Trends in Global Production, Consumption, and Utilization of Sorghum

Timothy J. Dalton and M. Hodjo

Contents

Abstract

Global production and consumption of sorghum has remained constant over the past decade but has shifted continentally and regionally. Despite cultivation across the globe, 20 nations account for 90% of all land allocated to sorghum and of those nations, ten account for 80%. Global patterns of plantings and production indicate that both reached lows in the early 1990s but are increasing through 2018. The long-term patterns also show that there is a statistically significant decline in sorghum production in Asia and the Americas and Caribbean while an increase in production in Sub-Saharan Africa. Across the globe, sorghum production has shifted away from Asia, and in particular India, and the United States, toward two separate groups of nations: those emerging as surplus producers and serving as granaries feeding the international marketplace for industrialized usage and secondly, nations consuming the grain locally, primarily as a foodstuff with local market appeal and trade with neighboring nations.

T. J. Dalton (✉) · M. Hodjo
Department of Agricultural Economics, Kansas State University, Manhattan, KS, USA
e-mail: tdalton@ksu.edu; hodjo@ksu.edu

V. A Tonapi et al. (eds.), *Sorghum in the 21st Century: Food – Fodder – Feed – Fuel for a Rapidly Changing World*, https://doi.org/10.1007/978-981-15-8249-3_1

One important factor to the sustainable development of markets and global trade in sorghum is to ensure that multi- and bilateral barriers to trade are not created to limit the flow of sorghum from those nations with a comparative advantage in its production to those nations with demand. The bifurcated usage of sorghum has important implications for technological change. Increased crop productivity, through genetic gain and cost of production savings, will be important as sorghum competes for land that could be occupied by alternative cereals supplying similar physical and chemical products especially in nations with low FSI consumption. By contrast, nations where sorghum is consumed as a human food will require innovation that preserves the value of the grain in environments with highly heterogeneous usage.

Keywords

Sorghum · Production · Consumption · Trade

1 Introduction

National trends in sorghum area, production, consumption, and utilization have changed substantially over the past decade on one hand, yet at the same time, aggregate global area, production, and utilization have remained relatively stable. These patterns are examined through visualization of disaggregated geographical data on national and regional trends describing the global sorghum economy.

At the regional and national scale, production and area have shifted around the global but the total amount of sorghum produced in 2018 is not significantly different from the amount produced in 2008. Over the same period of time, several nations have reduced their production of sorghum while many nations, especially in Sub-Saharan Africa, have increased production. Few nations around the globe produce surplus sorghum that is sold on the global market. Over the past decade, the volume and value of sorghum trade has hit an historic high and an historic low. Shifts in consumer demand, the availability of substitute commodities for feed and industrial usage, and international trade policy and tariffs have affected the flow of sorghum around the world.

The objective of this chapter is to document the global pattern of production, consumption, utilization, and trade of sorghum to establish a perspective on patterns from the 2018 year and to compare these patterns against those from 2008. National data for this chapter is extracted from the United States Department of Agriculture, Foreign Agricultural Service Production, Supply and Distribution database.[1] Where

[1]Two adjustments to the data were required for mapping purposes. Since data for all European nations are aggregated into a single observation, data for the entire European Union are mapped to France since it is the largest producer of sorghum. Secondly, the analysis compares data from 2008 to 2018. In 2008, the nation of South Sudan did not exist so it is not possible to compare it between time periods. Since both Sudan and South Sudan are important producers and consumers of sorghum, we create an artificial aggregation of the two nations and map this data within the boundary of Sudan prior to 2011 where comparisons between the two time periods are required.

Table 1 Area planted to sorghum by region and percentage of global total in 2018

Region	Hectares ('000)	Percentage of global area
Sub-Saharan Africa	28,017	68.0
Asia	6174	15.0
Americas and Caribbean	5599	13.6
Middle East and North America	677	1.6
Oceania	540	1.3
European Union	127	0.3
Former Soviet States	42	0.1
Global Total	41,176	100.0

possible, figures follow a similar categorization process with the five most important nations, followed by five additional nations that cumulative accounts for about 80% of the focus statistic, a third group of eight to ten nations that cumulatively account for 90% of the global share and then the remaining nations.

2 Land Allocation to Sorghum

Sorghum is grown on approximately 42 million hectares of land in 66 countries spread across the globe. The greatest area of harvested sorghum is located in Sub-Saharan Africa followed by Asia, the Americas and Caribbean. Combined, these three regions account for 95% of the harvested sorghum area across the globe (Table 1). Harvested sorghum area in Sub-Saharan Africa is more than four times the area planted in Asia, and five times that of the Americas and Caribbean illustrating the continental importance of the crop.

Despite cultivation across the globe, 20 nations account for 90% of all land allocated to sorghum and of those nations, ten account for 80%. Thirteen of the twenty top producers are located in Sub-Saharan Africa, four are located in the Americas, two in Asia and one in Oceania (Australia). Within these regions, there is considerable variation in sorghum plantings between nations (Fig. 1). The five nations with the highest acreage include Sudan, Nigeria, India, Niger, and the United States illustrating the global adaptation of the crop from tropical to temperate environments. These five nations account for 63% of all global acreage and the next five nations with the highest acreage, when combined with the first five, account for nearly 80% of global area. Following these top ten nations, an additional ten, distributed globally, harvested sorghum from less than 850,000 ha each and, when combined, account for an additional 10% of global area. Global area is concentrated when viewed at a continental scale (using the aggregations in Table 1) with a Herfindahl index of 50%, while at a national scale it can be considered as diversified with a Herfindahl index of 8.5%. This national diversification is overshadowed by the regional concentration in the Sahel of Africa.

Since 2008, there has been a numerical reduction in global area of harvested sorghum; however, this decline is not significantly different from zero ($p < 0.36$). At

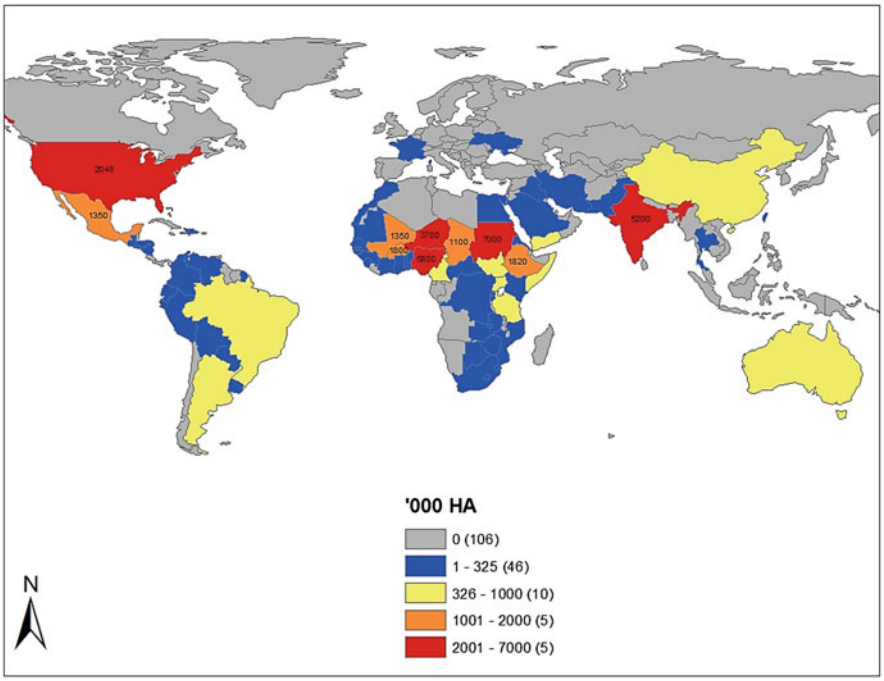

Fig. 1 Sorghum area harvested in 2018 ('000 ha)

the national level, using a pairwise comparison, there are significant differences between the area planted to sorghum in 2008 and 2018 ($p \leq 0.001$). While a few nations have dramatically reduced area, these declines are offset by nations that increased area (and those that have not changed) illustrating that there is not a major decline in sorghum area at the global level, but an areal shift from one nation to another.

The global distribution of this shift is not easily isolatable to one continent or subregion of a continent (Fig. 2). In Asia, harvested area in India has declined by nearly 31% between 2008 and 2018 while it has increased in China by 47%, albeit from a small area in 2008. Many Southern African nations have deemphasized sorghum plantings while area in several East and West African nations has increased. The exception to this trend is in Nigeria where there has been a 24% decrease in the area allocated to sorghum. In the Americas and Caribbean, the area in the United States and Mexico has declined while it has expanded in South America especially in the Southern Cone.

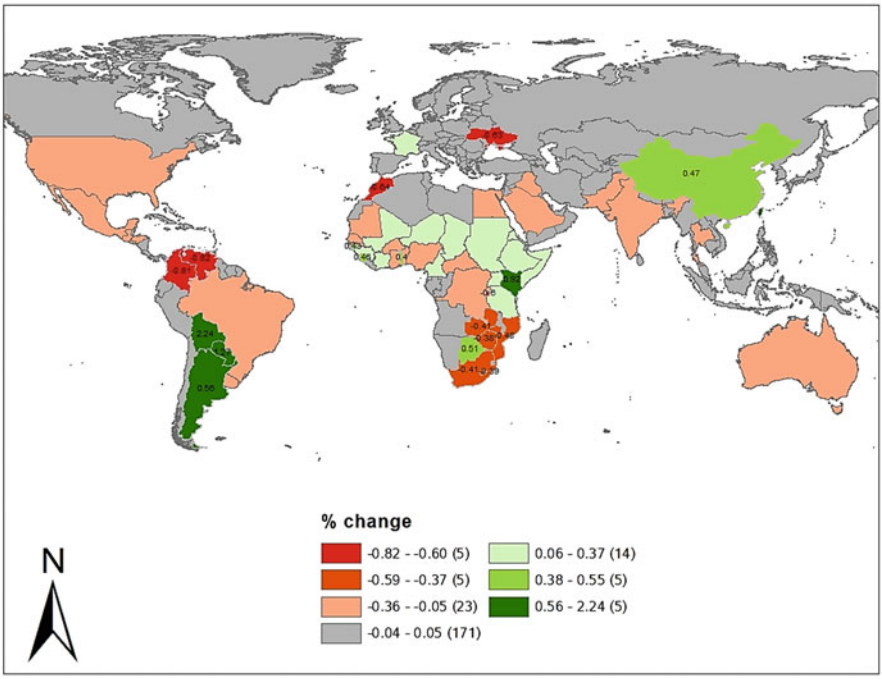

Fig. 2 Percentage change in area allocated to sorghum between 2008 and 2018 by nation

3 Global Sorghum Production

Over the past 40 years (1979–2018), global production of sorghum reached a peak of 70.5 million metric tons in 1981 and a minimum of 53.8 million metric tons in 1991. Despite the variations in annual output, 61.0 million metric tons of sorghum, on average, has been produced each year. There is a significant nonlinear "U"-shaped trend in global output over this time period where global sorghum output declined between 1979 and 2000, and then increased to 2018. Throughout this latter period, at least 90% of all sorghum production is concentrated in Asia, Sub-Saharan Africa and the Americas and Caribbean with a Herfindahl concentration index of between 30 and 37%, much lower than the area concentration index reflecting regional productivity differences (Fig. 3). Trends in production across the three most-important producing regions vary but are increasing by approximately 3% per year in Sub-Saharan Africa, while decreasing for the Americas and Caribbean (−1%), with the greatest proportional decreases occurring in Asia (−4.8%) when evaluated at the median over the 40-year period.

Similar to the current status of where sorghum is grown, 18 nations produce more than 90% of all global output. Production of sorghum is led by the United States, Nigeria, Mexico, Ethiopia, and Sudan with these five countries producing over half

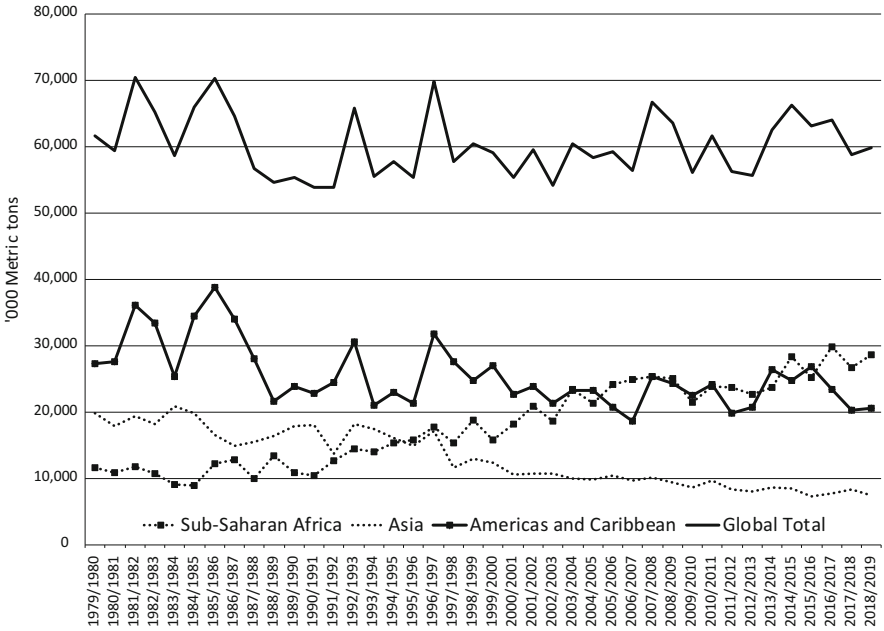

Fig. 3 Global and regional sorghum production trends from 1979 to 2018 ('000 MT)

of global output in 2018 (Fig. 4). Following these nations, the next five top-producing nations include India, China, Argentina, Brazil, and Burkina Faso and they cumulatively contribute an additional 25% of global output. An additional ten nations, spread across the globe, contribute a cumulative 15% to global production and complete the list of nations producing approximately 90% of total global output.

Over the past decade, several significant shifts in production have occurred (Fig. 5). The five nations reporting the largest increases in production include China, Ethiopia, Argentina, Bolivia, and Niger. We do not include South Sudan which became a nation in 2011 and did not exist in 2008. However, if we combine production in both South Sudan with Sudan and compare it against figures from 2008, these two nations, for comparison purposes, would have created one of the largest increases across the globe. By contrast, the five nations with the largest absolute decrease in sorghum output include India, the United States, Nigeria, Mexico, and Australia. The largest proportional declines occurred in Australia and India.

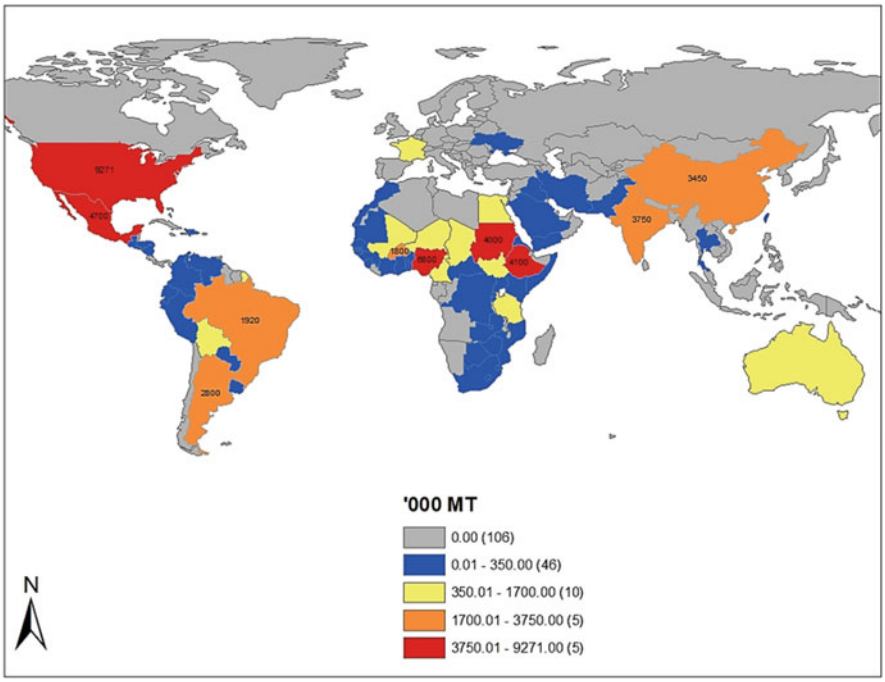

Fig. 4 Sorghum production by nation in 2018 ('000 MT)

4 Global Consumption of Sorghum

To a large extent, global consumption of sorghum follows production patterns, but with one major exception. Most of the world's largest producing nations—Nigeria, the United States, Mexico, Sudan, and Ethiopia—are among the largest consuming nations while China has more than doubled its consumption over the past decade and India has halved its usage. The increase in consumption in China began in 2012 and reached a peak in 2014 at 12.9 million MT but has subsequently decreased to levels that are only double its consumption in 2008 (Fig. 6).

Consumption patterns present a similar perspective as the shift in production patterns. In 2008, slightly more than 50% of global production was consumed in just four nations: Nigeria, Mexico, the United States, and India, followed by Sudan, Ethiopia, Brazil, China, and Australia bringing the cumulative total consumption to nearly 75% of total consumption. In 2018, the China rose to the fourth largest consumer of sorghum globally, but this was down from the highest position in 2014 when the nation consumed nearly 20% of global production, nearly twice the amount consumed by any other nation. During the same period, traditional consumers of sorghum, such as the United States, reduced its consumption to 25% of the levels observed in 2008. Figure 6 reflects 2018 patterns and are different from extremes observed in 2014 when China dominated global consumption.

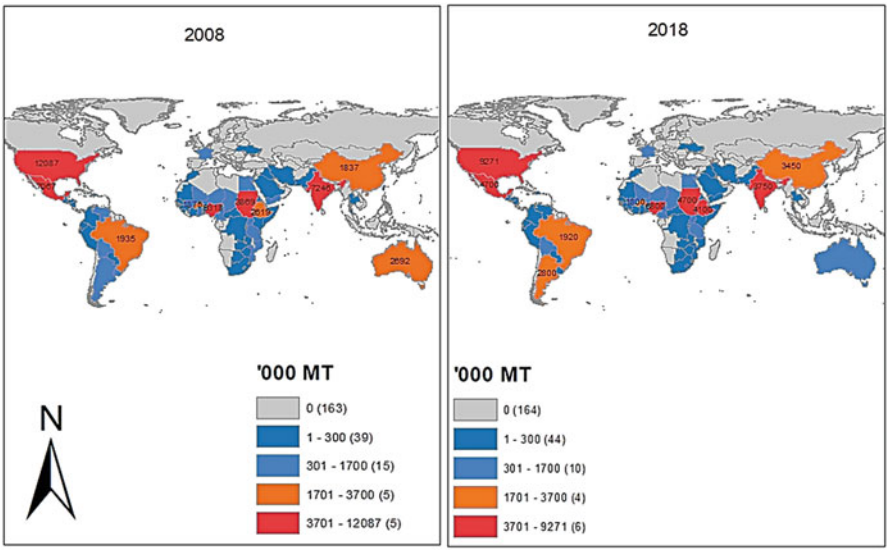

Fig. 5 Comparative national sorghum production between 2008 and 2018 ('000 MT)

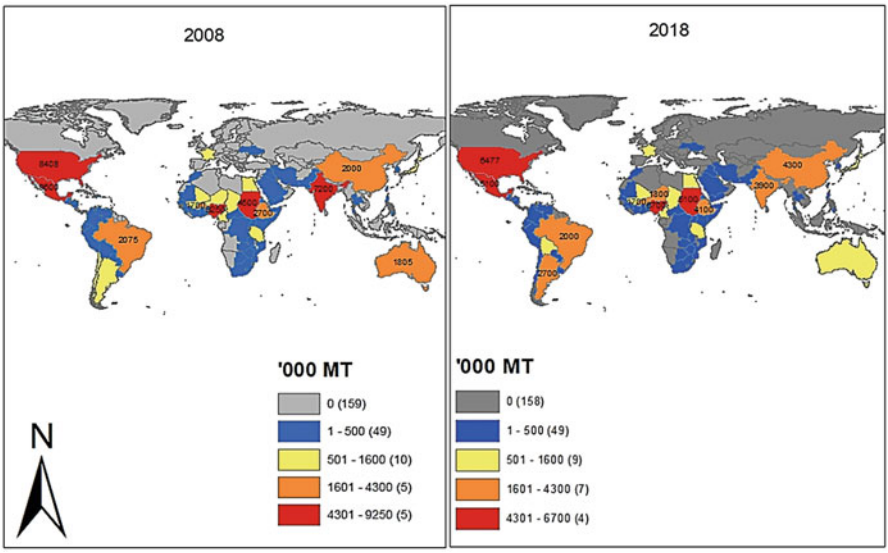

Fig. 6 Comparative national sorghum consumption between 2008 and 2018 ('000 MT)

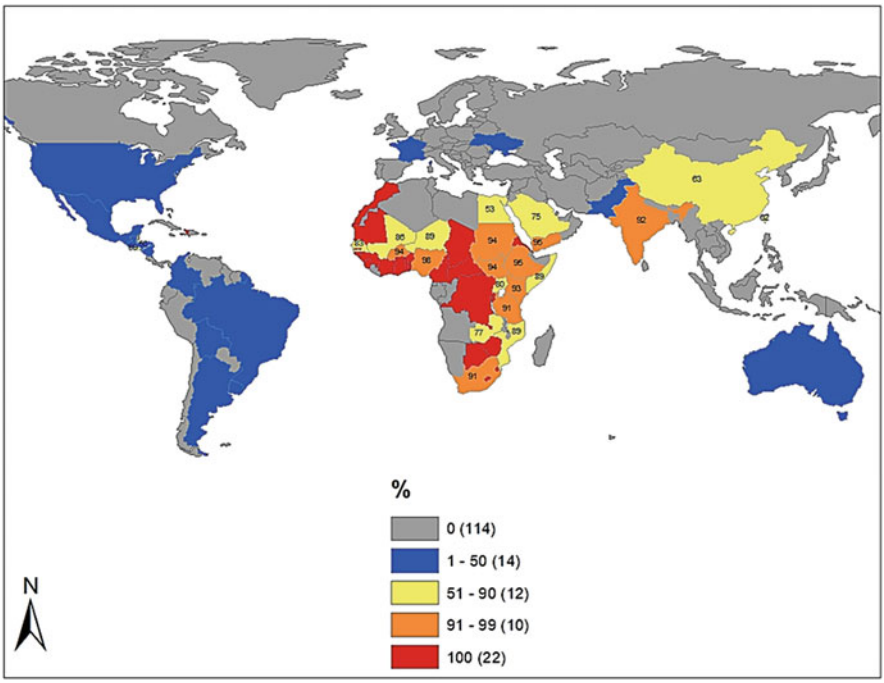

Fig. 7 Usage of sorghum as food, seed, and industrial purposes (% of total consumption)

Global consumption patterns are bifurcated into nations that consume sorghum primarily as human food and those that consume it as animal feed, forage, and for industrial purposes including ethanol production. Nations in Sub-Saharan Africa, the Middle East and North Africa and India consume nearly all of their sorghum as food while Europe, Australia, China, and Western Hemisphere nations, with the exception of Haiti and El Salvador, utilize sorghum for ethanol, in animal production and other non-human food purposes. These patterns have changed over time and this has several implications for future consumption patterns[2] (Fig. 7). Those nations that consume sorghum as a human food are likely to follow patterns where population growth, food preferences, and income will drive demand and consumption, much in the same manner that it has affected India. Nations consuming sorghum for feed and other industrial purposes will rely upon its value as a source of carbohydrates relative to other sources, plus intrinsic value-driven characteristics embodied in sorghum but not found in other grains.

[2]Figure 7 maps consumption of "FSI" or "Food, Seed and Industrial Usages." The latter usage includes sorghum used as a sweetner, beverages, and alcohol for beverages.

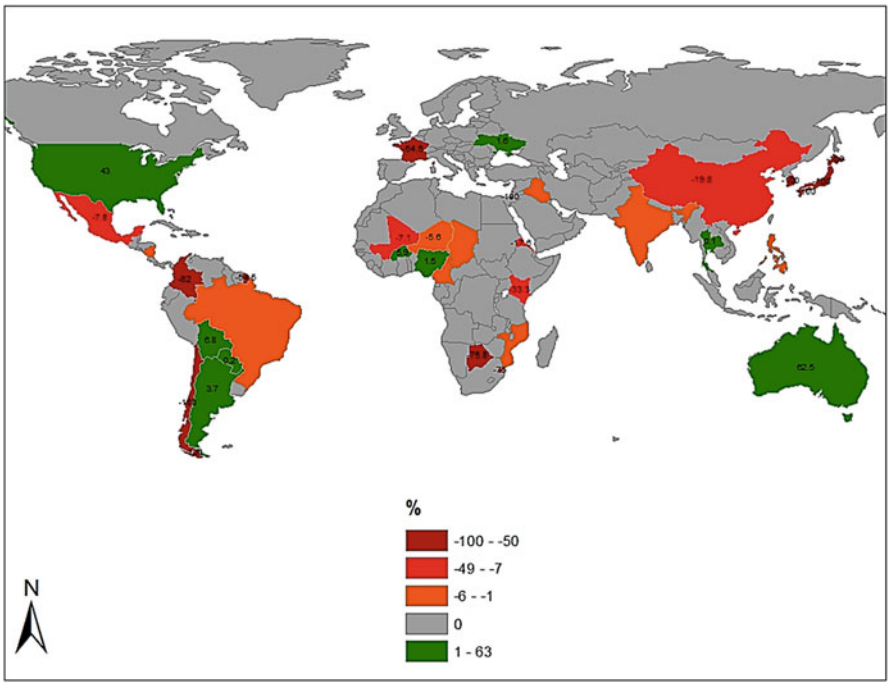

Fig. 8 Nations producing more sorghum than domestic consumption (% surplus)

5 Patterns of Global Trade

Rising industrial usage will place emphasis on nations that hold a comparative advantage in the production and distribution of sorghum. Only a few nations around the world produce more sorghum than they consume and these nations lead sorghum exports and trade (Fig. 8). In the past decade, there have been few changes in those nations producing significantly more sorghum than they consume, with the exception of several countries that fluctuate around the borderline of self-sufficiency.

Surplus producing nations turn to international trade and supply the world with sorghum destined for food, feed, and other usages. Four nations around the world supply over 90% of the global trade in sorghum: the United States, Australia, Argentina, and Ukraine and this is consistent between the two time periods. In 2018, two-thirds of the global supply of sorghum traded on international markets was produced in the United States and Australia supplied approximately 15%.

Prior to the dramatic increase in Chinese consumption of sorghum in 2014, slight more than 11% of the total global production in sorghum was traded internationally. Strong export promotion activities on the part of the United States combined with shifts in the Chinese diet toward the consumption of more meat and processed products led to the sharp increase in global sorghum trade. In 2014 and 2015, the

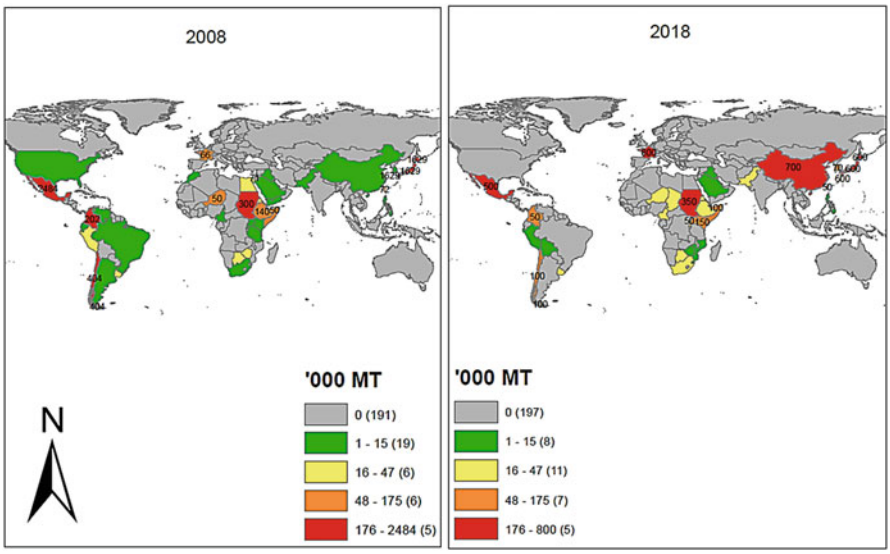

Fig. 9 Comparative analysis of sorghum imports by nation between 2008 and 2018 (MT '000)

global volume of traded sorghum topped 18% of global production, a figure not observed since the late 1980s. In 2018, as a result of trade tensions between the United States and China, the global trade of sorghum has declined to the lowest level observed over the past 50 years. This reduction in the demand for sorghum by China has provided new opportunities for importing nations (Fig. 9).

6 Conclusion

This chapter has presented information on the production, consumption, utilization, and trade of sorghum at a global level by focusing on national and regional statistical patterns on key features of the economy and comparing patterns from 2018 with patterns from 2008. In addition, longer-term statistical trends in area and production revealed that there are statistically significant convex patterns on area and output. Patterns of both indicate that area and production reached lows in the early 1990s but are increasing through 2018. The long-term patterns also show that there is a statistically significant decline in sorghum production in Asia and the Americas and Caribbean while an increase in production in Sub-Saharan Africa. In 1996, sorghum production in Sub-Saharan Africa surpassed output in Asia. And since the early 2000s, sorghum production in Sub-Saharan Africa has equaled the amount produced in the Americas and Caribbean. For the past 3 years, the region has been the largest producer of sorghum.

Across the globe, sorghum production has shifted away from Asia, and in particular India, and the United States, toward two separate groups of nations:

those emerging as surplus producers and serving as granaries feeding the international marketplace for industrialized usage and secondly, nations consuming the grain locally, primarily as a foodstuff with local market appeal and trade with neighboring nations. In 2015/2016, international trade of sorghum has reached an historic high and in 2018 an historic low, reflecting the volatility of the global marketplace and the impact of trade barriers and tariffs.

One important factor to the sustainable development of markets and global trade in sorghum is to ensure that multi- and bilateral barriers to trade are not created to limit the flow of sorghum from those nations with a comparative advantage in its production to those nations with demand. The recent declines in global trade are an obvious effect of such anticompetitive policies. Secondly, while there continues to be an increase in harvested area of sorghum, it is not clear whether this is occurring as sorghum is substituted for crops already farmed or whether it is occurring through extensification. For nations where sorghum area is in decline, that area is being occupied by alternative crops. A more sophisticated analysis should focus on the expansion of sorghum in Sub-Saharan Africa and determine the relative importance of increased factor usage, namely land, versus increased total factor productivity, that is embodied technical change and intensification, to ensure that strategic investments in research are targeted toward efficient outcomes and profitable factor usage.

The bifurcated usage of sorghum has important implications for technological change. Increased crop productivity, through genetic gain and cost of production savings, will be important as sorghum competes for land that could be occupied by alternative cereals supplying similar physical and chemical products especially in nations with low FSI consumption. By contrast, nations where sorghum is consumed as a human food will require innovation that preserves the value of the grain in environments with highly heterogeneous usage. This requires primary emphasis on maintaining and improving organoleptic characteristics found in localized contexts since it is a primary foodstuff. In addition, since trade of sorghum in these areas is thin, varietal development will require adaptation to localized agroecologies that take advantage of the adaption of, and preference for, the diversity of sorghum races.

The global sorghum economy is evolving and examination of global scale information masks the diversity of continental and national changes in the production, consumption, utilization, and trade. Over the past decade, sorghum production has shifted from Asia, Oceania and the Americas and Caribbean toward Sub-Saharan Africa. The exception to this generalization lies in the Cone of South America where production is increasing. The future of the global economy is more certain for nations in Sub-Saharan Africa where the production and consumption of sorghum is increasing and has been for several decades. In these nations, population and income growth, combined with food consumption preferences, will be primary determinants affecting demand. It is less clear in other areas of the world. In nations where domestic FSI consumption is less important, there are competing cereals supplying many of the same raw materials, and global markets have been stifled by trade barriers. The future for many of those nations lies within the complex calculus of the crop's economic value relative to substitutes and the re-liberalization of agricultural trade.

Acknowledgment This study is made possible by the support of the American People provided to the Feed the Future Innovation Lab for Collaborative Research on Sorghum and Millet through the United States Agency for International Development (USAID). The contents are the sole responsibility of the authors and do not necessarily reflect the views of USAID or the United States Government. Program activities are funded by the United States Agency for International Development (USAID) under Cooperative Agreement No. AID-OAA-A-13-00047.

Sources

United State Department of Agriculture Foreign Agricultural Service. Production, supply and distribution database. https://apps.fas.usda.gov/psdonline/app/index.html. Accessed 28 Apr 2019