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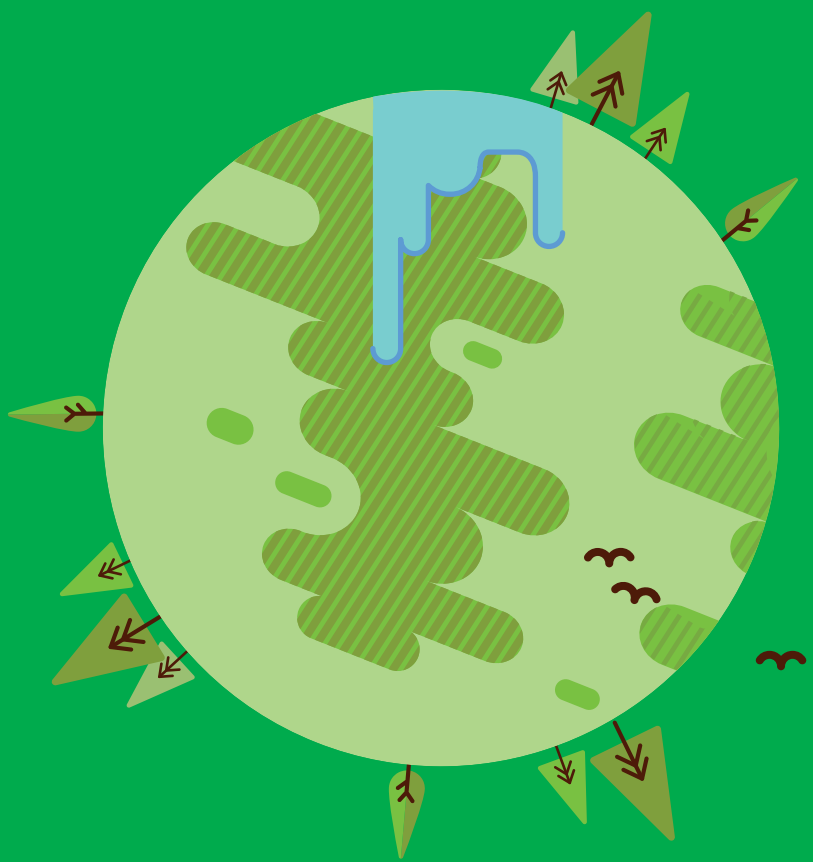
CLIMATE CHANGE, NUTRITION AND MONGOLIA:

A RISK PROFILE



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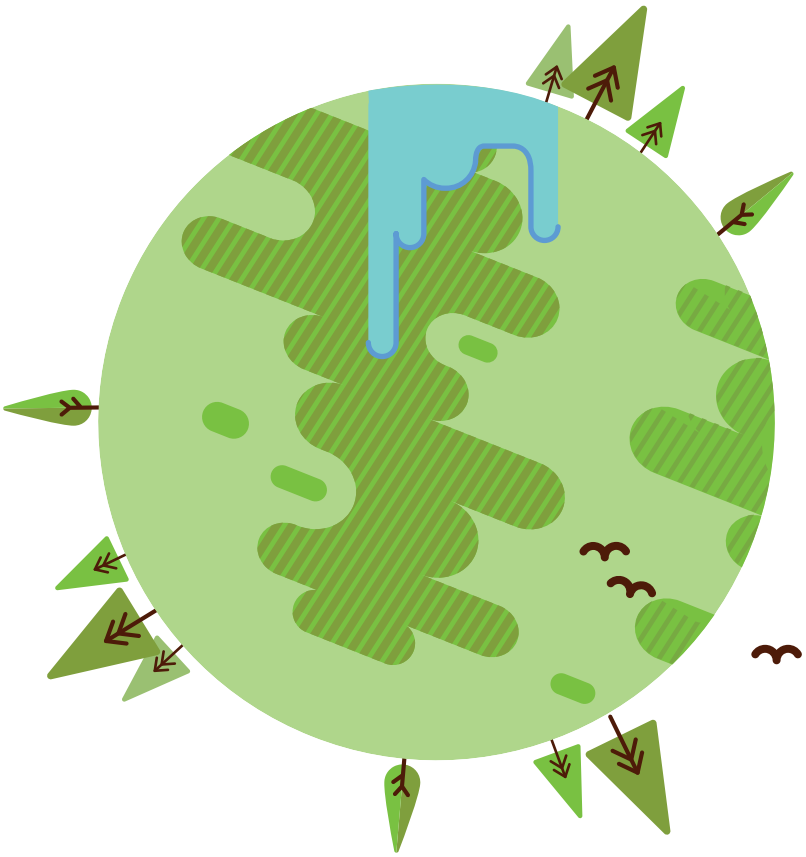

2023

Food and Agriculture Organization of the United Nations (FAO) and United Nations Children`s Fund (UNICEF). 2023. CLIMATE CHANGE AND NUTRITION IN MONGOLIA: A RISK PROFILE. Ulaanbaatar.

CLIMATE CHANGE AND MONGOLIA

Mongolia is severely affected by adverse climate change impacts, including substantially higher temperatures that have contributed to increased evapotranspiration and the drying up of the country's water resources. Moreover, the number and intensity of extreme events–especially droughts--is growing, with largest impacts on the poorer population employed in agriculture. At the same time, nutrition security remains out of reach with the co-existence of multiple forms of malnutrition, including obesity. The Mongolian pastoral culture is important to consider in balancing nutritional requirements, health risks, economics, sustainability of food production, including greenhouse gas emissions. While linkages between climate change and food security are increasingly understood, in particular the direct impacts of climate change on crop yields, associated higher food prices, and increased costs of healthy diets resulting in higher levels of malnutrition, other linkages between climate change and nutrition have been barely studied. Mongolia thus suffers from the syndemic of climate change, obesity and undernutrition, which are three co-occurring and interlinked epidemics.[1]

A better and more comprehensive understanding of the linkages between climate change and nutrition is key to developing effective interventions to ensure that Mongolia's population has access to sufficient, safe and nutritious food despite adverse climate outcomes. Importantly, climate change does not only affect food production but can exacerbate malnutrition by removing food and nutrients in all stages of the food value chain. Finally, given the important contribution of food systems to climate change, nutrition policy in Mongolia should more proactively consider environmental impacts.

MONGOLIA IN A CHANGING CLIMATE

Mongolia, the world's second largest landlocked country, sits between China and Russia. The country is characterized by a poorly diversified economy with extreme poverty affecting some 28%[2] of the population. The reliance on pastoral livestock and rainfed agriculture along with its fragile ecosystems put Mongolia's economy at risk for climate shocks and extreme weather events. Eighty percent of Mongolia's agricultural sector is concentrated in animal husbandry with around one third of the population relying on this livelihood. Due to the harsh climate of Mongolia, the crop growing season is relatively short, at 95-110 days.

From a climate perspective, the country is at a high elevation with a cold and dry continental climate, characterized by long, cold winters and short summers that make the country highly susceptible to extreme climate events of very low temperatures and droughts and significantly reduce agricultural productivity. Temperature and precipitation levels vary substantially by season. Severe winter storms followed by dry summers that expose livestock to risk of extreme cold and snow cover (white or ***Tsagaan dzud***) or lack of snow for livestock watering (black or ***Har dzud***) have occurred in Mongolia historically and have resulted in mass livestock deaths in the winter and following spring. Herders have developed resilience programs to manage these risks. However, the possible increase in frequency and intensity of ***dzud*** events affects the livelihood of families reliant on herd health.

Mean temperatures in Mongolia have risen by 2.24°C between 1940 and 2015, frost days have declined and the number of hot summer days has increased. There has been a decrease in mean annual precipitation of 7% (1940-2015) while winter snowfall has increased. Mongolia's projected warming is far above the global average and could exceed 5°C by the end of the century. Warming in maximum and minimum daily temperatures is expected to be faster than the average rate, potentially amplifying the stress exerted on human health, livelihoods, and ecosystems.

1 Swinburn, Boyd A., Vivica I. Kraak, Steven Allender, Vincent J. Atkins, Phillip I. Baker, Jessica R. Bogard, Hannah Brinsden, et al. 2019. "The Global Syndemic of Obesity, Undernutrition, and Climate Change: The Lancet Commission Report." The Lancet 393 (10173): 791–846.

2 ADB (Asian Development Bank). 2020. Mongolia's Economic Prospects: Resource Rich and Landlocked between two Giants. Edited by M. Helble, H. Hill, and D. Magee.

The impact of climate change has led to more extreme weather events including chronic drought, heat waves, flash floods on degraded lands and increased exposure to dust storms. Mongolia's unique ecosystems are likely to come under pressure from long-term warming and chronic drought, which could impact biodiversity and species loss across its landscapes. With higher temperatures, droughts and desertification are a growing concern and water sources important for livestock and food production are disappearing. An estimated 25% of lakes in the Mongolian Plateau have dried up. The drying up and salinization of lakes affects livestock watering and grazing as well as irrigation and human health directly. Milder winters, combined with degraded pastures and increased dryness has increased feed scarcity during the winter and spring. Sudden frosts have affected crop production, as have colder springs, shorter summers and warmer winters. Exacerbated by changing climate, climate extreme events have become more frequent and more severe in recent years – to the further detrimental effects on the country's food production system. Extreme rain events contribute to soil erosion and extreme cold events affect plant growth and livestock health.

CLIMATE CHANGE IMPACTS ON AGRICULTURE

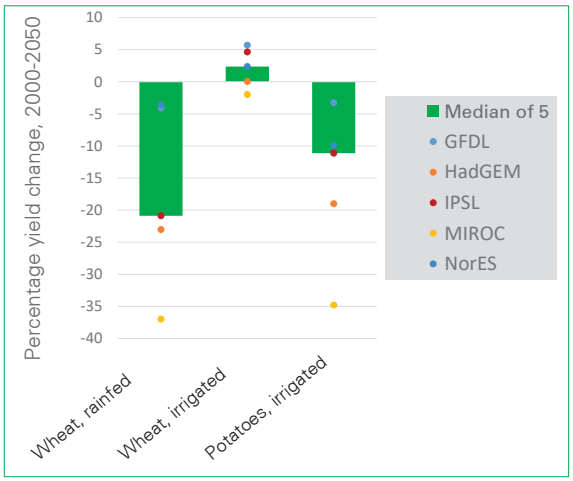

FIGURE 1 Climate change impacts on selected crops yields, 2000-2050, Mongolia
Source: *Authors. Note: GFDL = Geophysical Fluid Dynamics Laboratory climate model; HadGEM = Hadley Centre Global Environment Model; IPSL = Institut Pierre-Simon Laplace model; MIROC = Model for Interdisciplinary Research on Climate; NorES = Norwegian Earth System Model.*

Mongolia's agriculture sector is characterized by a predominance of livestock production, as reflected in the country's pastoral culture. In 2020, meat production was recorded at 625,000 metric tons (mt); dairy at 1,082,000 mt; cereals at 430,000 mt, 94% of which was wheat; and potatoes at 244,000 mt. Only three vegetables: cabbage, carrot, and turnip, accounted for around 70% of overall area planted with vegetables. In spite of mostly positive food production growth, the country has remained a net importer of food – relying on imports for 30% of cereal demand (100% for rice, 17% for wheat and 3% for barley); 48% of fruits and vegetables; and 100% of sugar. However, the country managed to maintain a net exporter status for livestock.

Direct effects of climate change on agriculture include changes in precipitation, and surface area temperatures, while indirect effects include impacts on water resource availability and seasonality, soil organic matter transformation, soil erosion, changes in pest and disease profiles, increases in invasive species, nutrient quality, and changes in arable areas. Climate change and an increase in the severity of droughts, are putting significant pressure on pasture production in Mongolia with increased threats to forage yield, livestock productivity and stocks and food production capacity. However, pasture areas might well expand with climate change.

In Mongolia, anthropogenic climate change associated with gradual changes in temperature and rainfall patterns is projected to increase temperatures and rainfall that, on average, are beneficial to agriculture. Winter crops are expected to increase in yield; spring crops will see declining yield, and climate change may allow planting of winter crops in places that were previously too cold (Figures 1, 2). The net effects of biophysical (changes in temperature and rainfall) and economic (farmer's response to price signals) impacts of climate change in 2050 on Mongolia's crop yields suggest an overall increase in yields of around 4% for cereals and a much higher, 28%-increase for potatoes with climate change while yields of fruits are expected to decline. Given growing global adverse impacts of climate change on food production, food prices are expected to substantially increase by 2050 compared to a scenario without climate change. Prices for potatoes are expected to grow by 36%, pulses by 14%, poultry meat

by 14%, vegetables by 12% and wheat by 8%. Higher food prices will change Mongolia's trade position and make it more difficult for Mongolia to source its foods from abroad. Projected imports of beef, wheat, rice, fruits and vegetables, and sugar will decline with climate-change, while projected exports of sheep/goat meat, dairy and pulses are expected to increase due to increases in world prices.

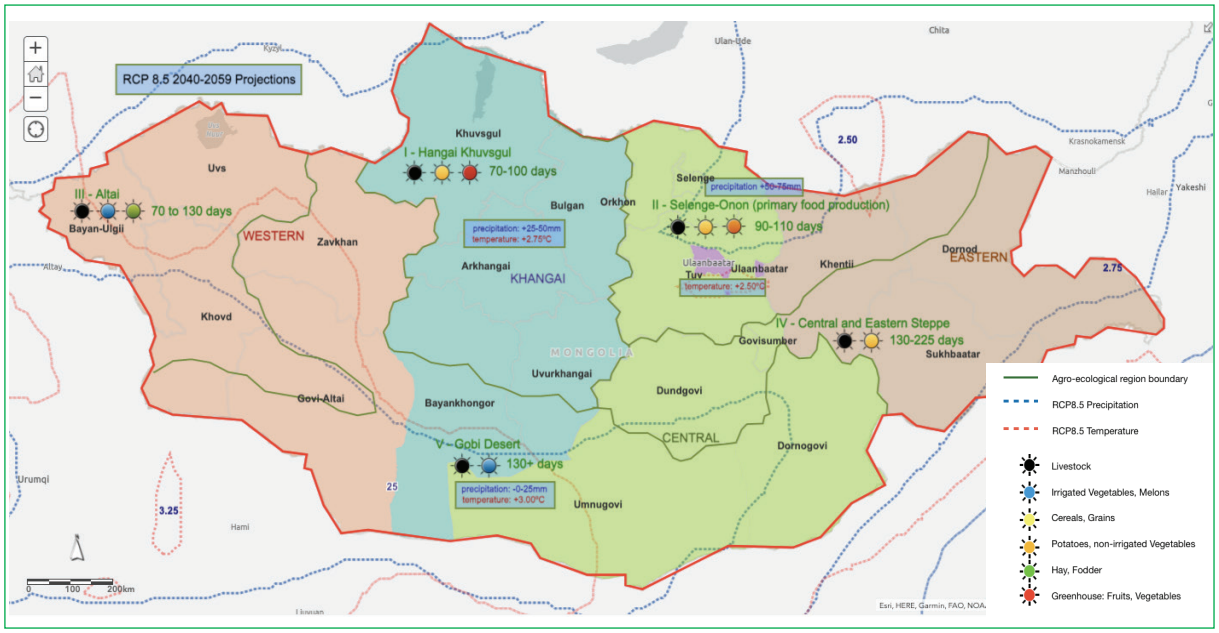

FIGURE 2. Map of Mongolia with key agricultural livelihoods and projected climate change impacts

Source: Authors.

NUTRITION IN MONGOLIA

Despite significant reductions in child stunting in recent decades, to 7.1% according to the 2022 SOFI report,[3] Mongolia continues to experience a widespread burden of multiple micronutrient deficiencies. The most recent Mongolian National Nutrition Survey found anemia prevalent in 27% of young children (<5 years) and 21% of pregnant women, vitamin A insufficiency or deficiency in 70% of young children and 12% of pregnant women, and vitamin D deficiency or insufficiency in 90% of young children and 96% of pregnant women[4]. Only 58% of young children are exclusively breastfed up to six months and only 44% achieve a minimum acceptable diet. Only 33% of urban and 41% of households nationwide are food secure, with severe insecurity affecting 26% and 17% of urban and rural households, nationwide are food secure, with severe insecurity affecting 26% and 17% of urban and rural households, respectively, according to the Household Food Insecurity Access Scale. Almost 50% of Mongolians cannot afford a healthy diet, while most of the population can afford a calorie dense diet.

A recent nationwide survey of men and non-pregnant women of reproductive age found low consumption of healthy, nutrient-dense food groups including fruits, non-tuberous vegetables, eggs, nuts and seeds, fish and poultry, and whole grains, while dietary inadequacy of 10 of 21 assessed nutrients, including fiber, folate, and vitamin was

3 FAO, IFAD, UNICEF, WFP and WHO. (2022). The State of Food Security and Nutrition in the World 2022. Repurposing food and agricultural policies to make healthy diets more affordable. Rome, FAO.

4 Public Health Institute of Mongolia. Nutrition Status of the Population of Mongolia—5th National Nutrition Survey Report; Ministry of Health: Ulaanbaatar, Mongolia, 2017. The survey which interviewed a cluster-randomized sample of 2249 households that included a child 0-59 months old.

>50% prevalent[5]. Despite wheat flour being an excellent candidate for mandatory mass fortification in Mongolia, with legislation and local industrial standards, iodized salt remains the only mass-fortified food in the country[6]. A review and update of the country's dietary guidelines[7] accompanied by an awareness campaign might help shift diets to increased consumption of fruits and vegetables.

Compounding micronutrient deficits is a growing burden of cardiometabolic risks in Mongolia. During the period from 2005 to 2013, the prevalence of overweight increased more than in all but three countries globally[8] and showed consistent increases in waist circumference, percent body fat, blood pressure, and cholesterol in adults[9]. Overweight or obesity currently affects 29% of schoolchildren and 63% of mothers and men, 61.9% of adults have elevated serum cholesterol, and 27.5% have high blood pressure or are on medication9. These trends are attributable to dietary risks including extremely high consumption of red meat, refined grains, and whole-fat dairy4, and low physical activity, which affects 22.3% of adults[9]. A recent policy analysis identified significant gaps in implementation of national policies for mitigating the burden of noncommunicable diseases (NCDs) in Mongolia, including a lack of physical activity guidelines, insufficient actions to address marketing of foods and beverages to children, a lack of national research funding for NCD prevention and control, and limited use of NCD-related surveys for research purposes[10].

In global studies comparing diets and NCD risk across countries, Mongolia scored lower than any other country in both 1990 and 2017 in the Alternative Healthy Eating Index (a metric of diet-related chronic disease risks)[11], ranked 1st among all countries in the fraction of cardiovascular (CVD) mortality attributable to dietary imbalances in both men (57%) and women (51%), and 4th in the rate of age-standardized all-cause mortality attributable to diet (323 deaths per 100,000)[8]. Mongolia also ranked 23rd and 11th in rates of all-cause and CVD mortality attributable to cardiometabolic risk factors, respectively.

CLIMATE CHANGE IMPACTS ON NUTRITION

Climate signals differ by country and by location within country and they are experienced differently by different economic sectors but also by gender. The level to which sectors, countries, communities, households and individuals can address climate change, including climate shocks and stressors on nutrition, depends on their resilience capacities vis-à-vis nutrition.

These include absorptive capacity--the ability to minimize exposure and sensitivity to shocks prior to their occurrence (ex-ante), and the ability to recover quickly (ex-post); adaptive capacity–the ability to make proactive and informed choices to manage climate risk more effectively; and transformative capacity-- the ability to make structural changes to reduce the likelihood of adverse climate impacts from happening. All of these capacities need to be strengthened to address adverse climate change impacts on nutrition. Response options include coping, risk management, adaptation and transformation at individual, household, community and government levels. The action space of different actors is limited by resilience capacities and other factors, such as risk tolerance, knowledge and perceptions of the options available, and expectations about impacts of alternative options.

5 Bromage, S., Daria, T., Lander, R. L., Tsolmon, S., Houghton, L. A., Tserennadmid, E., Gombo, N., Gibson, R. S., & Ganmaa, D. (2020). Diet and Nutrition Status of Mongolian Adults. Nutrients, 12(5), 1514.

6 Global Fortification Data Exchange. Dashboard: Country Fortification http://www.fortificationdata.org.

7 https://www.fao.org/nutrition/education/food-based-dietary-guidelines/regions/countries/mongolia/ar/

8 Institute for Health Metrics and Evaluation. GBD Compare. http://vizhub.healthdata.org/gbd-compare.

9 World Health Organization. Mongolian STEPS Survey on the Prevalence of Noncommunicable Disease and Injury Risk Factors-2013; World Health Organization: Ulaanbaatar, Mongolia, 2013.

10 Chimeddamba, O., Peeters, A., Walls, H. L., & Joyce, C. (2015). Noncommunicable Disease Prevention and Control in Mongolia: A Policy Analysis. BMC public health, 15, 660. https://doi.org/10.1186/s12889-015-2040-7

11 Wang, D.D.; Li, Y.; Afshin, A.; Springmann, M.; Mozaffarian, D.; Stampfer, M.J.; Hu, F.B.; Murray, C.J.L.; Willett, W.C. Global Improvement in Dietary Quality Could Lead to Substantial Reduction in Premature Death. J. Nutr. 2019, 149, 1065–1074.

PATHWAYS FROM CLIMATE CHANGE TO NUTRITION

The evidence of climate change impacts on nutrition remains globally limited. As shown in Figure 3, climate change can exacerbate undernutrition through three main pathways: **household food security** (access to safe, affordable, and sufficient food), **child feeding and care practices, and environmental health and access to health services.**[12]

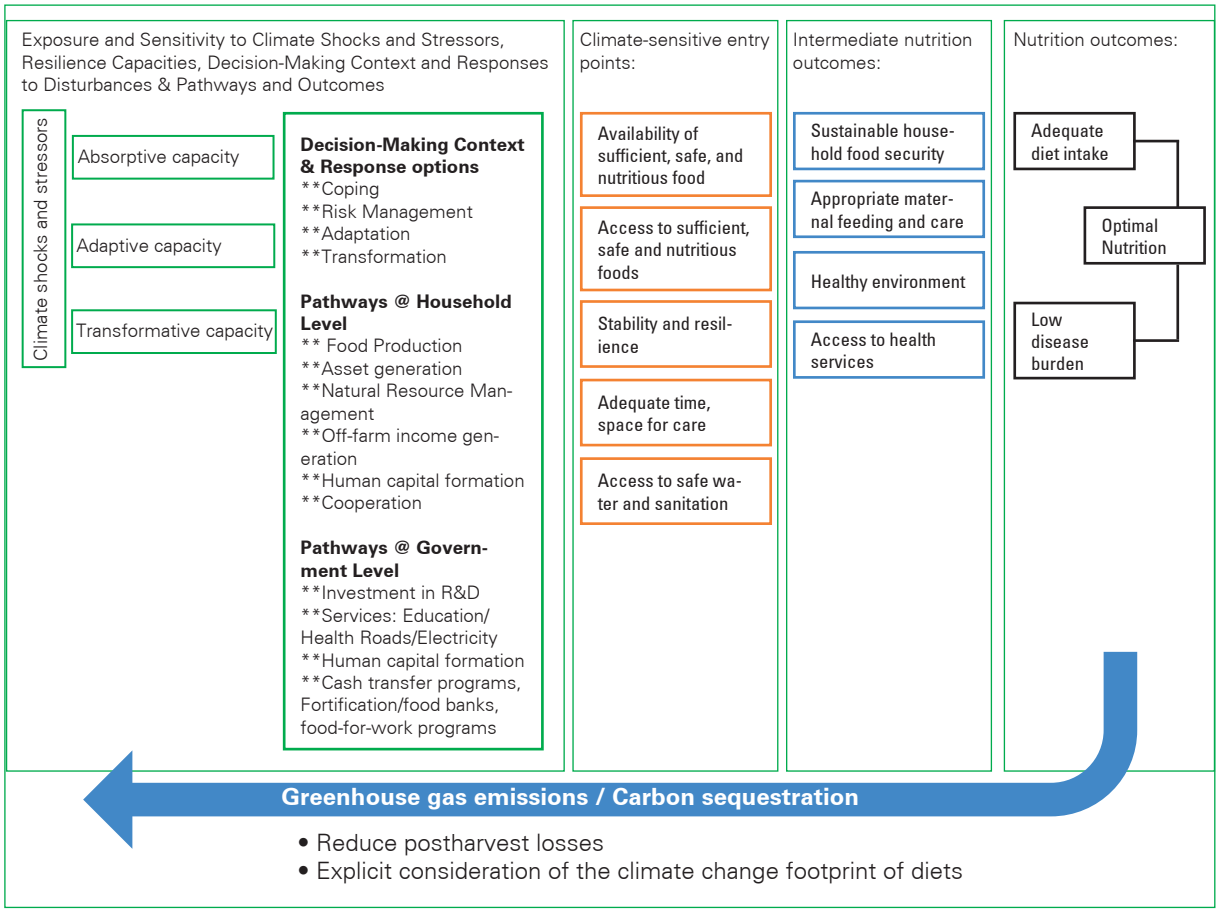

FIGURE 3. Framework linking climate shocks and stressors with nutrition outcomes

Source: Authors.

Impacting these pathways can have consequences on child growth outcomes. Among these pathways, evidence in Mongolia is limited to household food security. Specifically, there is evidence that climate extreme events, specifically dzuds which affect household food security and can lead to low birth weight and stunting of children of pastoralists in Mongolia.

Given the country's lack of diversification in the agriculture sector, growing threats to livestock systems could put pastoralist livelihoods but also the population at large that is depending on animal source foods at growing risk of food insecurity and malnutrition. The reduction of watering points and drying of grazing areas in parts of the country can reduce income and employment opportunities of herders, with potentially adverse food security and nutrition impacts. Moreover, climate extreme

12 Fanzo, J., C. Davis, R. McLaren, and J. Choufani. 2018. The effect of climate change across food systems: Implications for nutrition outcomes. Global Food Security 18: 12-19.

events can affect crop yields locally. Growing variability in water access can also affect food preparation and drinking water security and thus nutrition outcomes. Extreme heat and air pollution can have major effects on cardiovascular health; in particular, higher temperatures can increase the occurrence of heart attacks and strokes in people susceptible to cardiovascular disease. Given high obesity levels, high levels of air pollution in the capital city and the strong exposure of agricultural activities to heat and cold stresses in Mongolia, the government should urgently address air pollution challenges that will likely worsen with climate change and support programs directed at cardiovascular health, including ensuring adequate access to health services and stronger programming for improved diets supporting cardiovascular health.

Figure 3 describes a series of proactive interventions to reduce climate change impacts on nutrition outcomes in Mongolia based on the literature and analyses from this study.

1) Grow availability of sufficient, safe and nutritious food

Availability of sufficient food depends both on household, regional and national food production as well as on the ability of countries to source food from abroad. Recent climate change and other crises have made it clear that reliance on a single trading partner might be sub-optimal. As such, Mongolia should more actively diversify production of foods inside the country and also grow the number of countries food imports are sourced from.

2) Grow access to sufficient and safe food

Climate extreme events and other shocks are linked with food price increases and associated declines in dietary diversity. Ensuring that adequate diets are affordable in times of climate crises will require proactive social assistance programs by the government, such as cash-transfer programs and school feeding programs that should be expanded in size and scope during extreme climatic events. Moreover, the government should review the climate resilience of agricultural input, feed and food supply chains and implement investments to reduce interruptions during climate extreme events.

3) Grow stability and resilience of food, water and energy supplies

Including adequate food stocks, diversifying sources of food imports, improving water control through irrigation, and investing in enhanced storage and processing of food are all measures that can improve food security and nutrition outcomes. To achieve these results, investments in water and energy security are also needed, to ensure watering points, grow irrigation and improve cold storage and processing facilities.

4) Ensure adequate time and space for caring and reduce women's time burden

Emerging evidence suggests that during heat waves men tend to search for more remunerative, off-farm jobs, while women spend more time in food production, exposing them to adverse heat stress outcomes and reducing their time to care for their children. This is particularly worrisome when heat exposure is linked with malnutrition such as obesity or overweight, as extreme heat and air pollution can affect cardiovascular health. Climate change also reduces availability and quality of water bodies that women rely on as domestic water sources and can reduce the availability and quality of firewood. All of these climate change impacts can grow women's time burden potentially adversely affecting children's care and nutritional status.

5) Access to safe water and sanitation

Continued access to safe domestic water sources is important for nutrition given that water is essential for all bodily functions and processes and drinking water is an important source of nutrients. Safe drinking water is key for food processing and food preparation, including for infant foods. Growing evidence suggests that water-insecure households also tend to be food-insecure.

If climate resilience investments in these five areas at individual, household, community and government levels are strengthened, then the resilience of overall nutrition outcomes is improved. To address the multiple dimensions of undernutrition it is, moreover, important to ensure adequate access to healthcare facilities and staff, particularly for vulnerable populations, and especially for the rural poor.

LINKAGES BETWEEN CLIMATE CHANGE AND NUTRITION

Regions I (Hangai-Khuvsgul with precipitation of 200-400 mm) and IV (Central and Eastern Steppe with 130-220 mm) particularly lack dietary diversity and are also expected to see large increases in temperatures and small increases in rainfall (Figure 4). Growing vegetables without water control or greenhouses will become more challenging, potentially further reducing dietary diversity. Regions I, II (Selenge-Onon with precipitation of 325 mm, plus Ulaan Bataar) and IV also experience substantial food insecurity; but these are also regions where agricultural productivity is currently highest. Vitamin D is a challenge everywhere; even if the challenge possibly slightly declines with warmer weather, the best solution might be mandatory industrial fortification, alongside targeted supplementation measures.[13]

The most extreme climate change impacts are expected to occur in the South (Region V, Gobi Desert, precipitation of less than 100 mm), including the largest temperature increase and potential declines in precipitation. Additional assessments need to be undertaken to what extent livestock herding and irrigated agriculture will remain feasible. Here, the potential of groundwater pumping, advanced irrigation systems, heat-stress tolerant livestock and irrigated pastures should be considered.

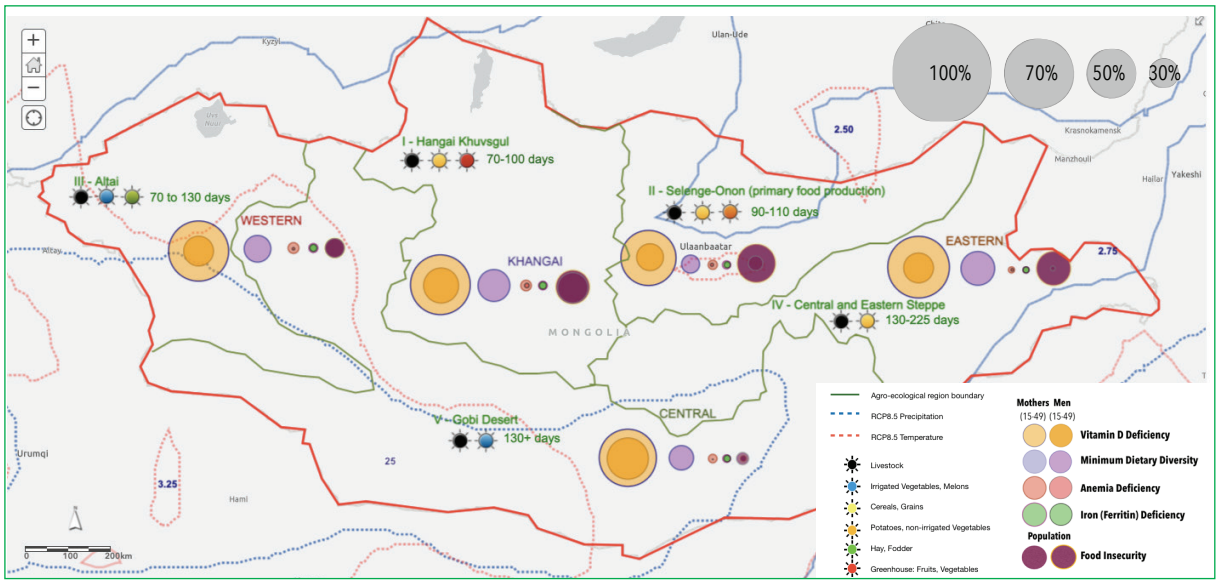

FIGURE 4 Agro-ecological zones, economic zones, predicted temperature and precipitation changes and key nutri-tional deficiencies
Source: Authors.

Moreover, given the country's large dependence on food imports, higher global food prices as a result of climate change could further limit dietary diversity of Mongolian households to nationally grown foods, including animal source foods, wheat and potatoes. Finally, growing urbanization and sedentarization of pastoralist households and a growing number of extreme climate events will likely further reduce mobility of children and adults, further contributing to overweight and obesity and associated health care costs.

13 Bromage S, Ganmaa D, Rich-Edwards JW, Rosner B, Bater J, Fawzi WW. Projected effectiveness of mandatory industrial fortification of wheat flour, milk, and edible oil with multiple micronutrients among Mongolian adults. PLoS One. 2018 Aug 2;13(8):e0201230.

CLIMATE CHANGE IMPACTS ON ANTHROPOMETRIC INDICES IN YOUNG CHILDREN

An analysis of the severe dzud of 2009–10, which resulted in the death of 10.3 million livestock showed that this weather shock significantly slowed the growth trajectory of exposed children from herding households with the effect driven by children who experienced the shock in utero. The study also notes that the provision of emergency aid mitigates the negative consequences of the climate shock.[14] The authors undertook an analysis using 18 years (2000-2018) of nationally-representative Multiple Indicator Cluster Survey (MICS) data[15] from Mongolian infants and young children (<5 years) to evaluate whether climate anomalies affect anthropometric Z-scores indicative of acute or chronic malnutrition, which might be explained through perturbations in child feeding practices. Data analyzed included potential predictors and confounders including sex, age, province and urban vs. rural locality, wealth score, mother's education, and variables on infant and young child feeding (IYCF): child ever been breastfed, child still being breastfed, child received vitamin or mineral supplementation, child received plain water, child received sweetened drink, child receive oral rehydration, and child received milk. The analysis revealed persistent stunting (height-for-age Z score <-2) and underweight (weight-for-age <-2) outside Ulaanbaatar and central Mongolia.

Children in regions with less precipitation had lower body mass index; of relevance to this finding, with climate change, precipitation is expected to decline in Khovd, Govi-Altai, and Omnogovi regions. Moreover, cumulative precipitation was a significant predictor for weight-for-age and weight-for-height Z-scores and body mass index. Weight-for-age improved with mothers' level of education, higher wealth scores, and when the child had been breastfed. Children, and those who were breastfed or living in Khangai, Ulaanbaatar, the Western region, and within the Central Eastern agricultural ecozone might also experience changes in weight-for-height Z-scores with decreased or increased precipitation.

CLIMATE CHANGE IMPACTS ON MONGOLIAN DIETS

The authors also analyzed twelve years (2008-2019) of nationally- and seasonally-representative data of 106,696 households taking part in the Mongolian Household Socio-Economic Survey (HSES) to evaluate relationships between key climate variables, precipitation and temperature, household per capita consumption of major food groups, and two dietary diversity scores – the Husehold Dietary Diversity Score (HDDS; range: 0-16) and Minimum Dietary Diversity Score (MDD-W; range: 0-10) – calculated using household per capita food consumption. Survey-weighted mean dietary diversity (measured by household per capita MDD-W) varied little across the years of analysis In all years, the highest mean MDD-W was found in Ulaanbaatar, followed by aimag centers, soum centers, and rural areas).

As can be seen in Figure 5, HDDS in Ovorkhangai increased over time and corresponded to increases in mean temperature while Bayan-Olgi had decreases in HDDS with increases in mean temperature. MDD-W had similar results (correlation between HDDS and MDD-W: r=0.89). Increases in egg consumption corresponded with higher temperatures. Vitamin A-rich vegetables and tubers consumption was generally linked with warmer temperatures. There was also a tendency to consume certain food groups in warmer temperatures, such as eggs, fish and seafood, organ meats, and oils and fats. The analysis also indicated higher household consumption of several dairy products, flesh meat, and fish and seafood with higher precipitation.

14 Groppo, V., & Kraehnert, K. (2016). Extreme weather events and child height: evidence from Mongolia. World Development, 86, 59-78.

15 Of note, MICS data had substantial deficiencies regarding data quality; data were collected during different seasons, and several administrative variables were missing.

This analysis suggests that to reduce the relationship of climate variables with consumption of different types of foods will require increased availability of retail stores that provide consistent quality of fresh products, including meats, seafood and vegetables as well as retail and transportation infrastructure that supports consistency in prices of fresh food products. If this cannot be provided, then there may be a higher risk that cold winters and other climate extremes could adversely affect dietary diversity and overall nutrition outcomes.

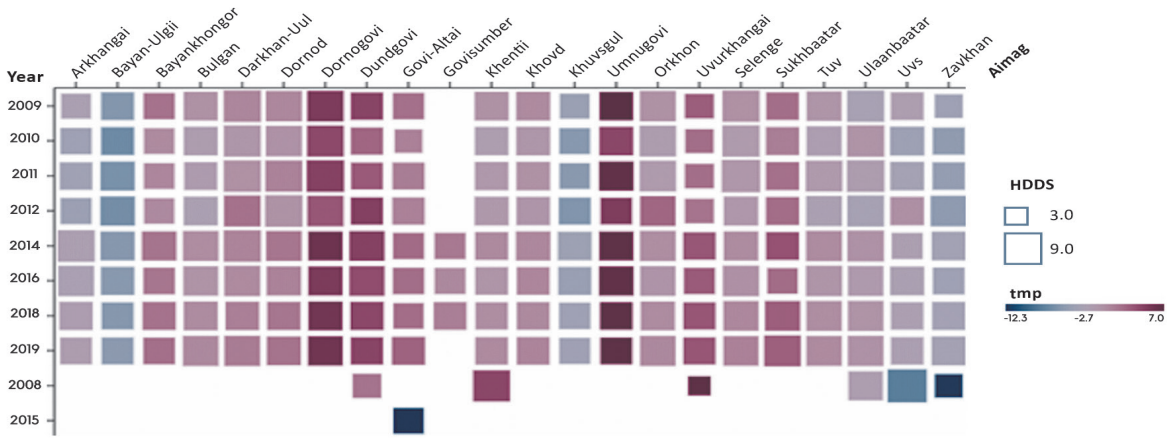

FIGURE 5 Relationship between HDDS and temperature across Mongolia

Source: *Authors; Notes: Darker red colors indicate warmer temperature and larger squares indicate higher HDDS.*

MONGOLIAN DIETS GROW CLIMATE CHANGE

Mongolia's Nationally Determined Contribution (NDC) to the UNFCCC estimates total emissions of 74.3 Mt CO_2-eq by 2030 and 49.1 Mt CO_2-eq in 2020. In 2014, Mongolia's total greenhouse gas emissions were calculated at 34 Mt CO_2-eq, almost half of which was contributed by agriculture. Within agriculture, emissions are almost entirely contributed by livestock populations that vary with extreme events. Mongolia's diets also contribute to water pollution and water depletion.

Mongolia's NDC proposes investments in the areas of livestock number management as well as manure management to address the high and growing greenhouse gas emissions from the agriculture sector. However, interventions are challenging given the dispersed location of livestock herds across the country. To reduce climate change impacts on Mongolia's nutrition, it is important for the country to invest in mitigation measures in the livestock sector.

CLIMATE CHANGE IMPACTS ON NUTRITION OF TWO FOOD VALUE CHAINS OF MONGOLIA

To identify bottlenecks in two key Mongolian value chains, meats and vegetables, a climate-nutrition value chain analysis was implemented for these two agricultural commodities through Key Informant Interviews and Focus Group Discussions.

Interviewees included livestock and vegetable producers at the soum level; meat and vegetable processors and traders, public officers at the province level; representatives of abattoirs and meat processing plants, the Ministry of Food, Agriculture and Light Industry, the Mongolian Meat Association, the Mongolian Greenhouse Entrepreneurs Association, the Academy for Climate Change Development, and the Mongolian Biotechnology Association.

According to herders, the following five signs of climate change are common in all natural zones: (1) desertification, (2) strong winds, (3) seasonal regime changes (late summers, warm winters), (4)

increased frequency of heavy rains and floods, and (5) heat stress or drought.

Figure 6 summarizes the results of Focus Group Discussions and Key Informant Interviews for the meat value chain. At the input supply stage, low pasture carrying capacity and remote pastures without watering points reduce livestock nutrition and thus animal growth and quality. Lack of precipitation reduces pasture quality and results in lower meat quality. This can be addressed by irrigating pastures, establishing artificial ponds and growing perennials on pastures. Similarly, with too many hot days, animals' body weight, yield, carcass weight, and meat protein content decrease, connective tissue increases, muscle water retention quality deteriorates due to the thickening of muscle fibers, and the meat becomes too hard, moistureless, and tasteless. Pregnant animals are less likely to withstand climate extremes and calving is often intentionally reduced to ensure animal survival.

At the production stage, lack of access to finance and labor shortages, the lack of acceptance of otor herders (pastoralists who migrate into other regions to escape dzuds) in other provinces and soums, and inaccurate forecasts of bad weather events reduce livestock productivity. Fodder banks, better management of otor movements and improved forecasting of extreme events can reduce the loss of livestock productivity during the production stage. At the slaughter stage, deterioration of meat and

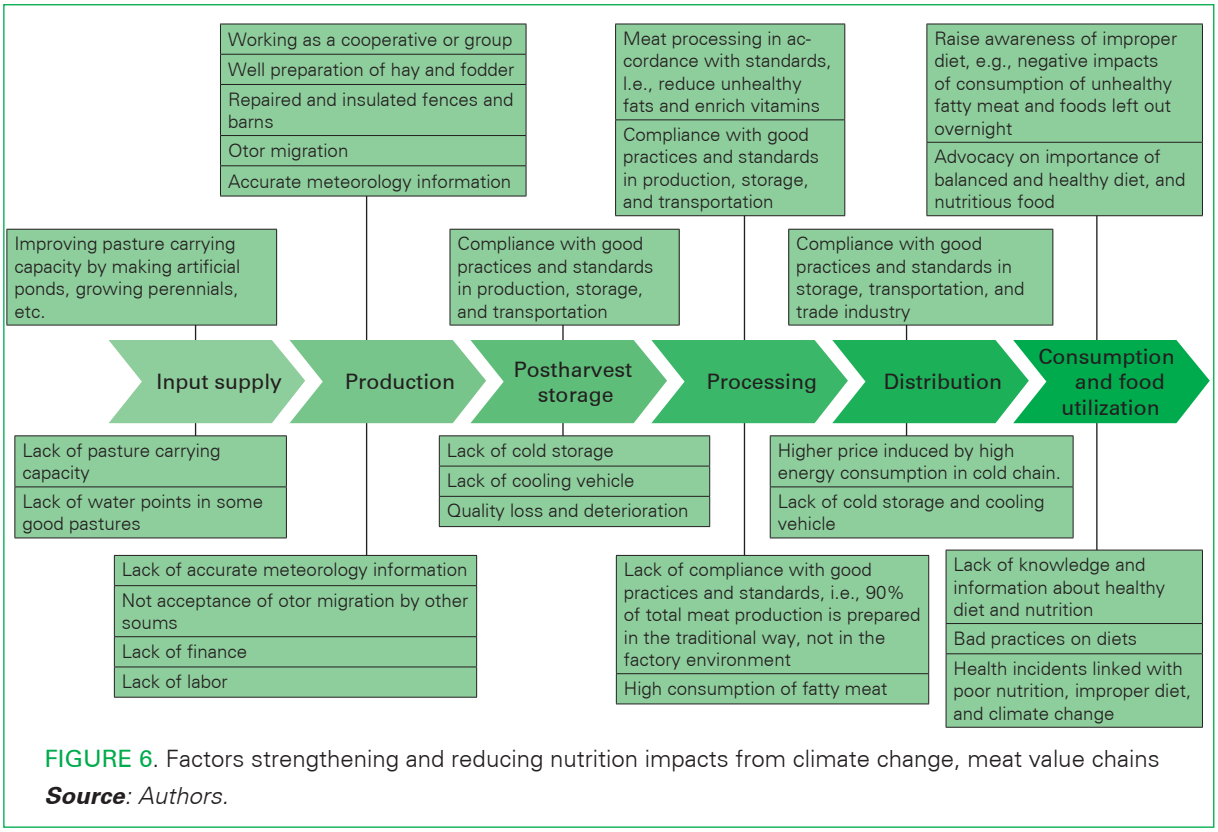

FIGURE 6. Factors strengthening and reducing nutrition impacts from climate change, meat value chains
***Source**: Authors.*

meat products due to lack of cold storage and cooling vehicles affects the quantity and quality of meat produced. To address this, better transportation, storage, and trade will be needed. The biggest challenge in the processing phase is the traditional preparation of meat, mainly in herders' homes, instead of abattoirs. Local slaughtering can lead to food contamination, foodborne illness, and adverse health effects. At the consumption stage, more information needs to be disseminated on healthy diets, with a focus on diversifying diets toward more consumption of fruits and vegetables. The dominance of meat consumption in pastoralist diets threatens food security and nutrition of herders directly as livestock production is subject to large climate risks. Index-based livestock insurance supports herders who signed up to the program during large and catastrophic losses. It remains unclear to what extent the insurance system can support larger payouts as a result of climate change.

Figure 7 summarizes the results of Focus Group Discussions for the vegetable value chain. In the input supply stage, a lack of quality soils affects vegetable production. Developing climate change- and drought-resistant seed varieties and enhancing farmers' knowledge of soil protection techniques can improve production and productivity of vegetables. Due to variable weather, some crops freeze due to sudden frosts during harvest, resulting in reduced yields and nutrients. Sudden fluctuations in air temperature, as well as loss of crops due to heavy rains and floods is not uncommon. At the production stage, financial and labor shortages, insufficient machinery, equipment, and irrigation, and lack of knowledge and skills of agricultural technology and improved practices have a negative impact on the quality and quantity of vegetables produced.

Because vegetable producers are predominantly considered informal, they are excluded from government-provided economic and financial support. Incentives from the Crop Production Support Fund are provided to large-scale, grain-growing enterprises. Very little government support exists for small/marginal vegetable-growing households The establishment of cooperatives, capacity building on agricultural technology and best practices, and more direct government support could help grow vegetable production. Lack of cold storage and cooling vehicles affects the storage, transportation, and distribution of fresh vegetables. Moreover, few vegetable processing plants are in operation. Processing enterprises and household growers do not always comply with best practices. Moreover, vegetable consumption remains low due to limited knowledge on the importance of dietary diversity of Mongolian consumers.

For both the meat and vegetable value chains, the slaughter (livestock) and post-harvest (vegetable) stages are key bottlenecks that result in low economic benefits to producers, poor diversity of diets of producers (particularly in the case of pastoralists), high risks of adverse climate change impacts, and lack of overall diversification of agricultural systems.

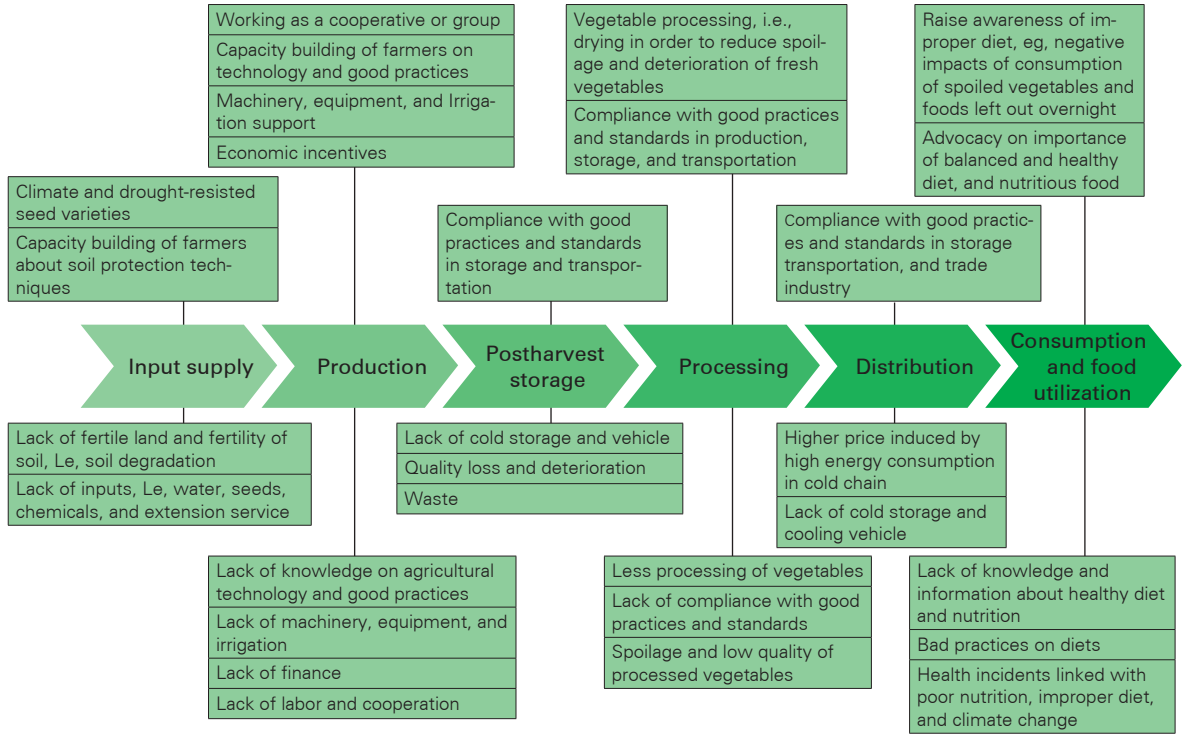

FIGURE 7 Factors strengthening and reducing nutrition impacts from climate change, vegetable

Source: *Authors.*

CONCLUSIONS

Mongolia's projected warming is far above the global average and could exceed 5°C by the end of the century with potentially large impacts on rural livelihoods, diets and nutrition. The country's traditional diet is a product of environmental constraints that have historically limited fruit and vegetable availability, particularly in rural areas in which diets remain mainly based on red meat, refined wheat flour, dairy products, and potatoes. In urban areas, Mongolia's rapidly globalized food environment, increasingly sedentary lifestyles, and inadequacies in non-communicable disease prevention policy have led to an obesogenic diet that compounds nutritive deficiencies of the traditional cuisine and has led to rising rates of cardiometabolic disease. Climate change is expected to worsen existing nutrition-related risks in the country through higher temperatures, increased intensity and frequency of climate extremes, and growing water scarcity and pollution and air pollution. These impacts will further challenge rural livelihoods, grow dependency on food imports, and challenge rural transportation and food storage.

Long-term strategies for addressing nutritional deficits in Mongolia will therefore require a multipronged approach that improves rural dietary diversity and boosts demand for healthy foods in both urban and rural areas, without exacerbating overweight. Pro-active climate-sensitive production and imports of food imports, improved storage and transportation to rural areas are important to address climate change impacts on diets and food security. To address the substantial number of climate change-nutrition risks in Mongolia, we propose a series of investments, policies and institutions. These are separated for the various components of the food systems.

For the production sector, improvements are important for both the livestock and food production sectors.

For the livestock sector that is particularly climate-sensitive, the following measures are proposed to reduce nutrition impacts:

- Invest in livestock breeding strategies to maintain or grow yield growth and meat quality and reduce greenhouse gas emissions
- Improve digital climate forecasting to help herders prepare for climate adverse events affecting livestock numbers and productivity
- Assess to what extent existing index-based livestock insurance is resilient to climate change impacts
- Grow fodder banks and watering points in strategic places to support farmers through dzud events and reduce the need for otor migrations

For the vegetable sector, the following measures are proposed:

- Consider greenhouses for more consistent vegetable production supported by solar energy to minimize fossil energy use
- Consider shifting food production centers for irrigated vegetables in Region V northeast to accommodate the changes in precipitation and temperature
- Support development of additional vegetable processing cooperatives to support national vegetable production and processing
- Provide capacity on best management practices in the vegetable sector and grow the diversity of locally grown vegetables

Additionally:

- Study what additional foods can be grown locally to reduce food import dependency, given projected higher global food prices that will depress national demands and could further reduce dietary diversity
- Invest in breeding of wheat given the importance of this cereal for national food security
- Actively invest in climate change mitigation as this can directly contribute to improved food security and nutrition in the country

For the processing, transportation and the retail sectors:

- Review the country's current food trade policy and ensure sufficient diversity of providers given the growing number of climate extreme and other events affecting trade in agricultural commodities

- Given the increase in extreme weather events and the remoteness of pastoralist groups, ensure that viable transportation pathways are maintained, either through improving road infrastructure or considering alternative measures to ensure food security and health access (for example drones)
- Develop abattoirs and cold storage facilities in strategic locations to improve meat quality, food safety and reduce consumption of fatty meats by pastoralists
- Improve cold storage facilities for fresh vegetables (and other perishables)
- Increase the availability of retail stores that provide consistent quality of fresh products, including meats, seafood and vegetables as well as retail and transportation infrastructure that supports consistency in prices of fresh food products

For the food consumption sector:

- Improve nutrition awareness and guidance of pregnant women, including on the benefits of breastfeeding
- Proactively target nutrition interventions (food safety nets, cash transfers, etc.) to areas that are increasingly affected by climate change, in particular lower precipitation levels and climate extreme events

Regarding the food environment:

- Review and revise the country's dietary guidelines.
- Develop separate nutrition programs for rural and urban areas given the differing climate and other adverse health and food security situation in these two areas
- Increase awareness on the role of diets for improved nutrition and health
- Facilitate implementation of a successful evidence-based fortification policy through renewed engagement with the primary stakeholders including flour producers and civil society, along with ministerial agencies involved in inspection, monitoring and evaluation.
- Review school feeding programs and use them to educate entire families on healthy diets.
- Close gaps in implementation of national policies for mitigating the burden of NCDs, including on physical activity, marketing of foods and beverages to children, and funding for research on NCD prevention and control
- Include information on diets as part of health checkups and 'medicine' to address high blood pressure and high cholesterol levels

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