medium-high access to services. Diversified cropping includes irrigated rice, cotton, wheat, faba, vegetables and berseem and cattle, fish and poultry.
Maize mixed	Mixed farming in sub humid areas dominated by maize with medium access to services. Other livelihood sources include legumes, cassava, tobacco, cotton, cattle, shoats, poultry, off-farm work.
Pastoral	Extensive pastoralism (dominated by cattle), found in dry semiarid (low rainfall) areas with poor access to services. Other livestock include camels, sheep and goats. Livelihoods include limited cereal cropping and off-farm work.
Root and tuber crop	Lowland farming dominated by roots and tubers (yams, cassava) found in humid areas of West and Central Africa. Other livelihood sources include legumes, cereals and off-farm work.

Sources: http://apps.worldagroforestry.org/downloads/Publications/PDFS/BC20004.pdf

MERCY CORPS