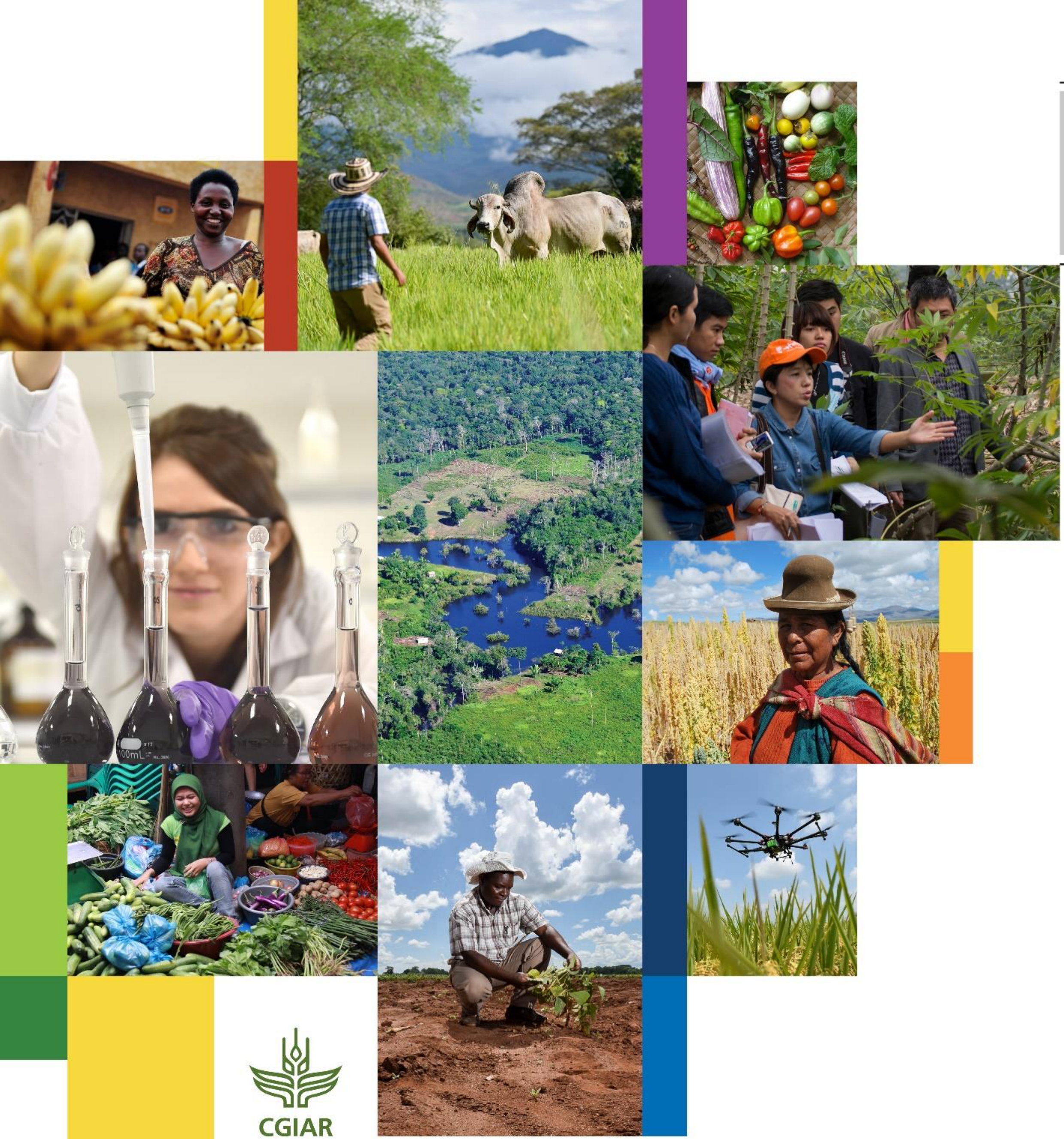

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Heat Stress Assessment for Dairy Cattle and Pig in Uganda

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21st February 2020

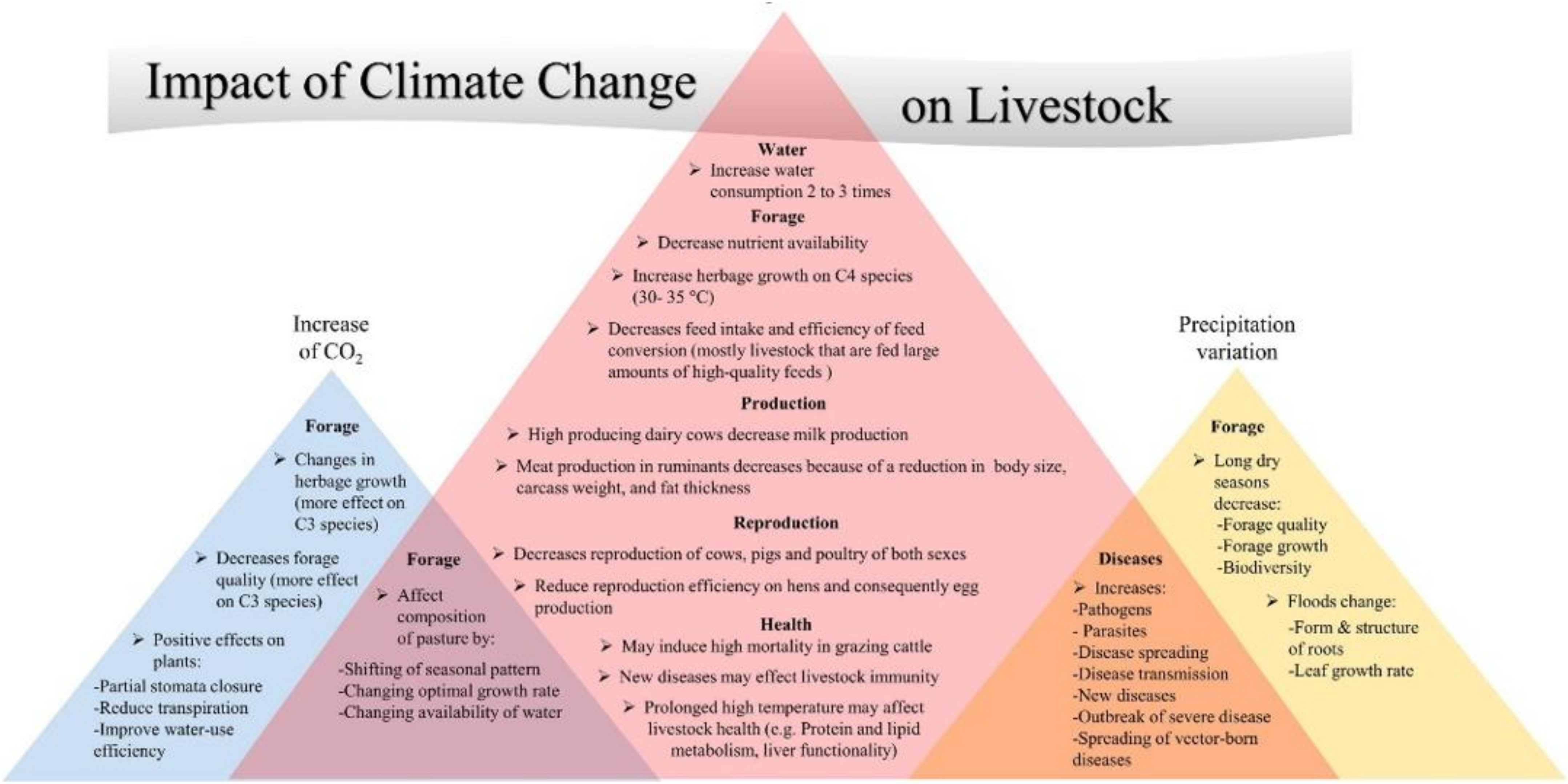
Kampala, Uganda

CGIAR

Climate change

- Rising temperatures.
- Increase in heavy precipitation (heavy rain and hail)
- Increase in hunger and water crises
- Health risks due to rising temperatures and heatwaves
- Increasing spread of pests and pathogens

Source: https://aventar.eu/tag/alteracoes-climaticas



Global demand for livestock products is expected to double by 2050!

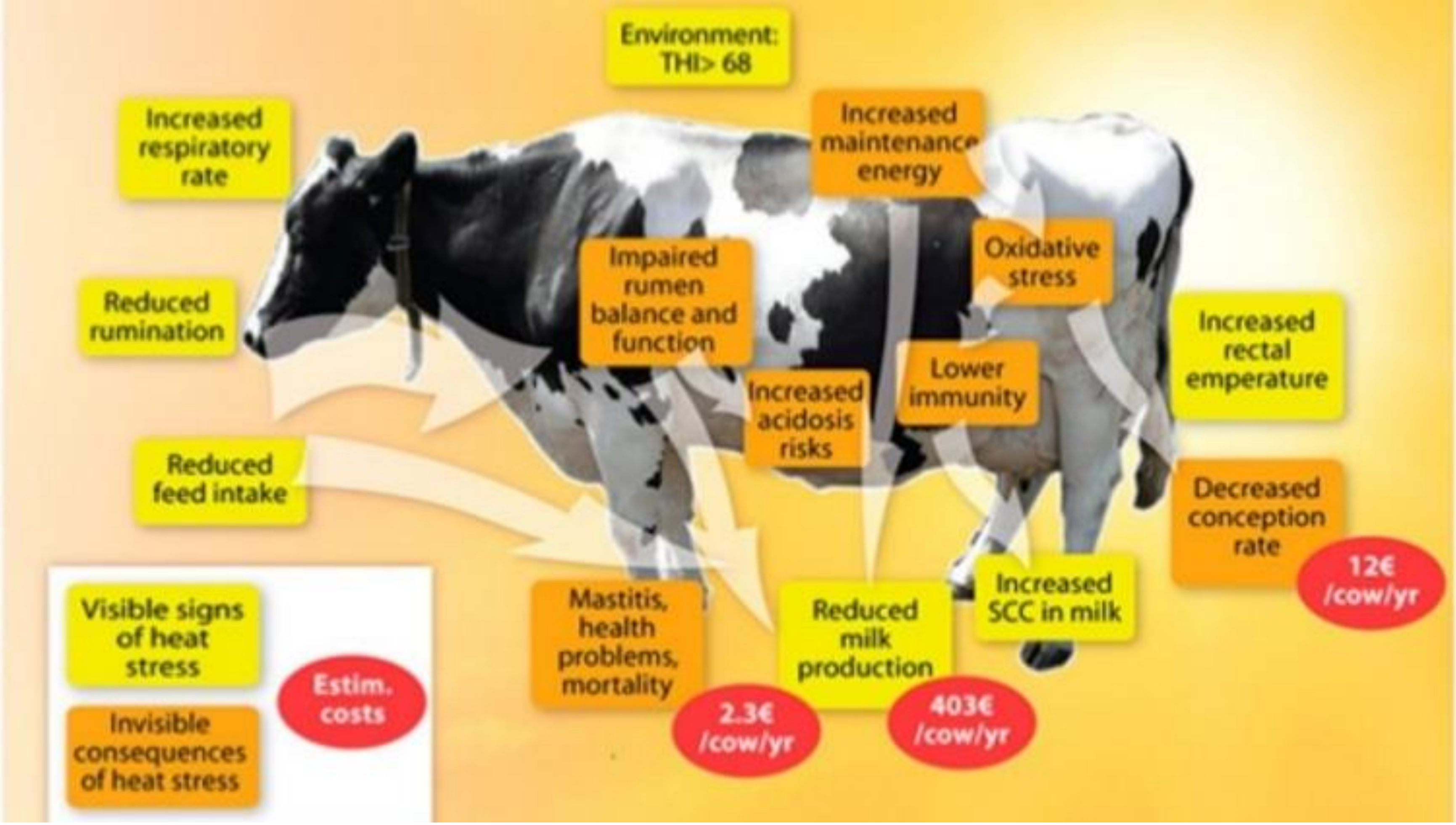
Rojas-Downing *et al.*, 2017

Heat stress and livestock

- Exposure to heat stress is a large geo. driver of current global livestock:
  - “The thermal environment is the most important ecological factor determining the growth, development, and productivity of domestic animals.” (Collier & Gebremedhin, 2015)
  - “Heat is a major constraint on animal productivity in the tropical belt and arid areas […]. ” (Silanikove, 2000)
  - Has been identified as one of the effect of climate change that farmers need to adapt.

Heat stress and livestock

- Animal’s cooling mechanisms are impaired.
- Animal’s body temperature rises and it shows signs of heat stress.
- Eats less
- Produces less metabolic heat as a natural protective mechanism.



Source: https://lallemandanimalnutrition.com

Temperature Humidity Index (THI)

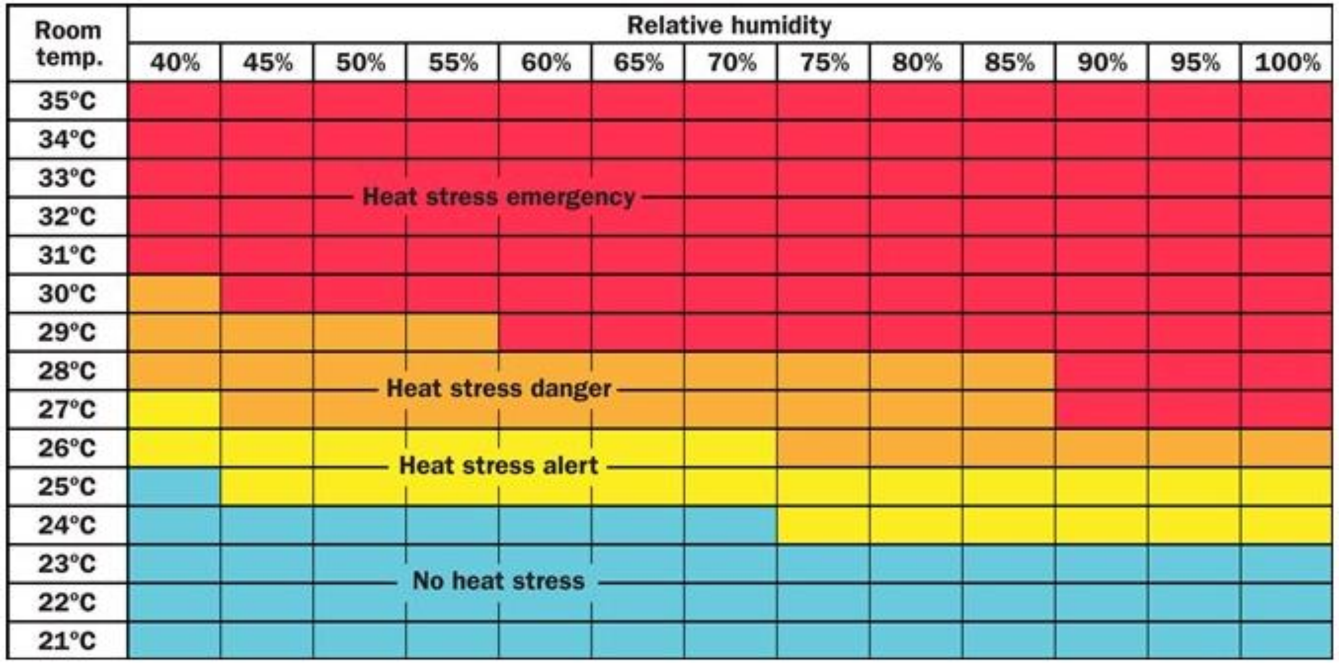
- Easy way to measure and evaluate heat stress

Dairy > THI = (1.8 × Tdb + 32) − [(0.55 − 0.0055 × RH) × (1.8 × Tdb − 26.8)] (National Research Council, 1971)

Swine > THI = 0.25 Twb + 0.75 Tdb (Roller and Goldman, 1969)

where:

Tdb is dry-bulb temperature in °C, Twb is wet-bulb temperature in °C, and RH is Relative humidity %



Adapted from Xin, H. and Harmon (1998)

THI thresholds and response

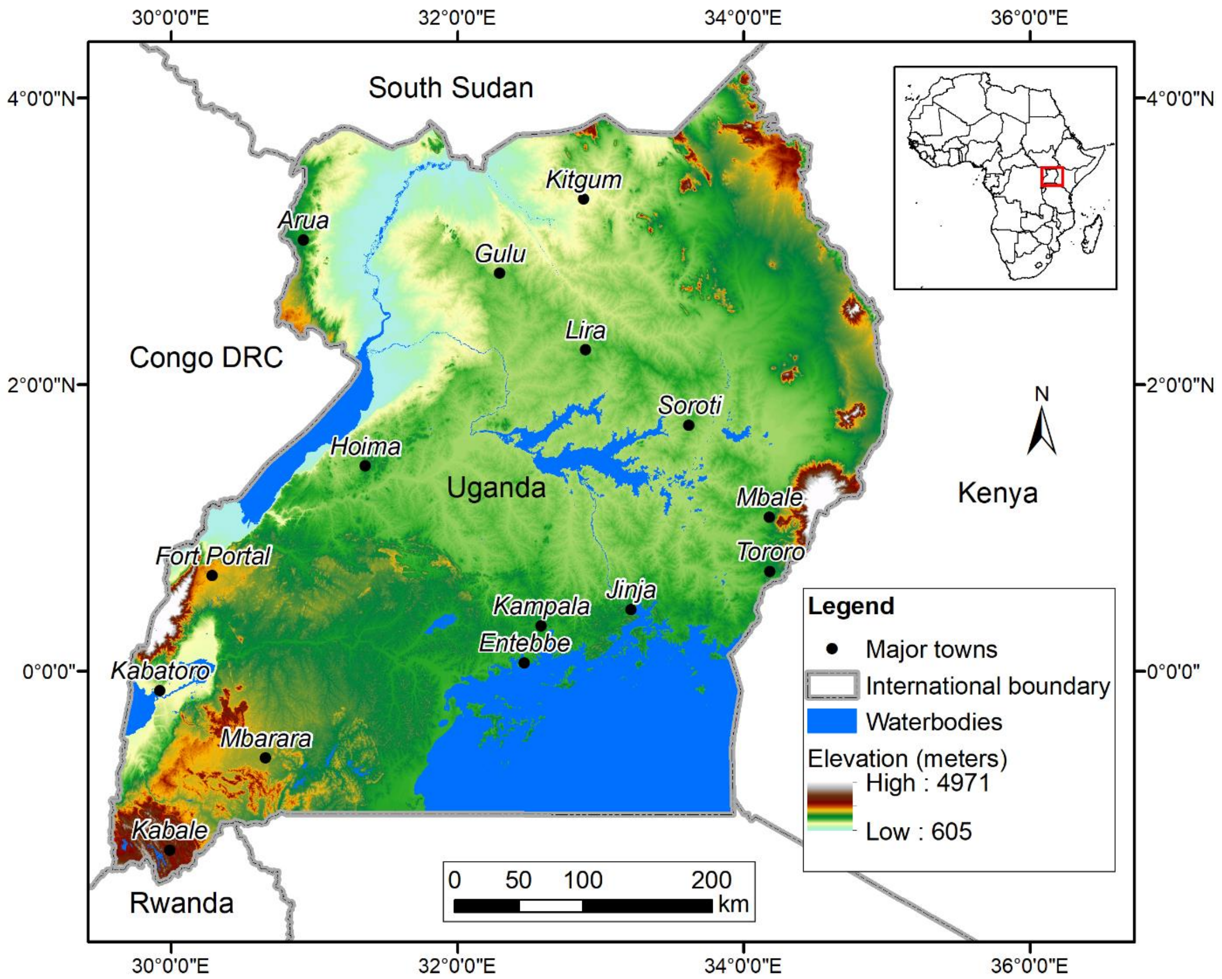
Category	Dairy Cattle	Pig	Response
None	THI < 72	THI < 74	i. Both productive and reproductive performance are optimum
Mild	72 ≤ THI < 79	74 ≤ THI < 78	i. Livestock body is able to control the heat stress by chemical and physical means. ii. Livestock seek for shade. iii. Increase in their rectal temperature, respiration rate. iv. Dilation of blood vessels
Moderate	79 ≤ THI < 89	78 ≤ THI < 83	i. Body temperature would increase and productive/reproductive performances are expected to be severely affected. ii. Respiration rate would significantly increase. iii. Dry matter intake and ratio of forage to concentrate intake is expected to decrease. iv. Water intake would significantly increase.
Severe and Danger	THI ≥ 89	THI ≥ 83	i. Respiration and excessive saliva production would increase. ii. The productive/reproductive performances will significantly decrease. iii. Rumination and urination will decrease. iv. In extreme cases, the stress would be significantly extreme and livestock may die.

Heat stress level	Practical example of [Temperature ; Relative Humidity]	Exposure duration	Milk loss under heat stress [kg/h ; kg/cow/day]
Stress Threshold THI [68-71]	[22°C (72°F) ; 50%]	4 hrs/day	[-0.283kg/h ; -1.1kg/cow/day]
Mild-Moderate Stress THI [72-79]	[25°C (77°F) ; 50%]	9 hrs/day	[-0.303kg/h ; - 2.7kg/cow/day]
Moderate-Severe Stress THI [80-89]	[30°C (86°F) ; 75%]	12 hrs/day	[-0.322kg/h ; -3.9kg/cow/day]
Severe Stress THI [90-99]	[34°C (93°F) ; 85%]		Not measured

Source: https://lallemandanimalnutrition.com

Case study: Uganda

- Characterized by the warm tropical climate.
- Hottest period = December to February ; Coolest period = March to May
- Population > 42 million as in 2018; annual growth rate of 3.7 %; population density of 213 per km2 (World Bank, 2018)



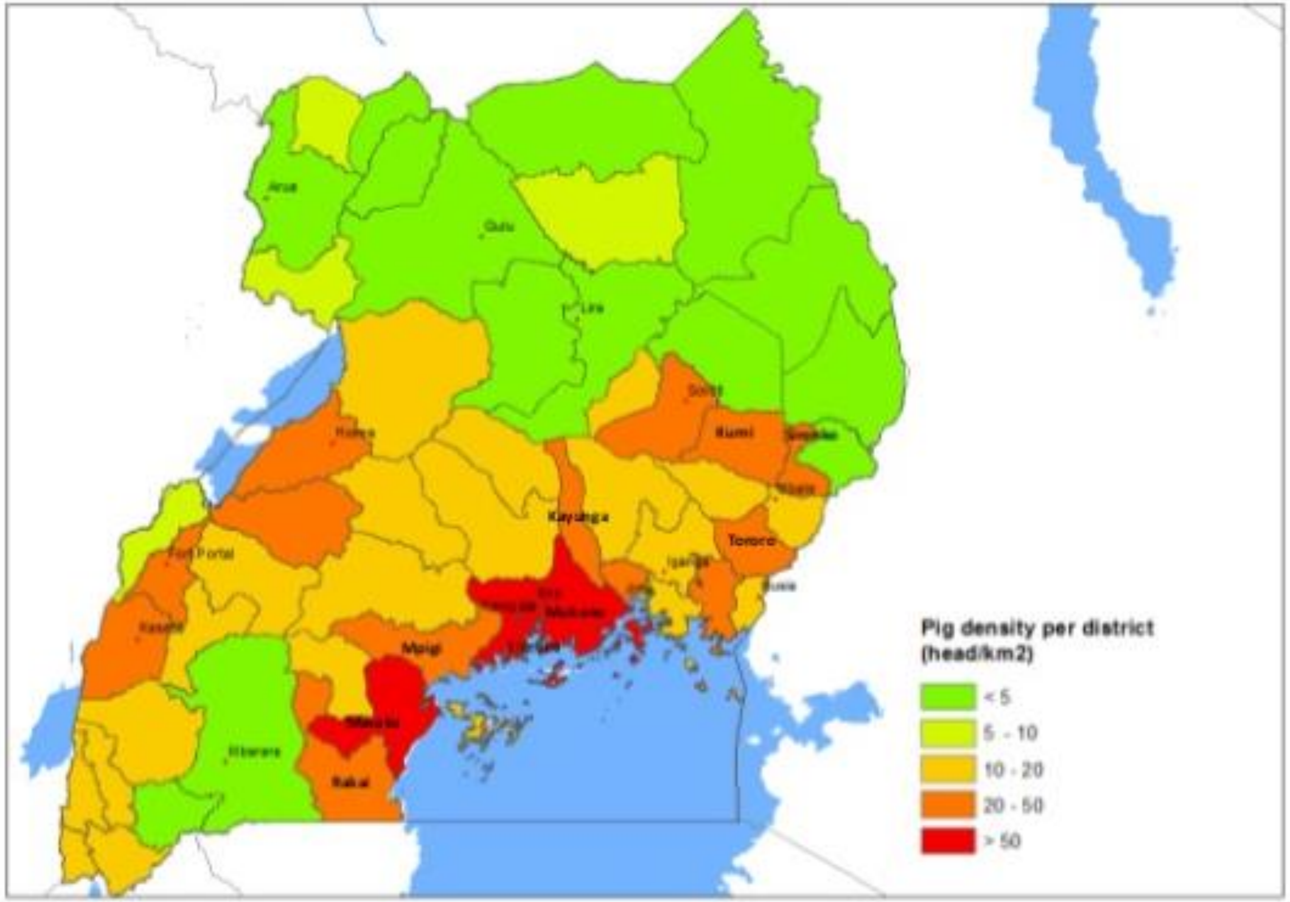
An Overview of the Ugandan Dairy and Swine Industry

- Pig sector contributes 15% of the agricultural GDP; source of livelihood to about 4.5 million people in the country (MAAIF, 2011).
- Pig is second to beef in terms of meat production (FAO, 2011). Uganda has about 3.5 million pigs (ILRI, 2013) reared by about 1.1 million small scale farmers (MAAIF, 2011).
- Highest per capita consumption of pork in East Africa estimated at 3 kilograms per person per year (FAO, 2011) as of 2011.
- Farmers faster embracing exotic and cross breeds.

Regional Distribution of the Pig Population in Uganda

- Practiced across all of Uganda.
- Concentrations around Kampala, Lake Victoria, between Lakes Victoria and Albert.
- Eastern Uganda in the Soroti-Mbali area

Pig density per district in 2008



Source: UBOS, 2008

An Overview of the Ugandan Dairy and Swine Industry

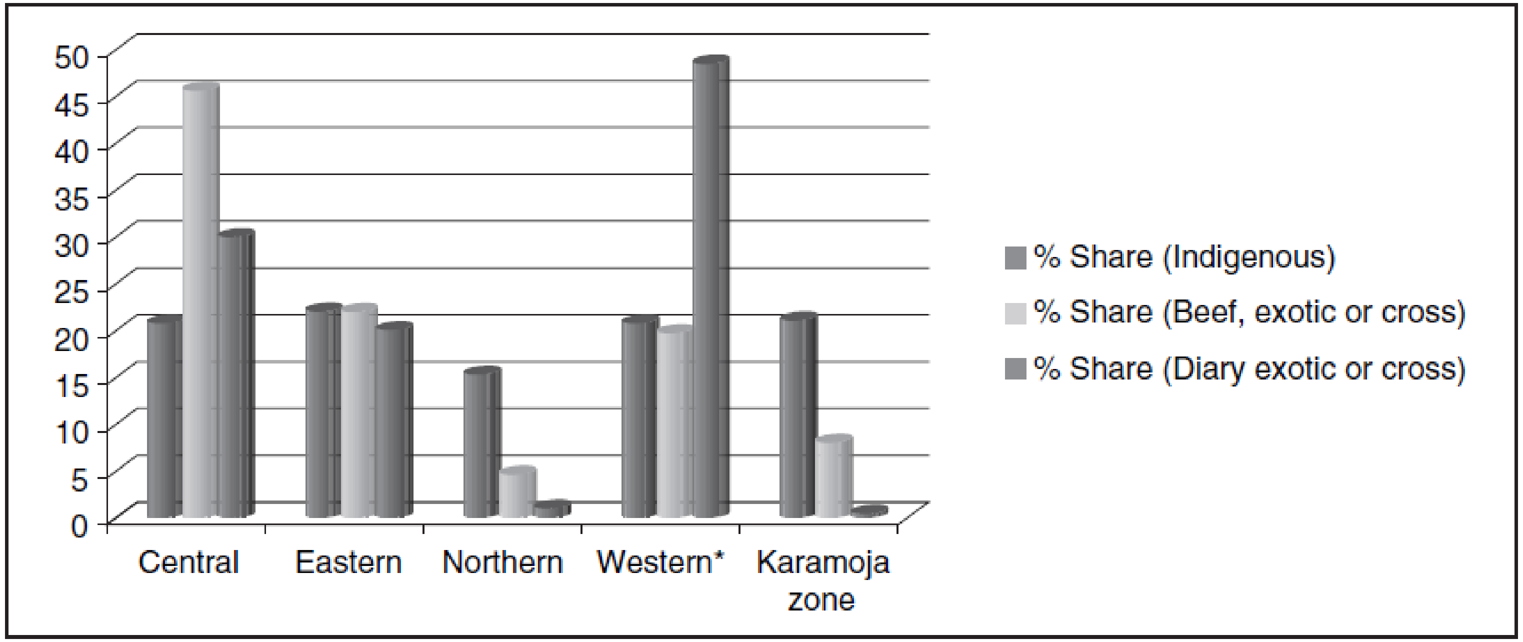
- Dairy sector contributes about 9% of the country’s Gross Domestic Product (GDP) in the country.

- Ninety percent of the cattle population is owned by small-scale farmers (Tijjani, K.I; Yetişemiyen, 2015).

- Breeds kept include the Holstein Friesian and their crosses, and others such as Nganda, Nkedi and Kyoga (Mugisha et al., 2014).

- Intensive systems and/or zero-grazing herds often include exotic breeds of cows.

Regional Distribution of the Cattle Population in Uganda



Source: UBOS, 2008

SLU news

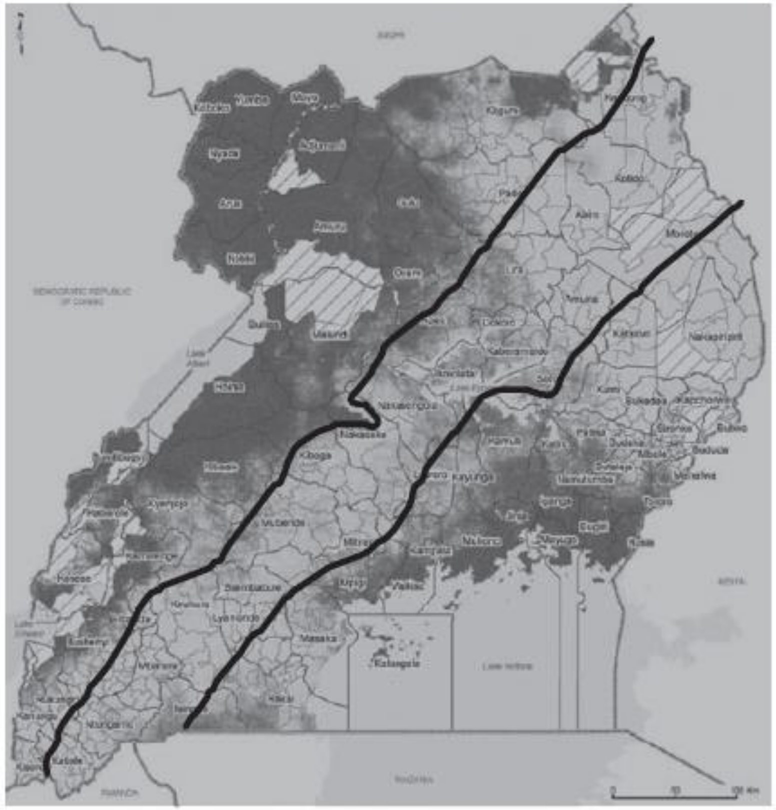
The Jersey breed of dairy cattle - a viable alternative to sustainable dairy in Uganda

PUBLISHED: 19 FEBRUARY 2019

Uganda is currently experiencing a population explosion. Therefore, there is a need to reduce the size of farming land. There is urgent need for increase in milk production to contribute to the animal protein needs of the population. AgriFoSe2030 and Makerere University are undertaking activities aimed at promoting the Jersey breed of dairy cattle as a viable alternative to inclusive and sustainable dairying in Uganda.

Exotic animals have been used to improve the milk yield of indigenous cattle through cross breeding, with some successes. However, the crossbred animals have suffered from diseases and do not perform well under the harsh hot and humid environments and in Uganda. There is also need to maintain the crossbred animals at 50% exotic and 50% indigenous for best performance.

Cattle corridor



Low incidence of tsetse fly infestation

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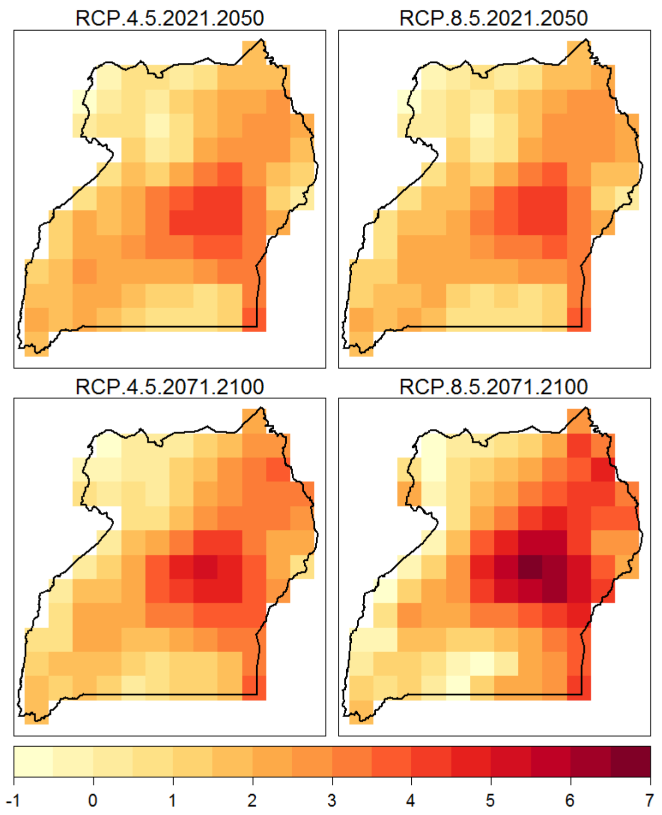
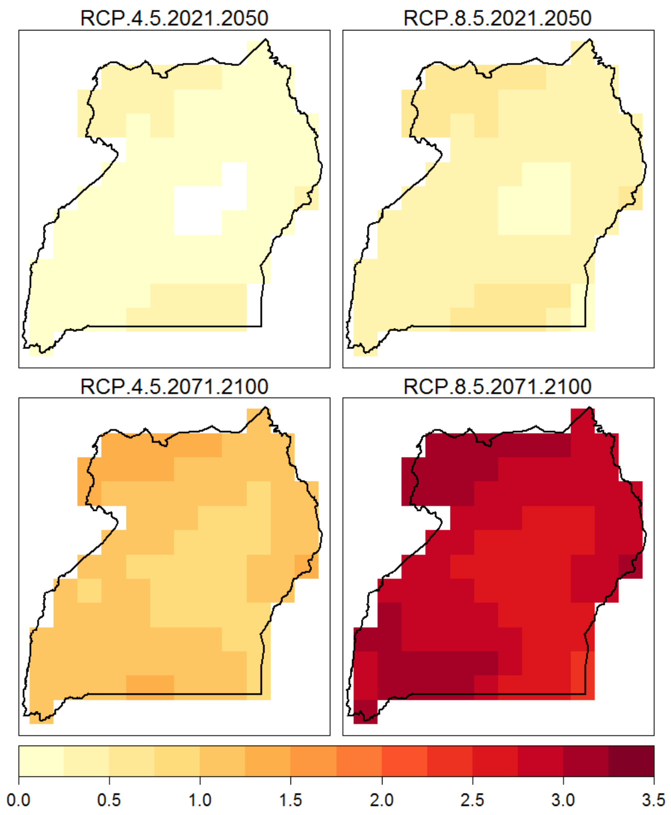
Climate Change Scenarios

Δ in Relative Humidity



Δ in Maximum Temperature



By 2100 maximum temperature is expected to increase by 1.5 and 3.5°C and relative humidity is expected to increase by 4 - 7% based on RCP 4.5 and RCP 8.5 scenarios

%

°C

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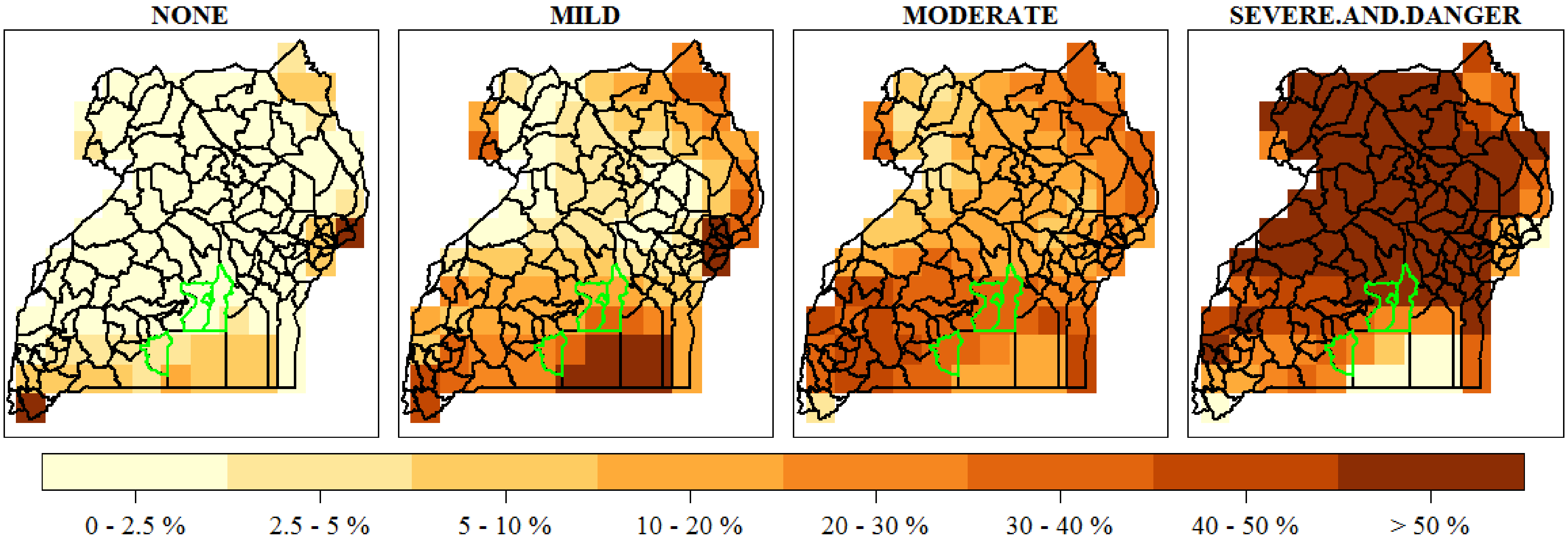
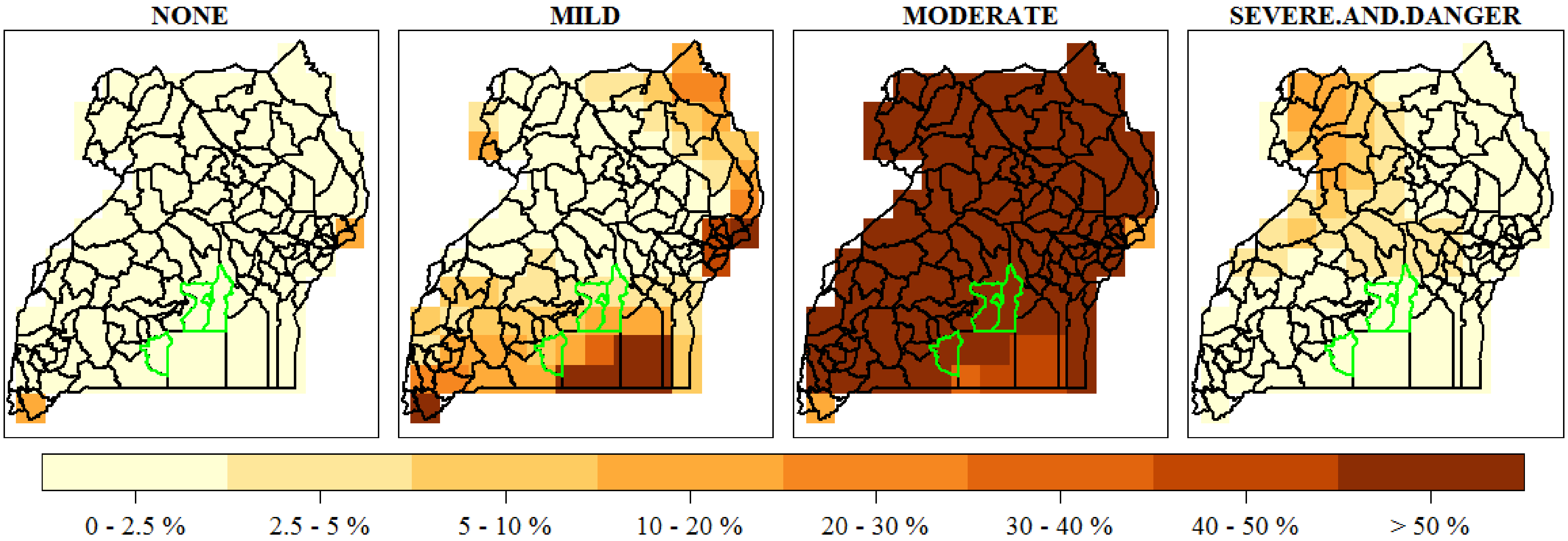
Heat Stress Mapping

Frequency of different THI categories for pig during the historical period (1981-2010)



Average severe frequency ranges from 10 % in the south to > 50 % in the north western parts

Frequency of different THI categories for dairy cattle during the historical period (1981-2010)

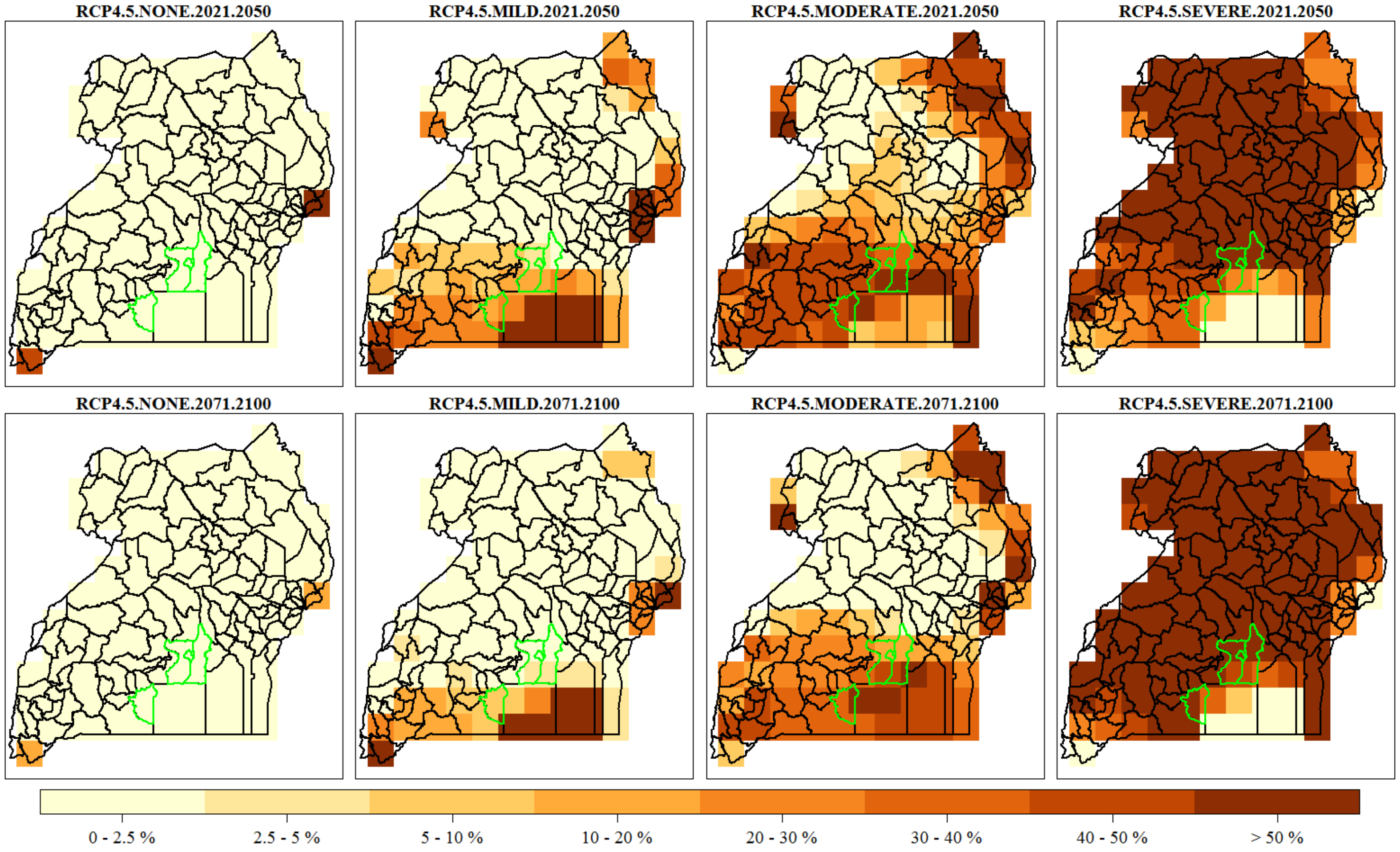


Average severe frequency ranges from 2.5 % in the south to 20 % in the north western parts; Most of the country is experiencing moderate conditions

Frequency of different THI categories for pig by 2021-2050 and 2071-2100 periods under RCP 4.5 scenario

Severe heat stress is dominant

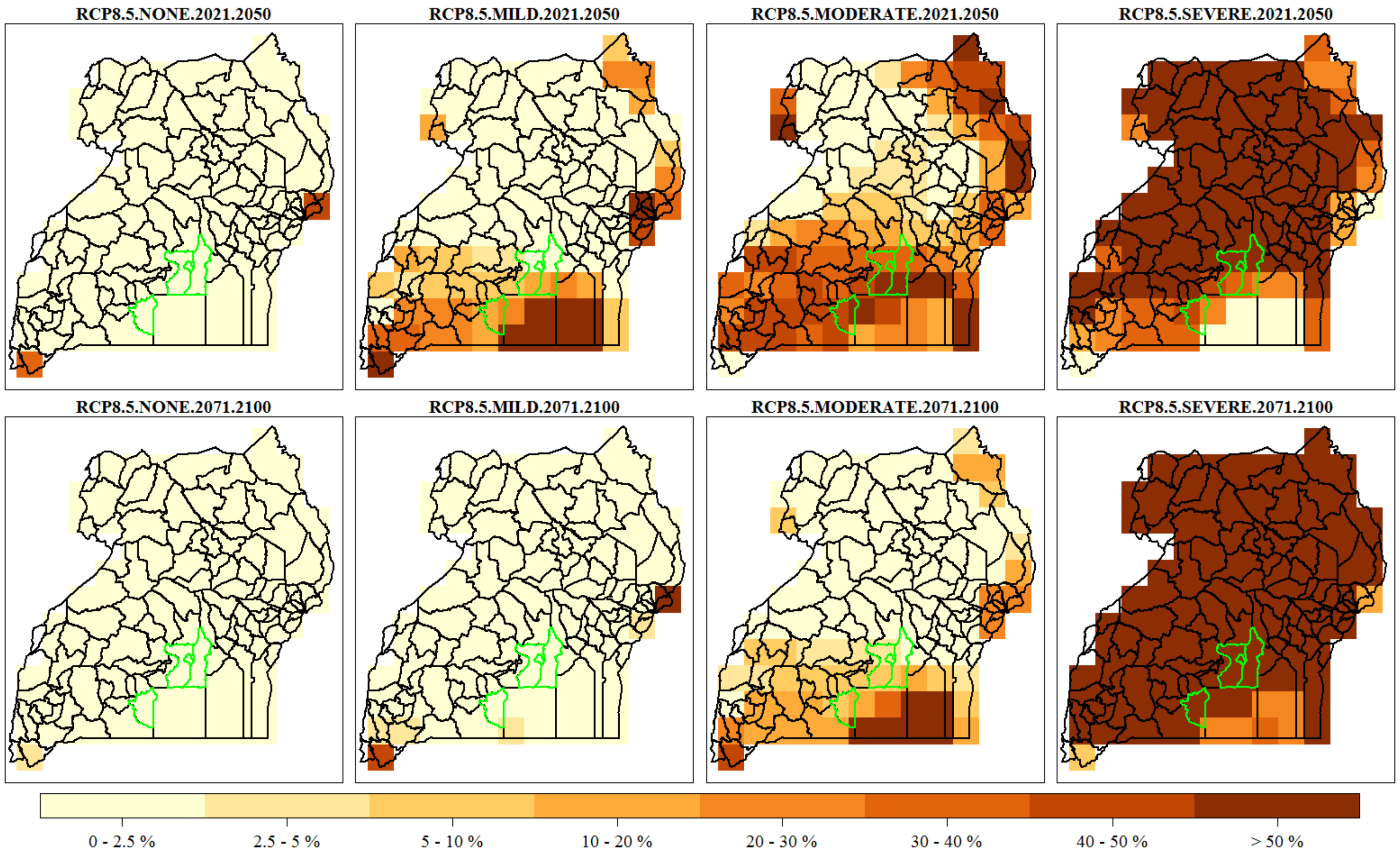
Most of southern parts are experiencing moderate conditions > 20 % of the time



Frequency of different THI categories for pig by 2021-2050 and 2071-2100 periods under RCP 8.5 scenario

Severe heat stress is dominant

Most of southern parts are experiencing moderate conditions > 30 % of the time



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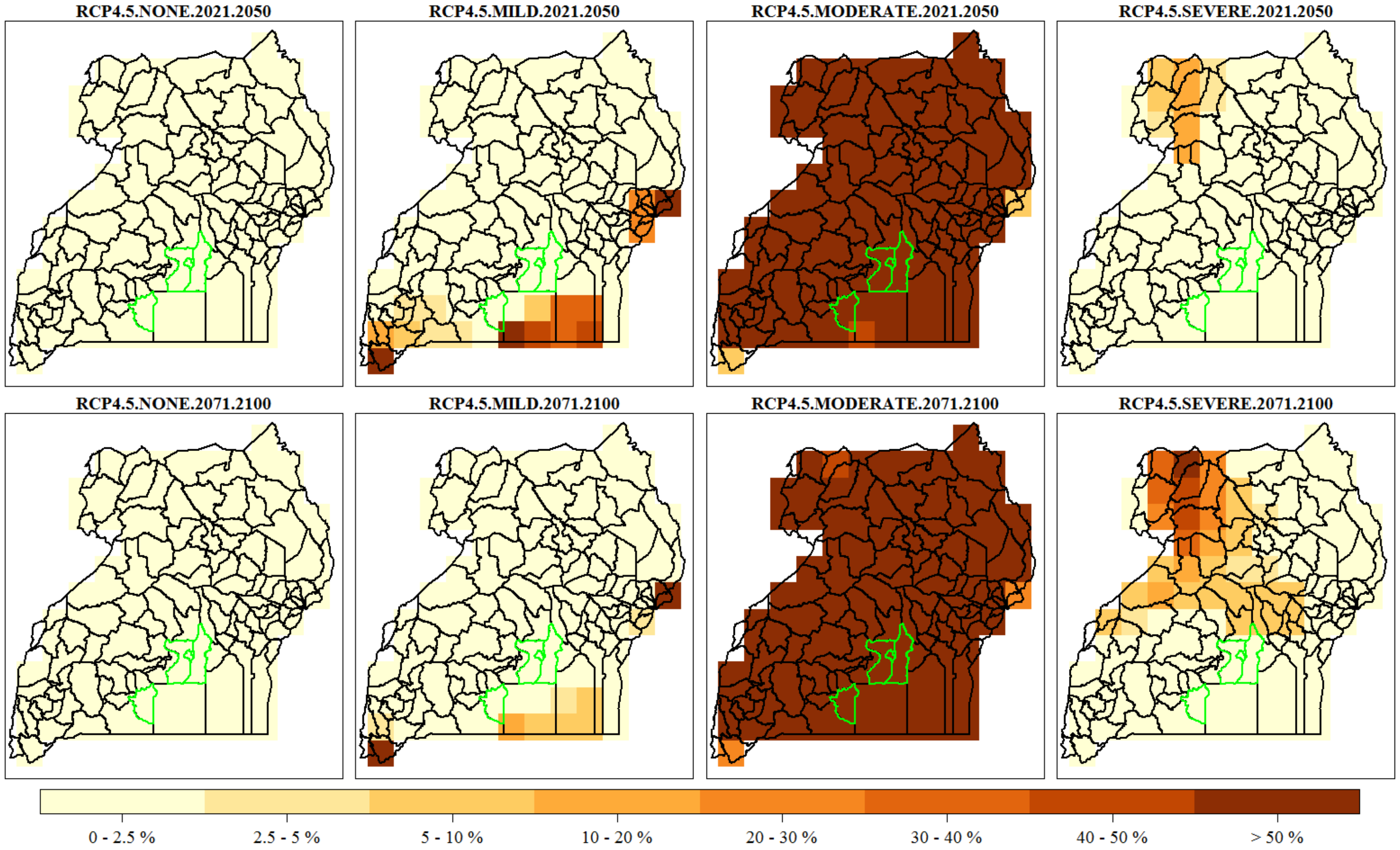
Frequency of different THI categories for dairy cattle by 2021-2050 and 2071-2100 periods under RCP 4.5 scenario

Moderate heat stress is dominant

North western parts are already experiencing severe conditions >10 % of the time



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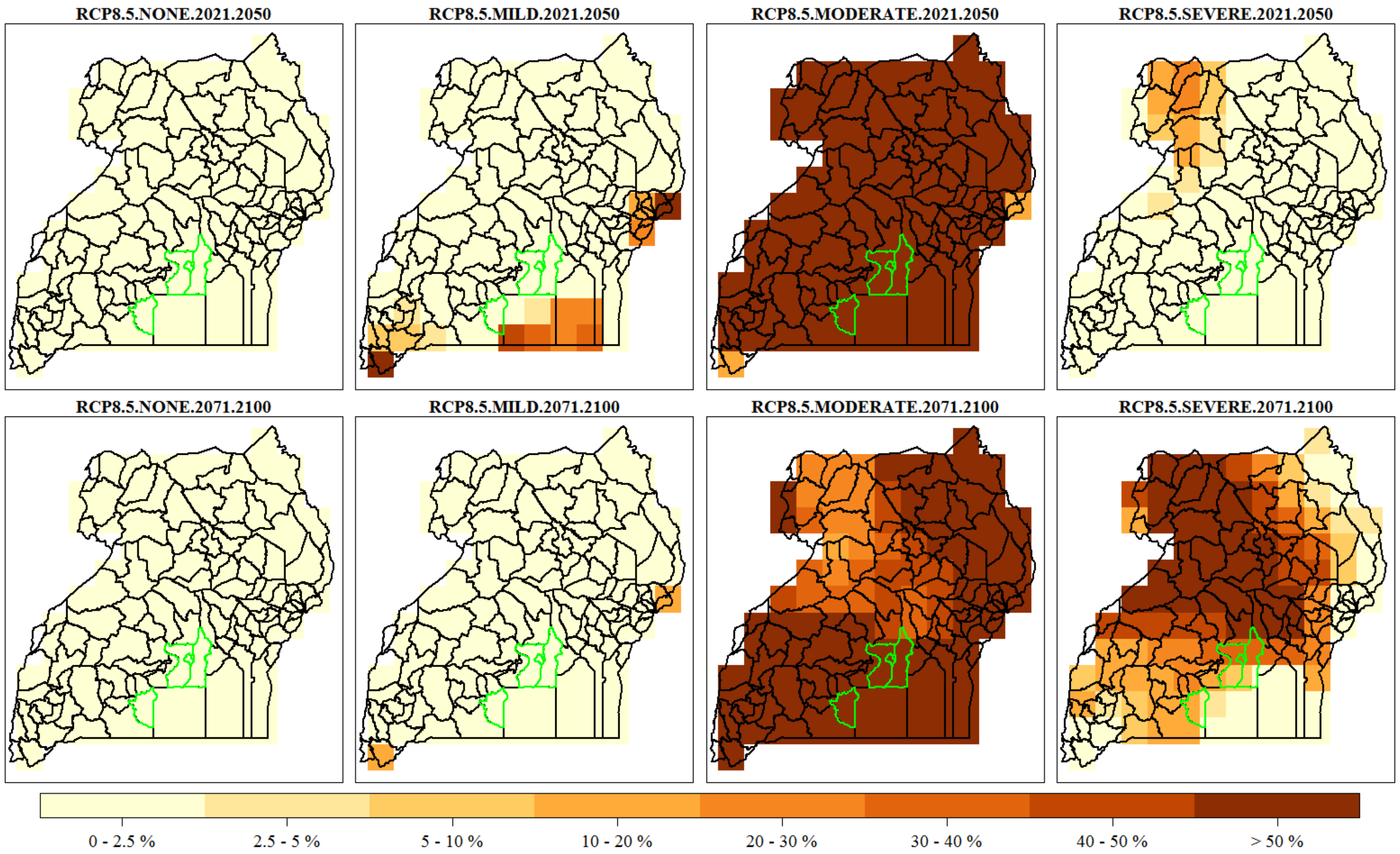
Frequency of different THI categories for dairy cattle by 2021-2050 and 2071-2100 periods under RCP 8.5 scenario

Moderate heat stress is dominant in 2021-2050 period

Central and North western parts are already experiencing severe conditions > 50 % of the time



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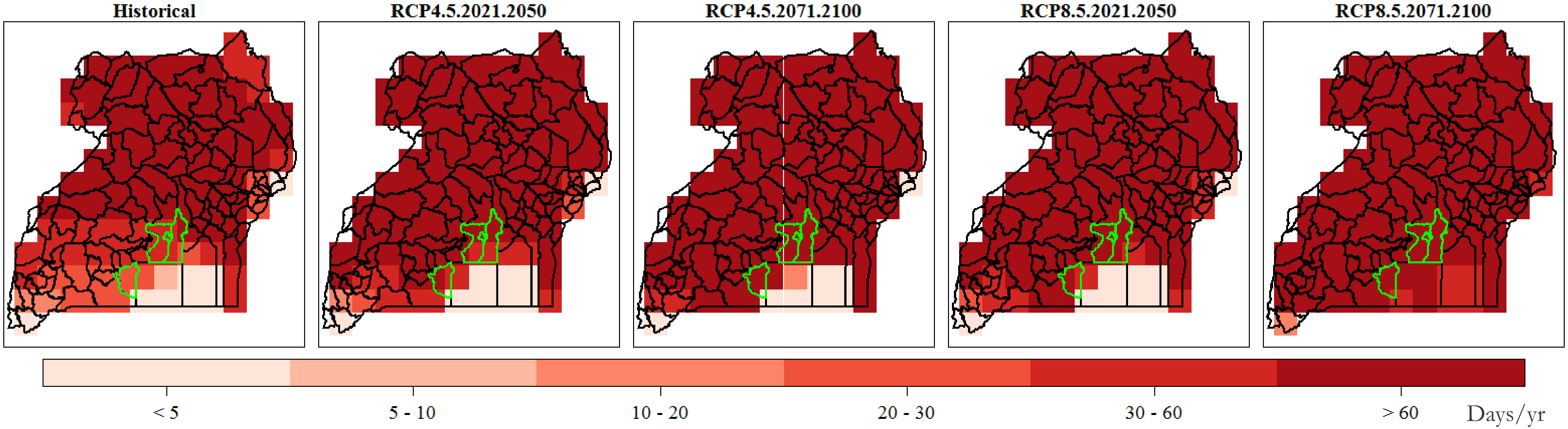
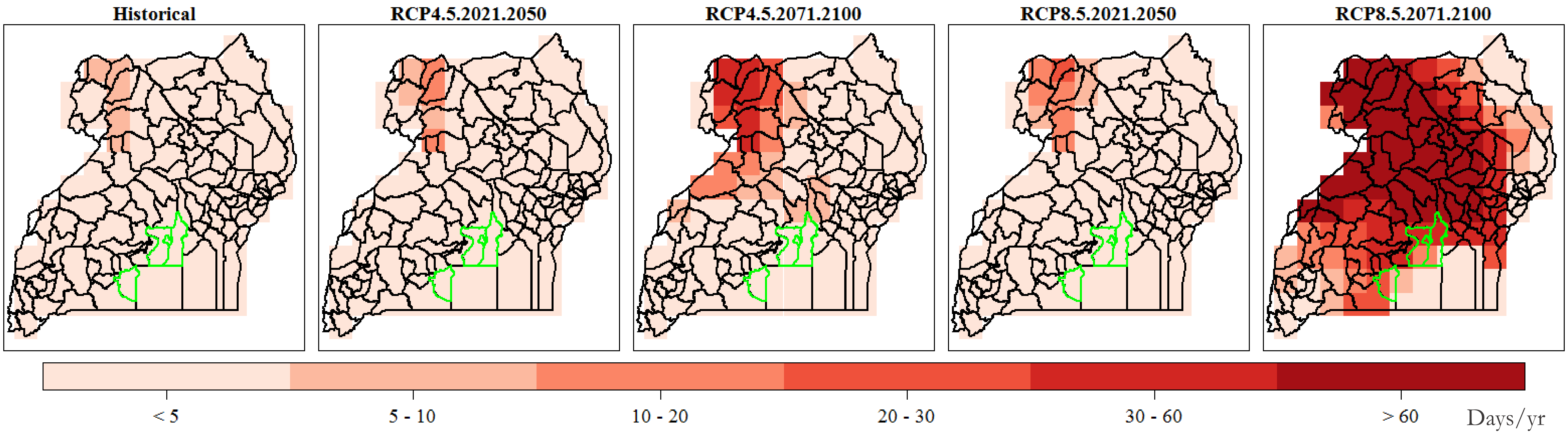
Projected changes in length of consecutive Severe/Danger heat stress condition for pig by 2021-2050 and 2071-2100 period under RCP4.5 and RCP8.5 scenarios



Average length of continuous Severe/Danger heat stress is expected to increase in the future periods across the whole country

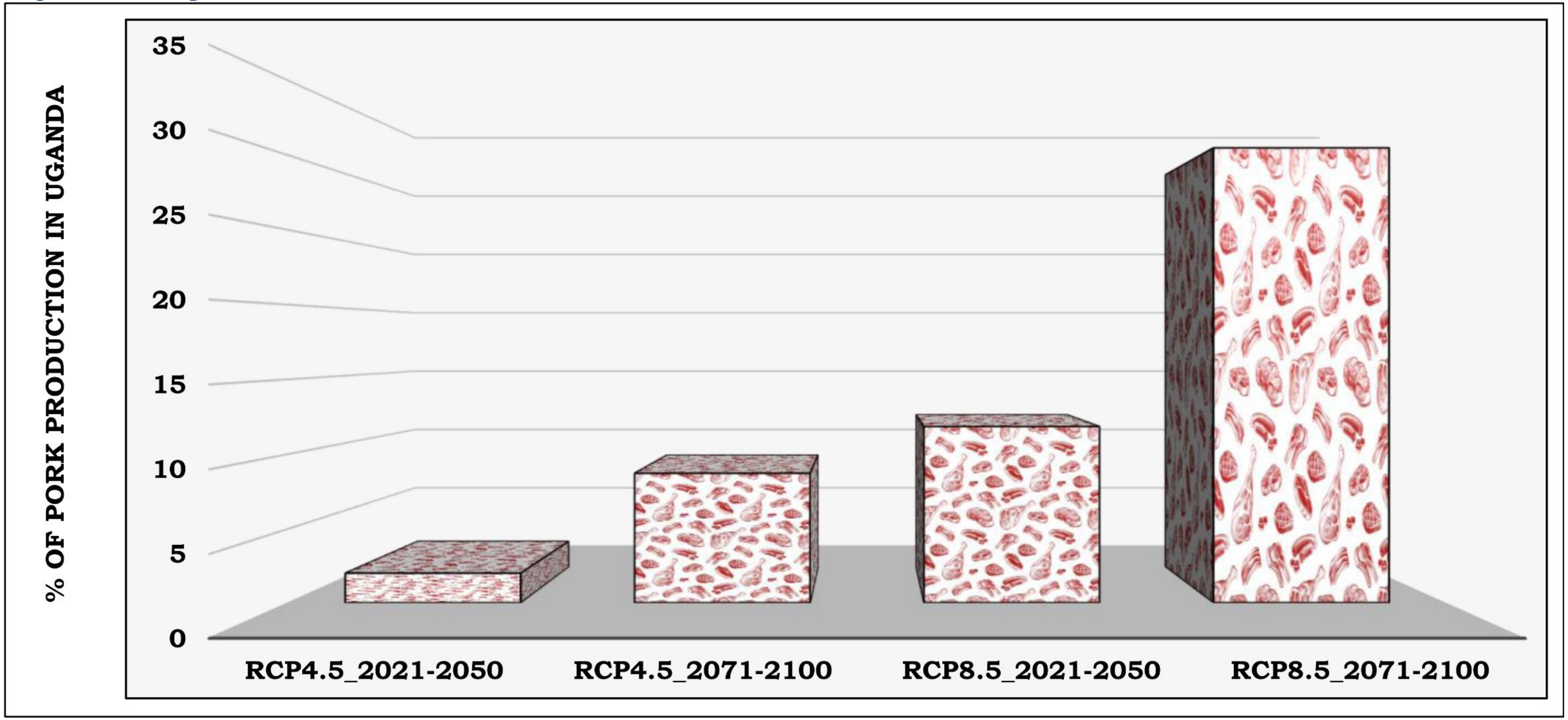
Projected changes in length of consecutive Severe/Danger heat stress condition for dairy cattle by 2021-2050 and 2071-2100 period under RCP4.5 and RCP8.5 scenarios



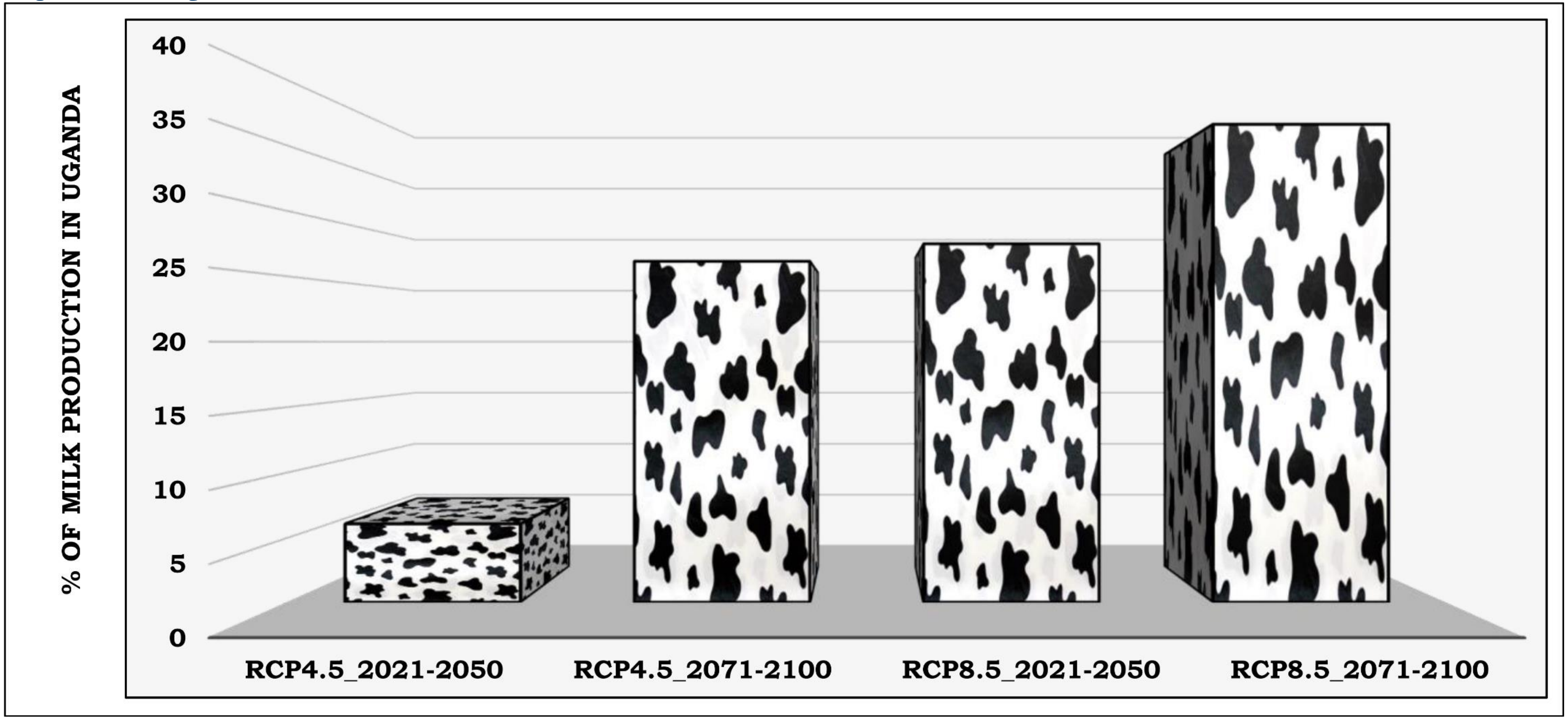
By 2071-2100, length of Severe/Danger heat stress is expected to be more extended in the north western parts; generally increase from < 5 days in the historical period to < 60 days based on RCP 8.5 in the central and north western parts

Assessing Impacts

Percentage of current pork production in Uganda which will be significantly challenged (at 95% confidence level) by increasing frequency of heat stress



Percentage of current milk production in Uganda which will be significantly challenged (at 95% confidence level) by increasing frequency of heat stress



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Conclusion

- Most regions have already experienced an increasing trend of severe heat stress historically and the trend is likely to continue in the future.
- The results presented here, might be less severe for highly heat stress adapted breeds or cross-breads. But the pattern of changes should be more or less the same.
- There is a need for experiments to be conducted for local breeds and formulate new THI formulae.
- It's necessary to adapt to the new climatic conditions in order to maintain the quantity and quality of livestock products.
- We still don't know how heat stress affects activities at different stages of the value chain.

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Thank you!

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