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# From Where the Buffalo Roam: India's Beef Exports

Maurice Landes, Alex Melton, and Seanicaa Edwards

## Abstract

Since the late 2000s, India's exports of beef—specifically water buffalo meat—have expanded rapidly, with India emerging as the world's largest beef exporter in 2014. The rapid growth in India's exports is predicated on three factors: (1) rising demand for relatively low-cost meat by consumers in developing-country markets; (2) India's large water buffalo herd, which was mostly untapped for meat production; and (3) the emergence of private sector, export-oriented Indian processors that have been effective in meeting the requirements of developing-country markets. Despite India's large and underutilized water buffalo herd, if current projected levels of beef exports are met over the next decade, the female buffalo herd, a source of more than half of India's milk production, may begin to decline, creating a tradeoff between milk and meat production. But, export growth might be sustained if producers eventually begin to respond to rising export demand by retaining and rearing male calves and/or feeding animals to higher weights. So far, Indian water buffalo meat exports have not been competitive with U.S. beef exports, primarily because they do not meet the quality preferences and animal health regulations required in the major markets that import U.S. beef.

**Keywords:** India, beef, carabeef, exports, water buffalo, production, marketing, herd dynamics, policy, projections.

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## Introduction

Since the late 2000s, India's exports of beef—specifically water buffalo meat, also known as carabeef—have expanded rapidly, with India moving just ahead of Brazil to become the world's largest exporter in 2014. India's beef exports during the period have grown at an annual rate of about 12 percent, rising from an average volume of 0.31 million tons during 1999-2001 to an estimated 1.95 million during 2013-15.<sup>1</sup> India's robust export growth contributed to the expansion of world beef trade during this period and also increased the country's share of the volume of shipments by major world beef exporters from just 5 percent during 1999-2001 to about 20 percent during 2013-15. The U.S. market share fluctuated during this period but declined from an average of 18 percent during 1999-2001 to 12 percent during 2013-15 (USDA/FAS, 2015a).

India's emergence as a major beef exporter has been facilitated by three main factors. First, global demand for beef is strong, particularly by low- and middle-income developing countries with a preference for India's relatively low-cost water buffalo meat. Second, India's water buffalo herd, by far the world's largest, has been underexploited for meat production because of relatively low domestic consumer preference for beef, whether from cattle or water buffalo, by a majority of Indian consumers.<sup>2</sup> Third, the development of private, export-oriented slaughter and packing facilities in several Indian States has led to the successful assembly and processing of animals and marketing of products to the specifications of a diverse set of export markets. While Indian exports of cattle beef are banned for religious reasons, and some States ban all cattle slaughter, buffalo do not hold the same religious significance to most Indians, and buffalo slaughter and exports remain legal throughout the country (DAHDF, 2002; FICCI, 2013).

India's expanding beef exports have implications for the United States and other beef exporters who seek to expand exports to the primarily developing-country markets now served by India. This study examines the available data and information on India's beef exports, the size and export potential of India's water buffalo herd, and India's export-oriented beef processing industry. The key issues to be addressed concern the potential for continued growth in demand for buffalo meat among current and possible future Indian markets, India's potential to continue to expand production and exports of buffalo meat, and the implications for U.S. competitiveness in world beef markets.

India's buffalo meat exports are low cost relative to exports from the United States and other major beef exporters, which reflects perceived quality differences—India exports buffalo meat produced primarily from culled, or nonproductive, dairy animals, and its product also cannot meet the relatively strict sanitary standards of many more advanced markets for beef imports. However, the Indian exports are meeting demand in the fastest growing segment of the world beef market, primarily among low- and middle-income countries in Asia and the Middle East, which is not currently served by U.S. beef. Analysis of India's capacity to sustain growth in buffalo meat exports is complicated by limited reliable data, but conservative assumptions on slaughter rates and weights suggest that production could fall below current USDA projections by about 2020. If, however, growers or processors in India respond to the commercial opportunity now afforded by export demand by rearing more male calves and/or adopting pre-slaughter feeding to boost low slaughter weights, production and export growth could be sustained. Success in obtaining official access to new markets, including ongoing market-opening initiatives with China and Russia, may also help determine future growth in India's beef exports.

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<sup>1</sup>Throughout the report, all tons are reported as metric tons.

<sup>2</sup>In India, the term “beef” refers to both cattle meat and water buffalo meat. Roughly 80 percent of the beef produced in India is estimated to be water buffalo meat. By regulation, only water buffalo meat can be exported.

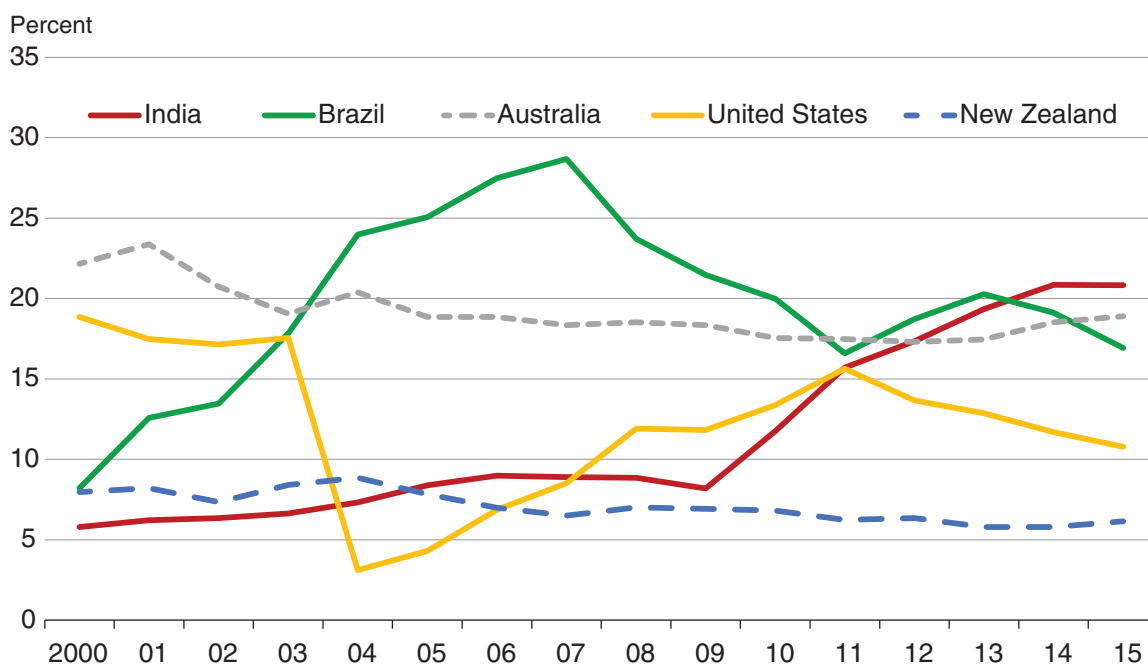
## India's Beef Exports

In 2000, the world's top five beef exporters were Australia, the United States, the European Union, Canada, and Brazil. Among those countries today, only Australia, Brazil, and the United States remain in the top five, and India has emerged as the top exporter (fig. 1). Growth in India's beef exports and global market share has been particularly strong since the late 2000s, with the volume of exports expanding about 17 percent annually since 2008. Export growth has been mostly to middle-income markets in Asia, the Middle East, and North Africa, with India's water buffalo beef typically trading at low unit values relative to beef from other countries.

The export markets for Indian water buffalo beef are largely determined by two factors. First, because the beef is produced mostly from culled water buffalo used for dairy purposes, it is a relatively low-priced product that is particularly appealing to lower income consumers, primarily in developing-country markets. Such consumers often exhibit relatively high propensities to spend new income on higher value foods, such as meat, as well as high responsiveness to changes in the price of food and other goods. At this point, there is very little commercial feeding of water buffalo in India to produce a higher quality product for developed-country markets, nor is India able to ensure that its products meet the typically more strict sanitary and disease-free standards of developed-country markets.

The relative perceived quality of Indian water buffalo beef is reflected in the reported unit values for the frozen, boneless product exported by India and the frozen, boneless beef products shipped by other suppliers, including Argentina, Australia, Brazil, New Zealand, and the United States (fig. 2). Among

Figure 1  
Global market shares of major beef exporters

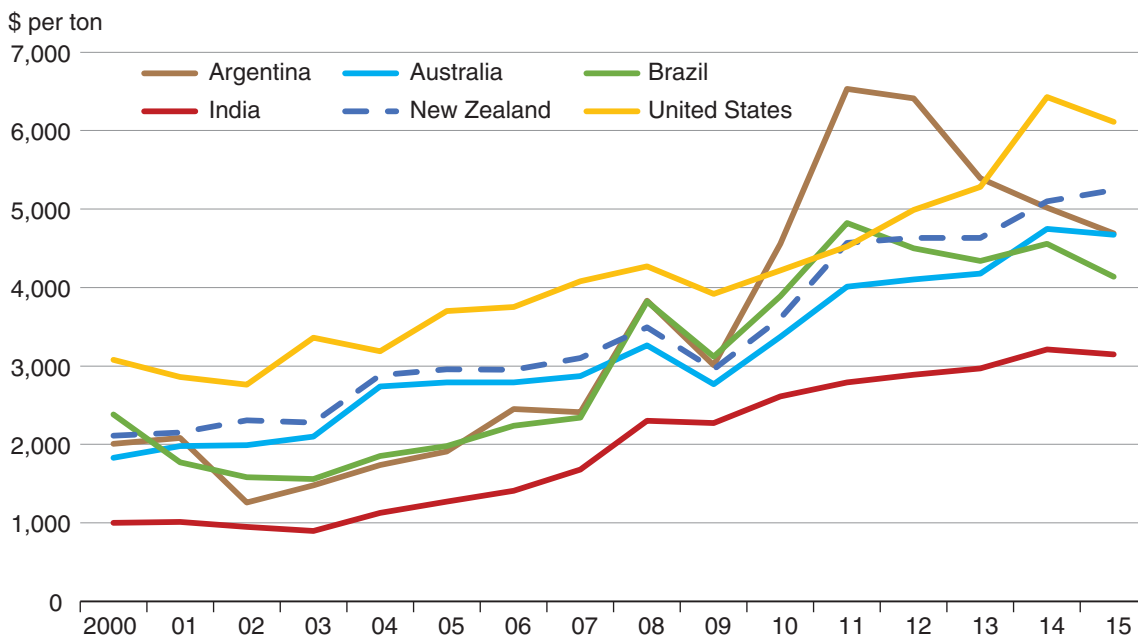


Note: Includes fresh, chilled, frozen, and prepared beef.

Source: USDA, Economic Research Service using data from USDA, Foreign Agricultural Service, PS&D Online database.

Figure 2

**Export unit values for frozen, boneless beef for major exporters**



Note: Beef, frozen boneless (HS code: 020230).

Source: USDA, Economic Research Service using data from World Trade Atlas.

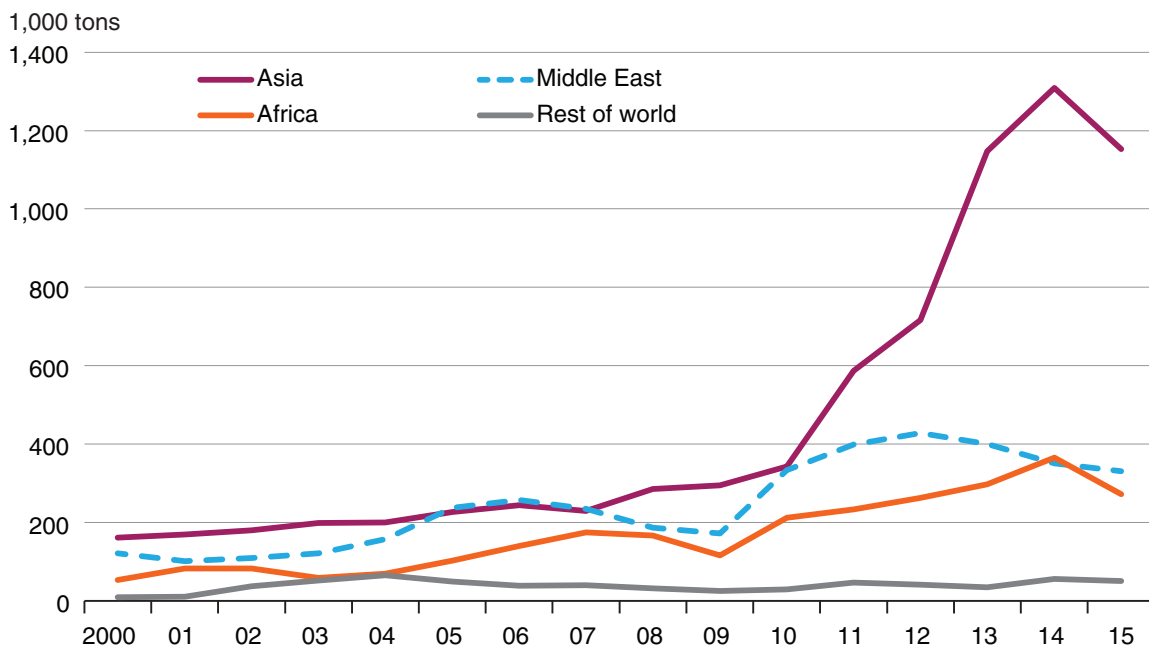
major beef exporters, India has consistently had the lowest unit value since 2000. The U.S. export unit value is typically among the highest of the major exporters, reflecting the perceived quality of U.S. fed beef and the U.S. product’s relatively broad acceptance in developed-country markets. Unit values for other major exporters, particularly Argentina, Brazil, and Australia, which tend to export more grass-fed beef with similar leanness characteristics as Indian beef, still consistently trade at substantial premiums to the Indian product (World Trade Atlas, 2015). Unit values are not a perfect estimator of quality, as varying baskets of goods can fall within an individual trade code. While all products included are frozen boneless beef, the cuts and other characteristics may vary. India, however, appears to be a significantly cheaper option for importers seeking low-cost beef.

The second key factor that helps determine export markets for Indian water buffalo beef is that the product is required by law to be produced in accordance with halal standards (APEDA, 2015a). This characteristic, along with the capacity of India’s export-oriented packers to meet other quality and sanitary standards required by certain markets, makes Indian water buffalo beef competitive in numerous developing-country markets in Southeast Asia, the Middle East, and North Africa with Muslim populations that require the observance of Muslim slaughter practices.

### India’s beef export markets

India’s beef exports to Asia, the Middle East, and Africa increased dramatically in recent years and now account for about 97 percent of India’s total beef exports (fig. 3; appendix I). The largest share goes to Southeast Asia, with Vietnam, Malaysia, Thailand, and the Philippines accounting for the bulk of shipments to the region. The Middle East region, primarily Saudi Arabia, United Arab

Figure 3  
**Indian beef exports by region**



Note: Includes fresh, chilled, frozen, and prepared beef.  
 Source: USDA, Economic Research Service using data from World Trade Atlas.

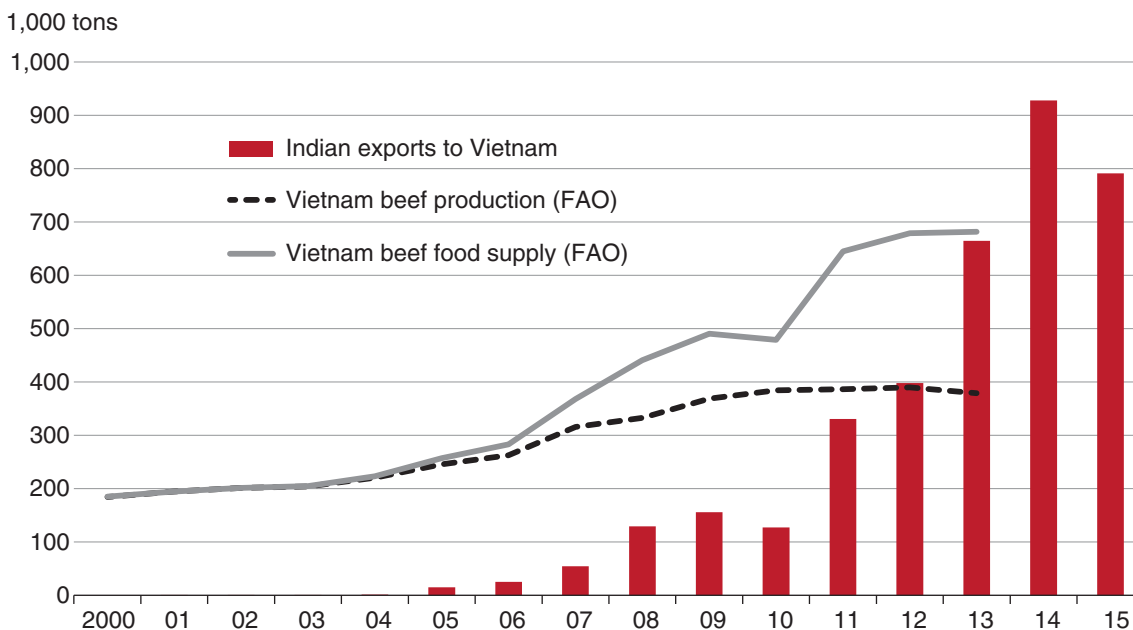
Emirates, Kuwait, and Jordan, is the second largest destination for Indian beef exports, followed by North Africa (World Trade Atlas, 2015).

India’s beef exports face tariff protection in a number of top export destinations. Among 19 of India’s top 25 beef export markets during 2012-14, 8 have current Most Favored Nation (MFN) tariffs for frozen deboned beef of less than 10 percent, 7 have tariffs of 10-20 percent, and 4 have tariffs of greater than 20 percent (WTO, 2015). However, India’s participation in a regional trade agreement with members of the Association of Southeast Asian Nations (ASEAN) affords it preferential access for its beef exports to Thailand (where India faces a 0 tariff, compared with the 50-percent MFN tariff), Laos (21 percent, compared with 30 percent), and the Philippines (7 percent, compared with 10 percent) (ASEAN, 2015).

The single-largest reported destination for India’s beef exports—and the source of the country’s most recent export growth—is Vietnam. India’s beef exports to Vietnam reached a record 927,760 tons in 2014, before slipping to 791,188 tons in 2015, and accounted for 44-45 percent of India’s beef exports in both years. Growth in shipments to Vietnam began in the mid-2000s but increased sharply beginning in 2011 (fig. 4).

The final destination of Indian beef exported to Vietnam is not clear. While Indian export data identify Vietnam as the final destination, the imports cannot be verified by Vietnamese import data. They also cannot be verified by the beef commodity balances for Vietnam maintained by the Food and Agriculture Organization of the United Nations (FAO) in its FAOSTAT database, which suggests that it is unlikely that such a large volume of beef is being consumed in Vietnam and that Vietnam is likely a trans-shipment point for Indian beef destined for other markets in Asia (Thukral

Figure 4  
**Indian beef exports to Vietnam**



Note: Includes exports of fresh, chilled, frozen, and prepared beef.

Source: USDA, Economic Research Service using data from World Trade Atlas and Food and Agriculture Organization of the United Nations (FAO) FAOSTAT database.

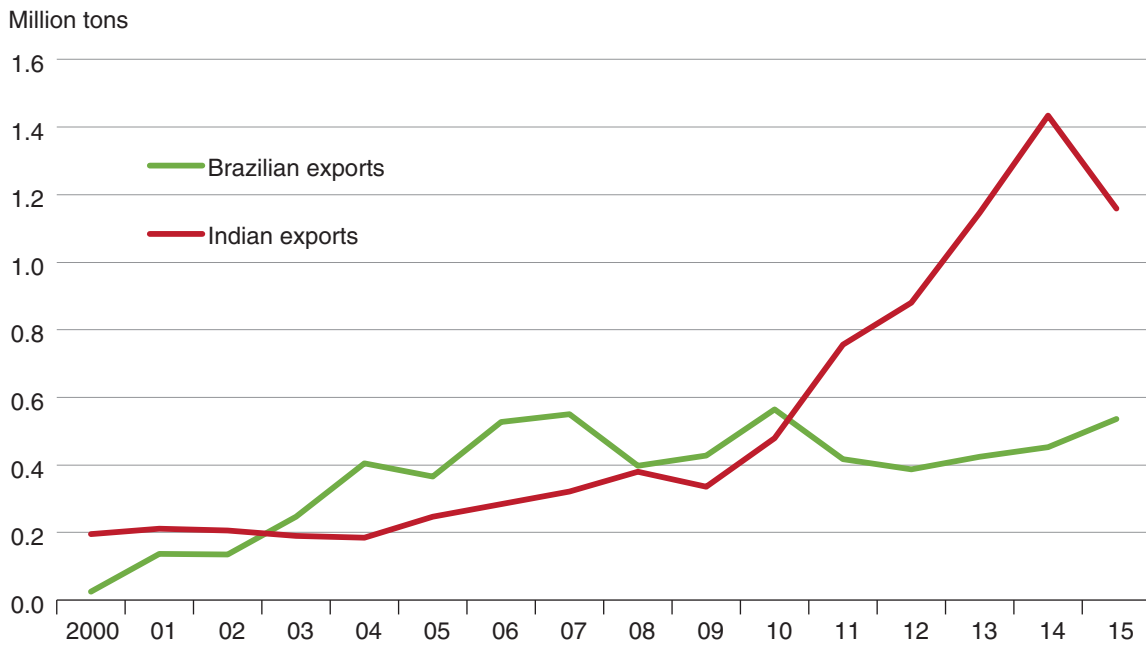
et al., 2014). If a significant proportion of Indian exports is being trans-shipped to third-country markets, India’s beef exports are highly dependent on either the continuation of these trans-shipment routes or the formal opening of the involved third-country markets.

Brazil and Australia, two other major beef exporters, have more of their top markets in common with India than does the United States (see box “U.S.-India Competition in World Beef Markets”). Both Brazil and Australia had 9 of their top 25 markets in common with India during 2013-15 (World Trade Atlas, 2015). In the case of Brazil and India, their exports to their top common markets both generally expanded until 2010, after which only India’s share of those markets increased (fig. 5). More recently, in 2015, the sharp depreciation of the Brazilian real has closed the gap between Indian and Brazilian export unit values for beef and is expected to lead to some recovery in Brazil’s market share. India-Australia competition in top common markets for these two countries has been less significant and suggests that they are competing in distinctly different market segments within those markets (fig. 6).

### Characteristics of India’s beef exports

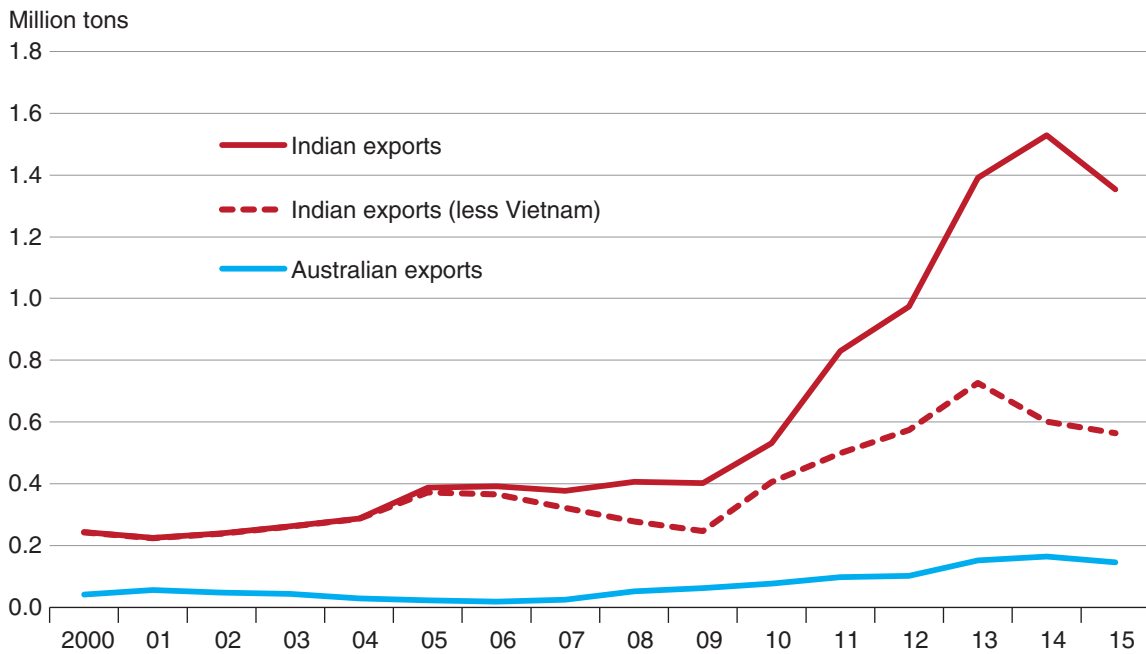
Indian trade regulations do not permit exports of cattle meat. Exports of buffalo meat from breeding or milking animals are also not permitted, and buffalo slaughtered for exports are reported to be primarily culled dairy animals, as well as male calves and culled draft animals. All Indian exports of buffalo meat must be in the form of deboned meat rather than carcasses, and exports are primarily in the form of frozen, rather than chilled, boxed beef (FICCI, 2013; APEDA, 2015a).

Figure 5  
**India and Brazil beef exports to common top markets**



Notes: Exports of fresh, chilled, frozen, and prepared beef. The nine top common markets are Algeria, Angola, Egypt, Iran, Jordan, Lebanon, Philippines, United Arab Emirates, and Vietnam.  
 Source: USDA, Economic Research Service using data from World Trade Atlas.

Figure 6  
**Indian and Australian beef exports to common top markets**



Notes: Exports of fresh, chilled, frozen, and prepared beef. The top nine common markets are Jordan, Kuwait, Malaysia, Philippines, Saudi Arabia, Thailand, United Arab Emirates, Qatar, and Vietnam.  
 Source: USDA, Economic Research Service using data from World Trade Atlas.



## U.S.-India Competition in World Beef Markets

Although India is the number one beef exporting country in the world and the United States is also a major beef exporter, India's primary export markets are starkly different from those of the United States (box table 1). Among the top 25 beef export markets for each country, only 5 countries are common to both (Vietnam, Egypt, Philippines, United Arab Emirates (UAE), and Kuwait). The bulk of the relatively higher priced and high-quality beef exports by the United States go to more developed and higher income markets, such as Japan, Canada, Hong Kong, and South Korea, as well as the neighboring Mexican market. In contrast, the bulk of Indian exports go to relatively low-income markets that are more sensitive to price than quality, and to markets with a preference for meat produced to halal standards.

Box table 1

**Comparison of top 25 U.S. and Indian beef export markets**

Food supply growth <sup>1</sup>	2013-15 exports	Top Indian markets		Top U.S. markets	2013-15 exports	Food supply growth <sup>1</sup>
<i>Percent</i>	<i>1,000 tons</i>				<i>1,000 tons</i>	<i>Percent</i>
11.2	795	Vietnam		Japan	271	-2.0
2.7	177	Malaysia		Canada	190	-0.1
4.7	160	Egypt		Mexico	180	0.8
0.2	147	Thailand		Hong Kong	179	6.3
9.4	99	Saudi Arabia		South Korea	150	1.4
1.5	61	Philippines		Taiwan	47	3.5
3.7	60	Algeria		Netherlands	17	0.3
9.6	57	UAE		Chile	13	1.0
4.7	43	Iraq		Philippines	12	1.5
4.3	42	Jordan		Egypt	9	4.7
5.4	38	Kuwait		Italy	8	-0.3
1.8	32	Angola		D. Republic	8	4.7
3.0	29	Iran		UAE	7	9.6
13.5	20	Congo		Germany	5	0.6
8.3	18	Oman		Vietnam	5	11.2
6.5	18	Turkmenistan		Bahamas	4	3.9
-2.4	11	Gabon		Guatemala	4	1.9
4.9	10	Lebanon		Kuwait	4	5.4
6.8	10	Azerbaijan		Indonesia	3	3.6
NA	9	Qatar		Panama	2	1.4
2.6	8	Laos		Singapore	2	NA
NA	7	Syria		Jamaica	2	-4.0
-2.9	5	Tajikistan		Cayman Islands	2	NA
5.2	5	Pakistan		Peru	2	2.7
3.8	5	Senegal		Colombia	2	0.6
7.2	1,851	Total above <sup>2</sup>		Total above <sup>2</sup>	1,126	1.2

<sup>1</sup>Growth rate between 1999-2001 average and 2009-11 average supply of beef for food use; most recent FAO data.

<sup>2</sup>Average food supply growth rate is weighted by 2012-14 exports. NA = Not available.

Source: USDA, Economic Research Service using data from World Trade Atlas and Food and Agriculture Organization of the United Nations (FAO) FAOSTAT database.

Continued—

## U.S.-India Competition in World Beef Markets—continued

Importantly, India's markets consist of countries whose sanitary regulations permit meat imports from countries classified as endemic for foot-and-mouth disease (FMD) by the World Organization for Animal Health (OIE). Because India is classified by the OIE as FMD-endemic, its status prevents it from accessing the major markets served by U.S. beef exports. Although there have been minimal negative effects on Indian buffalo meat production from FMD in recent years, India's ongoing problems with controlling FMD will likely prevent it from gaining access to more developed markets such as the United States, Japan, Canada, and South Korea in the foreseeable future.

However, an important point of contrast between the U.S. and Indian beef export markets is that in quantity terms, beef demand is generally growing faster in the top markets served by India than in those served by the United States (box table 1). Although the United States and India both export to a few markets with rapid demand growth, such as Vietnam, Egypt, the UAE, and Kuwait, India's exports to these markets are substantially larger. On average, annual growth in the food supply of beef (a proxy for consumption) during the 2000-10 period (weighted by 2013-15 average beef exports to each country) in India's top 25 markets was about 7.2 percent, compared with just 1.2 percent for the top 25 U.S. markets. This suggests that the segments of the global beef market served by India have been growing substantially faster than those served by the United States and might be expected to continue their relatively fast growth.

Indian buffalo beef has several other characteristics that are relevant to consumer preferences in some markets:

- All buffalo slaughtered for export are required to be slaughtered according to halal standards. This enables Indian buffalo beef to meet a key requirement for entry into Islamic country markets (FICCI, 2013; APEDA, 2015a).
- Hormones, antibiotics, and other chemicals are not commonly used in rearing Indian buffalo. While not certified as organic, India's generally low-intensity production practices may be a selling point in some markets (FICCI, 2013; APEDA, 2015a).
- Indian buffalo beef is a relatively lean product that is comparable to cattle beef in terms of nutritional value and palatability. It is reported to be 93 percent chemically lean, helping it to be relatively lower in calories and cholesterol than beef from fed cattle. It has relatively good binding properties, which makes it suitable for processing (FICCI, 2013; APEDA, 2015a).

*Sanitary standards and practices.* To improve and ensure scientific and hygienic slaughter and processing practices for exported meat, the Government of India establishes procedures and standards, along with financial incentives to State governments, to implement the standards and practices. According to India's constitution, State governments, rather than the central Government, have the responsibility to implement these and other agricultural policies. Procedures and standards set by the Government of India include:

- *Licensing and registration of meat-packing plants and slaughter facilities.* Registration of slaughter and processing plants is handled by the Agricultural and Processed Food Products Export Development Authority (APEDA). As of 2011, Indian export policy, which is enforced by the central Government, requires that meat exports be sourced exclusively from APEDA-registered facilities (FICCI, 2013; APEDA, 2015c).

- *Mandatory approvals of modern slaughterhouses that process buffalo meat for export.* APEDA enforces Hazard Analysis and Critical Control Points (HACCP) procedures, providing HACCP accreditation through an interdepartmental panel (FICCI, 2013; APEDA, 2015c).<sup>3</sup>
- *Animal health certificates.* Export shipments are required to undergo microbiological and other tests, with a comprehensive pre-shipment inspection certificate issued by a government laboratory. The certificate indicates that the product comes from healthy livestock, based on both ante-mortem and post-mortem inspections, and is free from infectious diseases, including FMD (FICCI, 2013; APEDA, 2015c).

India is a member of the International Organization for Animal Health (OIE), which requires regular reporting on animal diseases. India is currently classified as free from all of the OIE “A” list diseases affecting cattle and buffalo, except FMD (FICCI). In the case of FMD, 54 districts (out of a total of 640 districts) achieved 100-percent coverage with twice yearly vaccinations in 2002-07, and a control program is underway in additional areas that will bring the total up to 230 districts (FICCI, 2013). India’s FMD surveillance and testing are generally not recognized by developed-country markets that typically require FMD-free status, as well as product traceability.

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<sup>3</sup>Hazard analysis and critical control points (HACCP) refers to a systematic approach to reducing biological, chemical, and physical hazards affecting food safety.

## India's Water Buffalo Sector

While expanding demand has been the key impetus for growth in India's buffalo beef exports, India's large and underexploited water buffalo herd has, so far, provided an unconstrained source of supply. Data with which to reliably evaluate the potential for continued growth in water buffalo slaughter, meat production, and exports are limited. Livestock census data, collected every 5 years, include animal numbers by sex, with the latest estimates for 2012. India's Department of Animal Husbandry, Dairying, and Fisheries (DAHDF) provides annual State-level data on water buffalo slaughter, meat production, and carcass yield, but these data appear to cover only animals processed for the domestic market (Rabobank, 2012). Official trade data appear to provide reliable information on total beef exports, which, given the prohibition on exports of cattle beef, are assumed to be all buffalo beef. Finally, a recent survey by the Federation of Indian Chambers of Commerce and Industry (FICCI) provides information on the processing and marketing chain.

This analysis uses these data, together with specific assumptions on variables such as buffalo birth, death, slaughter, and carcass yields, to generate a baseline outlook through 2025, along with scenarios based on alternative plausible assumptions for key variables. Findings suggest that India may not be able to sustain the recent rapid growth in buffalo beef production and exports unless it reduces its reliance on slaughter of culled dairy animals and increases its reliance on rearing and feeding male calves, which are currently not reared or fed for meat production.

### The water buffalo herd

India is home to the world's largest concentration of water buffalo (scientific name: *Bubalus bubalis*). Estimates in India's 2012 Livestock Census place the country's water buffalo population at about 109 million head (DAHDF, 2014). FAO estimates the world water buffalo population in 2013 at about 193 million head, making India home to roughly 56 percent of the world total (FAOSTAT, 2015). India has 11 distinct indigenous breeds of water buffalo, but a majority of its herd is referred to as nondescript. Among the recognized breeds, the most common is the Murrah buffalo, which accounts for about two-thirds of the buffalo population within India's 11 recognized breeds.

Overall, India's water buffalo herd has been growing at about 1.3 percent per year since the late 1990s, faster than the rate for the country's total bovine herd, which also includes a shrinking herd of indigeneous cattle (scientific name: *Bos indicus*) and a rapidly expanding herd of cross-bred cattle (table 1). Females account for the bulk of the water buffalo herd. Female water buffalo are prized as dairy animals because of the high butterfat content of their milk compared with cattle milk. They also thrive in India's tropical and subtropical climate and disease conditions, and on low-value feeds and crop residues. About 53 percent of India's milk production came from water buffalo in 2012. Over the last decade, expansion of the buffalo dairy herd and rising yields enabled buffalo milk production to grow about 4.8 percent annually, slower than the growth in cross-bred milk output but about the same rate as total Indian milk production (DAHDF, 2014). Most water buffalo in India are owned by smallholder farmers with a few hectares of land and a few dairy animals. Available data indicate that female dairy animals culled from India's broadly dispersed and mostly small-scale holdings are the primary source of animals slaughtered for export (FICCI, 2013; Rabobank, 2012).

Male water buffalo are traditionally of lower utility and value than female buffalo. Some are used as draft animals and are actually favored for this purpose in some areas of India, but they are not generally reared and fed for meat purposes. A large share of male calves—estimated at about 70 percent

Table 1

**India's water buffalo and cattle inventory and growth rates**

	1997	2003	2007	2012	Annual growth rate	
					1997-2012	2007-2012
	1,000s				Percent	
<b>Water buffalo</b>						
Male	18,625	17,888	19,597	16,103	-1.0	-3.9
Female	71,294	80,034	85,745	92,599	1.8	1.5
Total	89,920	97,922	105,342	108,702	1.3	0.6
Milk animals	42,731	47,224	48,642	51,054	1.2	1.0
<b>Indigenous cattle</b>						
Male	90,202	77,534	76,779	61,949	-2.5	-4.2
Female	88,580	82,961	89,236	89,224	0.0	-0.0
Total	178,782	160,495	166,015	151,173	-1.1	-1.9
Milk animals	49,874	46,855	48,042	48,124	-0.2	0.0
<b>Exotic/crossbred cattle</b>						
Male	5,344	4,945	6,844	5,971	0.7	-2.7
Female	14,755	19,741	26,216	33,760	5.7	5.2
Total	20,099	24,686	33,060	39,731	4.6	3.7
Milk animals	8,355	11,231	14,407	19,420	5.8	6.2%
<b>Total</b>						
Male	114,171	100,367	103,220	84,023	-2.0	-4.0
Female	174,629	182,736	201,197	215,583	1.4	1.4
Total	288,801	283,103	304,417	299,606	0.2	-0.3
Milk animals	100,960	105,310	111,091	118,598	1.1	1.3

Source: USDA, Economic Research Service using data from Ministry of Agriculture, Department of Animal Husbandry, Dairying and Fisheries; Basic Animal Husbandry and Fisheries Statistics, various issues.

(Rabobank, 2012)—die or are slaughtered within a short period of birth. The male-female breakdown of the buffalo herd from census data covering 1992-2012 shows the female share of the buffalo herd rising to 85 percent in 2012 (table 1). Correspondingly, the male share of the herd has declined steadily, with a particularly large drop between 2007 and 2012. The implication is that more male buffalo, either young or old, are also being slaughtered for either domestic or export purposes.

Compared with cattle herds in the United States and other countries that have relatively high demand for red meat, India's male water buffalo appear to represent a potentially large and mostly underutilized resource for meat production. In 2010, the DAHDF established a "Salvaging and Rearing of Male Buffalo Calves" scheme that provides funding to State governments to extend subsidies and/or loans to livestock farmers to encourage them to rear, rather than dispose of, young male buffaloes (DAHDF, n.d.; DAHDF, 2011). But, that project has reportedly not had a noticeable impact so far (FICCI, 2013).

## Water buffalo marketing

There are distinct marketing chains for Indian water buffalo that provide meat for the domestic and international markets. Both marketing chains begin with the same, highly fragmented back end, in which most animals originate from small, mixed-crop and dairy operations that may own two to three dairy animals and sell their occasional cull animals either in a local market or to a local live-stock trader or aggregator. Rearing, feeding, and selling buffalo for meat production is not typically a planned farm business but a residual activity (FICCI, 2013). Because of this, India lacks a systematic linkage between the sellers of animals, traders, and processors to facilitate supply responsiveness to changes in demand.

Animals destined for India's domestic market are sold by the trader/aggregator or market commission agent to a municipal slaughterhouse, with the butchered meat then sold onward to either a wholesaler or retailer. India's DAHDF provides data on buffalo slaughter, meat production, and carcass yields that indicate trends in these variables for domestically marketed water buffalo meat (DAHDF, 2014). These data are collected through municipal slaughter facilities, only a few of which are certified to participate in the export market (FICCI, 2013). The DAHDF data may also include some production for the export market but appear to primarily cover domestic marketing because annual beef exports now far exceed the production reported in the DAHDF data. The data indicate relatively strong growth in slaughter numbers and meat production but slow growth in carcass yields for the domestic market between 2007/08 and 2012/13 (table 2). The apparent lack of growth in carcass yields suggests that growers and aggregators, at least so far, are not yet responding to the expanding export market opportunity through commercial feeding of animals destined for slaughter.

In contrast to India's beef exports, beef marketed domestically faces relatively limited demand and has shown little growth. Overall meat demand is constrained by the prevalence of vegetarian diets, while meat preferences among nonvegetarian consumers favor poultry and fish (see box "Domestic Demand for Beef in India").

Water buffalo destined for the export market go through a somewhat shorter supply chain in which animals move directly from the livestock markets or trader/aggregators to an export-oriented processor that handles slaughter, processing, and export marketing and logistics. These processing firms are also responsible for ensuring compliance with central and State government regulations

Table 2

**Indian water buffalo slaughter, meat production, and carcass yield for the domestic market<sup>1</sup>**

	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	Annual growth 2007-12
	<i>Percent</i>						
Slaughter (1,000s)	4,947	5,597	6,061	6,890	8,450	9,016	13
Meat production (1,000 tons)	557	623	670	805	975	1,104	15
Carcass yield/head (kgs)	113	111	111	117	115	122	2

Note: These data appear to report only slaughter, production, and yield for water buffalao meat produced for the domestic market. Indian beef exports now exceed the production reported here. <sup>1</sup>Production and yield on deboned basis.

Source: USDA, Economic Research Service using data from Department of Animal Husbandry, Dairying, and Fisheries.

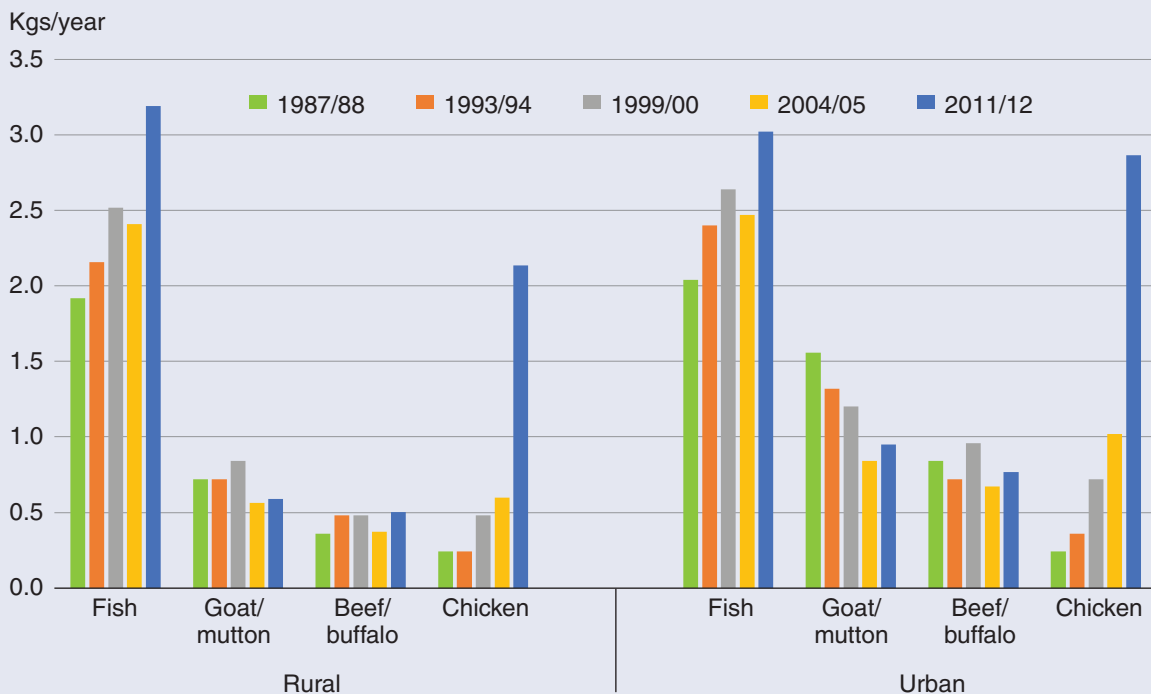
## Domestic Demand for Beef in India

The recent growth in all beef (cattle and water buffalo) production in India is driven by both domestic and export demand, with exports of buffalo meat the fastest growing component of demand. Beef has traditionally been one of the major meats consumed in India—it now ranks fourth behind fish, chicken, and goat and mutton. But, unlike consumption of chicken and fish, per capita consumption of beef has not shown a consistent pattern of growth since the early 1990s (box fig. 1). Most of India’s majority Hindu population (about 80 percent of the population in 2011) does not eat cattle beef, with demand for cattle beef confined primarily to India’s minority Muslim (14 percent) and Christian (2 percent) communities. Although Hindu religious restrictions on the slaughter and consumption of cattle do not apply to water buffalo meat, demand for water buffalo meat appears to be limited among Hindus.

The limited consumer preference for beef, whether from cattle or buffalo, in India is evident from the relatively low per capita consumption of beef relative to that in other countries, including those with similar levels of per capita income (box fig. 2). Recent movements in domestic prices provide further evidence of the limited consumer demand for beef in India (box fig. 3). Despite the rapid expansion of Indian exports of water buffalo meat since the mid-2000s, domestic all-beef prices have trended downward in real (inflation-adjusted) terms (Ministry of Commerce & Industry, 2015). Meat price movements also highlight two key developments in India’s market for meats. First, prices for fish are rising in real terms, reflecting both relatively broad acceptance of fish among Indian consumers and sluggish gains in domestic production. Second, the rapid expansion of poultry demand in India is supported not only by its similarly broad consumer acceptance but also by declining real prices. Declining real chicken prices reflect competitively priced domestic corn and soybean meal (India is an exporter of both commodities), as well as the efficiency of India’s integrated poultry industry (Landes et al., 2004).

Box figure 1

### Per capita consumption of fish and meats in India



Source: USDA, Economic Research Service using data from National Sample Survey Organization.

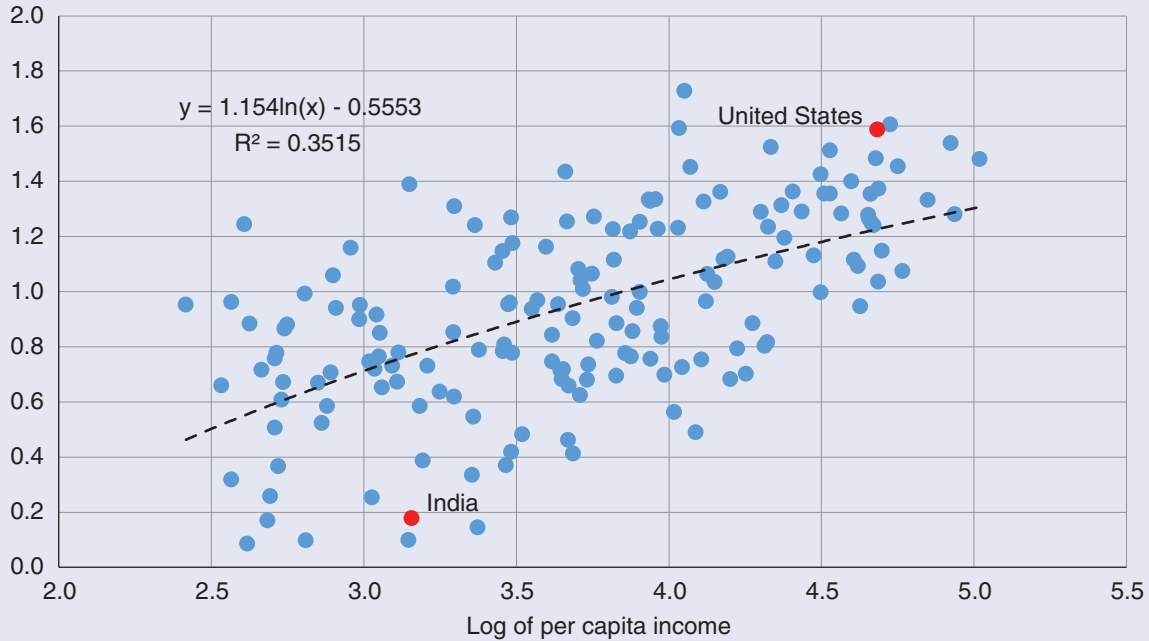
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## Domestic Demand for Beef in India—continued

Box figure 2

### World per capita beef consumption versus income

Log of per capita beef consumption

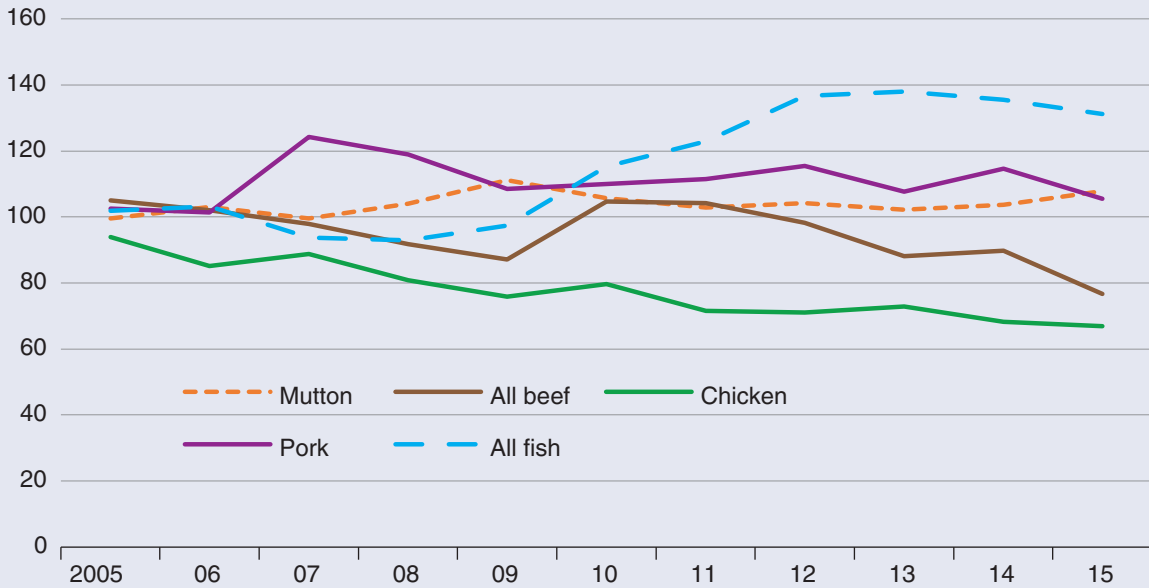


Source: USDA, Economic Research Service using data from World Bank, Development Indicators (per capita income); FAO (beef consumption); ERS International Macroeconomic Data (population).

Box figure 3

### Trends in inflation-adjusted meat prices in India

Deflated wholesale price index (2004-05 = 100)



Source: USDA, Economic Research Service using data from Government of India, Ministry of Commerce, Office of the Economic Advisor.



on the types of animals (not pregnant, not breeding, and not lactating) and animal health (veterinary certification of fitness for slaughter; FMD-free) that are eligible for export (FICCI, 2013).

Because of the rapidly expanding demand for water buffalo by export-oriented firms, livestock traders/aggregators play an increasingly important role in the market (FICCI, 2013). There are no data available on the various costs being incurred by trader/aggregators in acquiring animals to meet the growing export demand, but it is likely that the small-scale, dispersed nature of the back end of the supply chain is leading to higher costs over time as animals are collected from a broader area. Available data on water buffalo prices from a 2012 study (FICCI, 2013) indicate that livestock traders were paying their suppliers close to the market price and receiving margins of about 37 percent for water buffalo sold to exporters (table 3). Trader/aggregators reported that transportation was their largest single cost category. However, data on changes in water buffalo prices during the period of export growth that might have provided evidence of supply and demand conditions in the live animal markets are not available.

The supply chain price buildup for Indian exports of water buffalo meat provided in the FICCI study indicates that the live animal price received by the farmer accounts for about 52 percent of the cost of exported water buffalo meat, while the trader/aggregator share is about 19 percent and the exporter share about 28 percent (table 4). There is, however, no information on how this cost structure may be changing as exports expand.

Table 3

**Representative water buffalo prices in the export supply chain, 2012**

Variable	
Live weight (kgs)	300
Carcass yield, deboned meat, kgs <sup>1</sup>	180
Price paid by trader/aggregator price, rupees/head	16,000
Livestock market price, rupees/head	17,000
Price paid to trade/aggregator by exporter <sup>2</sup>	21,960
Trader-exporter margin	37%

<sup>1</sup>Carcass yield differs from table 2 because it is based on a survey of export-oriented firms. The data in table 2 are from municipal facilities that produce primarily for the domestic market. <sup>2</sup>Assumes Rs122-125/kg bone-in.

Source: USDA, Economic Research Service using data from Federation of Indian Chambers of Commerce and Industry.

Table 4

**Marketing chain cost of Indian buffalo meat exports, 2012**

Weight of live buffalo (kgs)	300
Farmer price (from trader/aggregator), live (rupees)	16,000
Carcass yield (kgs)	180
Farmer price (from trader/aggregator), carcass equiv (rupees/kg)	89
Trader/aggregator price (from exporter), live (rupees)	21,960
Trader/aggregator price (from exporter), carcass equiv (rupees/kg)	122
Export price (rupees/kg)	170
Farmer share of export price	52
Trader/aggregator share of export price	19
Exporter share of export price	28

Source: USDA, Economic Research Service using data from Federation of Indian Chambers of Commerce and Industry.

## Export-Oriented Processing Industry

In addition to expanding international demand and a large water buffalo herd that has been under-exploited for meat production, the development of an export-oriented meat processing industry has been a key to India's emergence as a major beef exporter. While the processing and marketing of meat for domestic use occurs primarily through small-scale municipal slaughter houses and meat shops, India's export-oriented slaughter and processing facilities are relatively modern and large-scale. APEDA data indicate that there are 49 registered export-oriented buffalo slaughter and processing facilities in the country, along with 39 facilities that handle only processing and 11 that handle only slaughter. The Indian Government, via the Ministry of Food Processing Industries (MOFPI), has established a plan seeking to both modernize and create new abattoirs for animal slaughter. Many of the projects already undertaken under the plan have been for the creation or modernization of export-oriented slaughterhouses used for buffalo meat production (MOFPI, 2013).

Comprehensive data on the scale of the facilities are not available, but an Internet search of the integrated slaughter and processing firms certified by APEDA and reporting their capacity on their websites finds that the average production capacity of each unit is about 150 tons per day of deboned meat. Assuming 300 work days per year, this translates into an annual capacity of 2.2 million tons of deboned meat from the integrated units, plus whatever can be produced from the nonintegrated units. It is not clear if the capacity estimates assume single or multiple work shifts. If the capacities given already assume a maximum number of shifts, then current exports of 2.2 million tons imply a high rate of use of current capacity, but there are no reports that slaughter or processing capacity is a constraint to exports.

### Processor regulations

Export-oriented processors must be registered by the Government of India (GOI) through APEDA under a process that also includes the GOI Export Inspection Council, and Food Safety and Standards Authority of India (FSSAI). Registrations are renewed annually, subject to a re-inspection of the facility. APEDA and its partner agencies set the standards for slaughter and processing facilities, handle inspections of the plants and products destined for export, and are tasked with making improvements in packaging and marketing and providing necessary training. All export-oriented units have HACCP and ISO: 9000 certifications and are required to be biosecure.<sup>4</sup>

According to APEDA certification guidelines, all integrated, export-oriented units have the full range of facilities. For slaughter, this includes lairage (accommodations for animals awaiting slaughter), stunning facilities, slaughter line, de-hiding, splitting, washing, and weighing. For processing, this includes facilities for chilling, deboning, plate freezing, blast freezing, modern packing, and cold storage.

### Location of export-oriented processing capacity

India's export-oriented processing capacity is currently concentrated in a few States (table 5). Uttar Pradesh (UP), India's largest State with the largest share of the buffalo herd, accounts for by far the country's largest share of export-oriented capacity and, likely, the largest share of India's exports

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<sup>4</sup>ISO: 9000 refers to a set of quality management standards that help ensure that the needs of customers and stakeholders, as well as any statutory and regulatory requirements related to a product, are met.

Table 5

**Water buffalo inventory and export processing units in India, by State**

State	Water buffalo inventory						Export-oriented processors		
	Total			Female			Slaughter and processing	Slaughter only	Processing only
	2007	2012	% change	2007	2012	% change			
	<i>1,000s</i>						<i>Number</i>		
Uttar Pradesh	23,812	30,625	29	18,427	25,711	40	34	6	26
Rajasthan	11,092	12,976	17	9,766	11,401	17			1
Gujarat	8,774	10,386	18	7,757	9,550	23			
Andhra Pradesh	13,272	10,623	-20	11,164	9,272	-17	3	2	2
Madhya Pradesh	9,129	8,188	-10	7,537	6,904	-8			
Bihar	6,690	7,567	13	5,401	6,591	22	1		1
Haryana	5,953	6,085	2	5,037	5,147	2			
Maharashtra	6,073	5,594	-8	5,202	4,998	-4	5	2	7
Punjab	5,062	5,160	2	4,545	4,626	2	4		
Karnataka	4,327	3,471	-20	3,829	3,110	-19			1
Uttarakhand	1,220	988	-19	1,063	874	-18			
Himachal Pradesh	762	716	-6	703	656	-7			
Jammu & Kashmir	1,050	739	-30	910	660	-27			
Tamil Nadu	2,009	780	-61	1,514	680	-55			
Jharkhand	1,506	1,186	-21	742	614	-17			
Chattisgarh	1,604	1,391	-13	594	600	1			
Odisha	1,190	726	-39	589	391	-34			
Other	1,818	1,501	-17	965	814	-16	2	1	1
All-India	105,343	108,702	3	85,745	92,599	8			

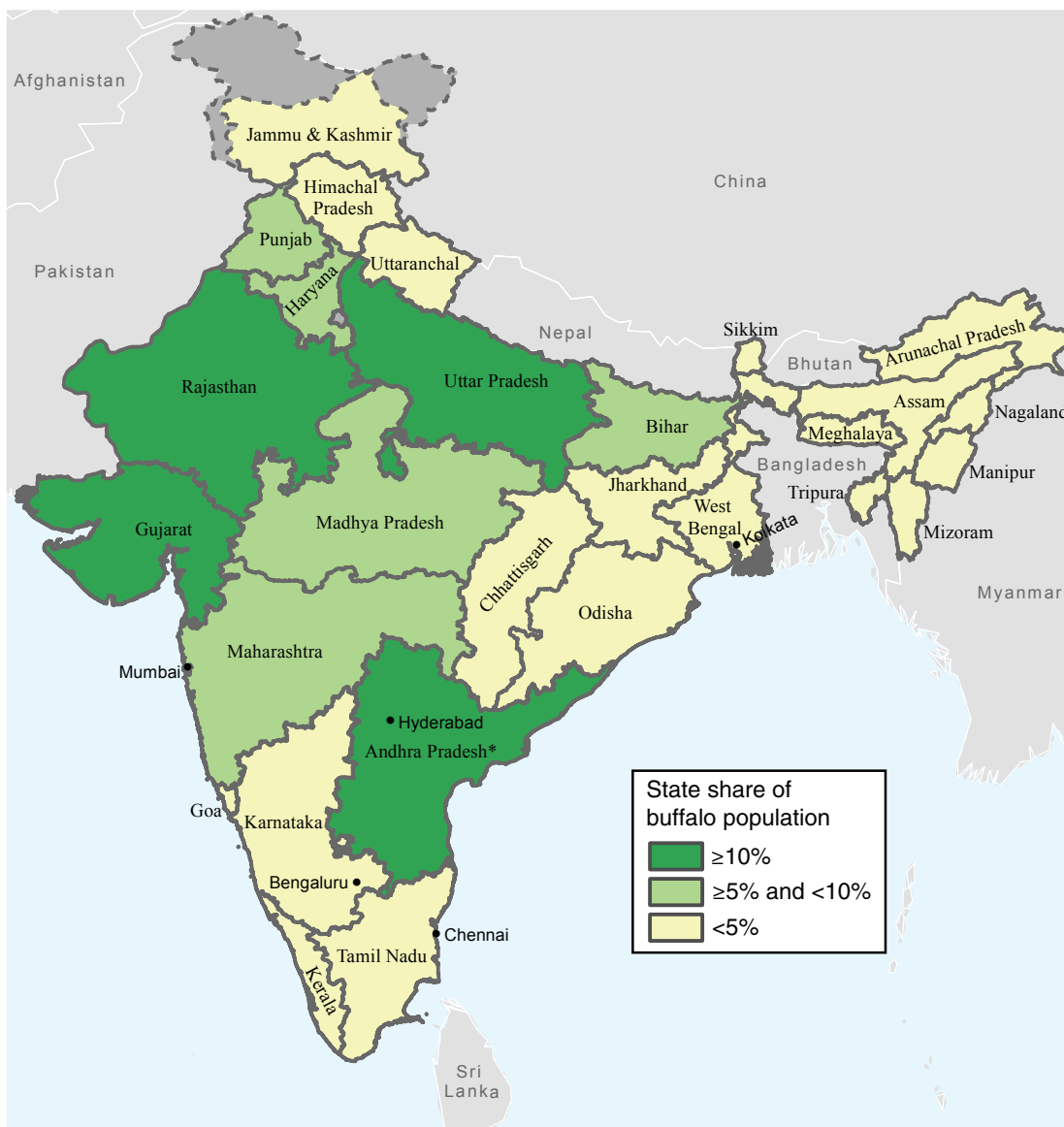
Sources: USDA, Economic Research Service using data from Department of Animal Husbandry, Dairying, and Fisheries, Animal Husbandry Statistics; Federation of Indian Chambers of Commerce and Industry.

of water buffalo meat. Livestock census data indicate that, despite the export activity, UP's female water buffalo herd—which is believed to provide the bulk of exports—expanded more than that in any other State between 2007 and 2012. It may be that a significant portion of the animals slaughtered by UP exporters originate in the bordering States of Bihar and Rajasthan, both of which are reported to be animal procurement centers.

Maharashtra, Andhra Pradesh, and Punjab each also has multiple export-oriented processors, along with a sizable share of the water buffalo herd. However, a large share of India's water buffalo herd appears to be in States such as Gujarat, Rajasthan, Madhya Pradesh, and Karnataka that have little proximity to export-oriented processors (table 5; fig. 7).

The data in table 5 highlight two issues relevant to assessing the potential for India's water buffalo meat exports to expand. The first is that the data suggest potential for exploiting a larger share of the herd for meat exports through the location of new processing in other States. While State-level regulations may be impeding expansion in some States, that does not appear to be the case in a number of other States.

Figure 7  
**State shares of water buffalo population in India, 2012**



\*Andhra Pradesh was divided into two States, Andhra Pradesh and Telangana in June 2014. Water buffalo inventory data are available only for Andhra Pradesh prior to its division.

Source: USDA, Economic Research Service using data from Department of Animal Husbandry, Dairying, and Fisheries (2014).

The second issue is the extent to which the growth of buffalo meat production and exports in India is reducing the country’s inventory of female buffalo and, particularly, the milking herd. Census data indicate increases in the size of India’s female water buffalo herd overall and in several important States between 2007 and 2012 (UP, Rajasthan, Gujarat, and Bihar) but also reveal noticeable declines in the female herd in most other States (table 5). Data on buffalo milk production for the same period are mixed, showing growth rates above the national average in most of these same States but relatively weak growth in others, such as Punjab and Bihar. The data do not reveal any strong correlation between the location of export-oriented slaughter activity (as represented by slaughter capacity) and changes in female water buffalo inventories. The declines in the female herd in many States in 2012 may be the result of factors other than export demand.

## Export Scenarios

USDA annually updates 10-year projections for U.S. and global agriculture using a combination of economic models and expert judgment to estimate the expected behavior of major commodity sectors (USDA/OCE, 2016). The projection framework incorporates available national data and information on the performance of the commodity sectors and also enforces global consistency in the supply, use, and trade analysis for each commodity. With India emerging as a major beef exporter, the USDA projections now include India's beef sector.

The current projections for Indian beef supply and use, which aggregate both cattle and water buffalo meat, call for 3.1 percent annual growth in India's beef exports between the 2014-16 average level and 2025 (table 6). Annual growth in domestic beef consumption in India is projected at 1.7 percent during the period, reflecting limited consumer preferences for beef compared with that for fish and chicken meat, with most of the projected growth in production driven by export demand (fig. 8). With this projected growth, Indian exports account for an increasing share of world beef trade and of the rising demand for beef imports by low- and middle-income countries (fig. 9).

The projections for Indian beef production and trade are, however, highly uncertain because of the limited availability of reliable data on India's water buffalo sector, as well as the short period of recent growth from which to gauge the sustainability of high rates of production and export growth. The following analysis examines the available data on herd dynamics, the implications of the current USDA projections for India's water buffalo inventory, and the sensitivity of the projections to alternative assumptions for selected variables.

Table 6

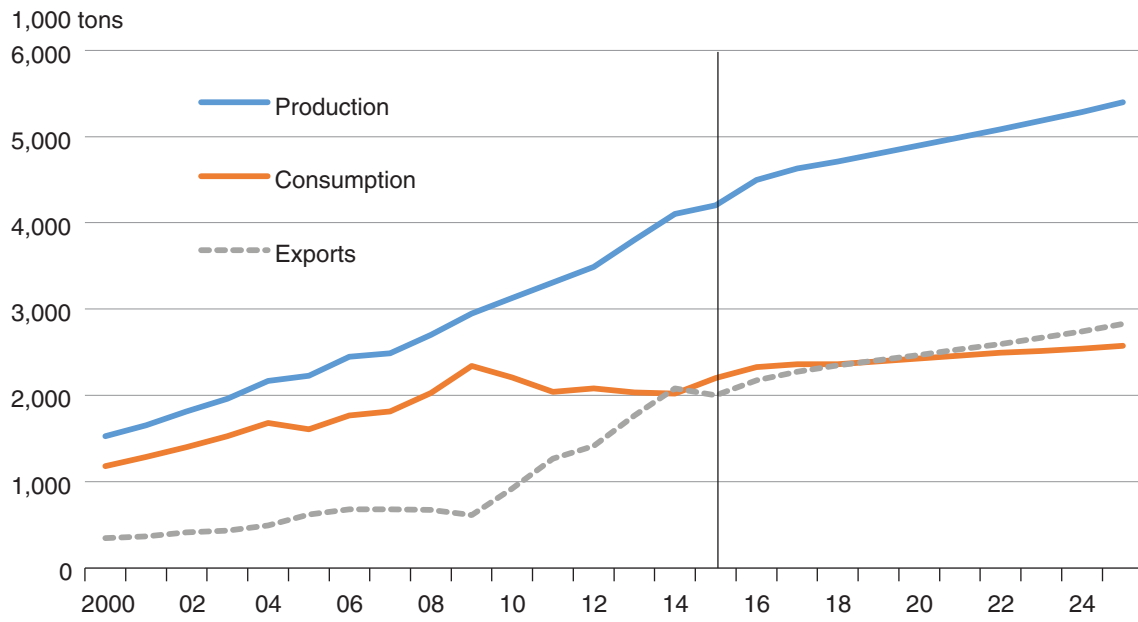
### Projections for supply and use of beef in India

	Historical data				Projections									
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
	<i>1,000 tons</i>													
Beef (cattle & water buffalo meat): <sup>1</sup>														
Production	3,491	3,800	4,100	4,200	4,500	4,629	4,711	4,801	4,896	4,991	5,084	5,182	5,284	5,399
Consumption	2,080	2,035	2,018	2,200	2,325	2,357	2,361	2,393	2,427	2,460	2,492	2,515	2,542	2,573
Exports	1,411	1,765	2,082	2,000	2,175	2,272	2,350	2,408	2,469	2,531	2,592	2,667	2,742	2,826
Buffalo meat: <sup>2</sup>														
Production	3,016	3,365	3,699	3,796	4,108	4,267	4,384	4,505	4,633	4,761	4,888	5,022	5,161	5,313
Consumption	1,605	1,600	1,617	1,796	1,933	1,995	2,034	2,097	2,164	2,230	2,296	2,355	2,419	2,487
Exports	1,411	1,765	2,082	2,000	2,175	2,272	2,350	2,408	2,469	2,531	2,592	2,667	2,742	2,826
Memo item:														
Buffalo % of beef production <sup>3</sup>	77	79	80	82	83	85	86	88	89	91	92	94	95	97

Sources: <sup>1</sup>From *USDA Agricultural Projections to 2025*. <sup>2</sup>ERS estimate. Assumes all beef exports are water buffalo meat and shares of water buffalo meat in domestic beef production are consistent with Department of Animal Husbandry, Dairying, and Fisheries data.

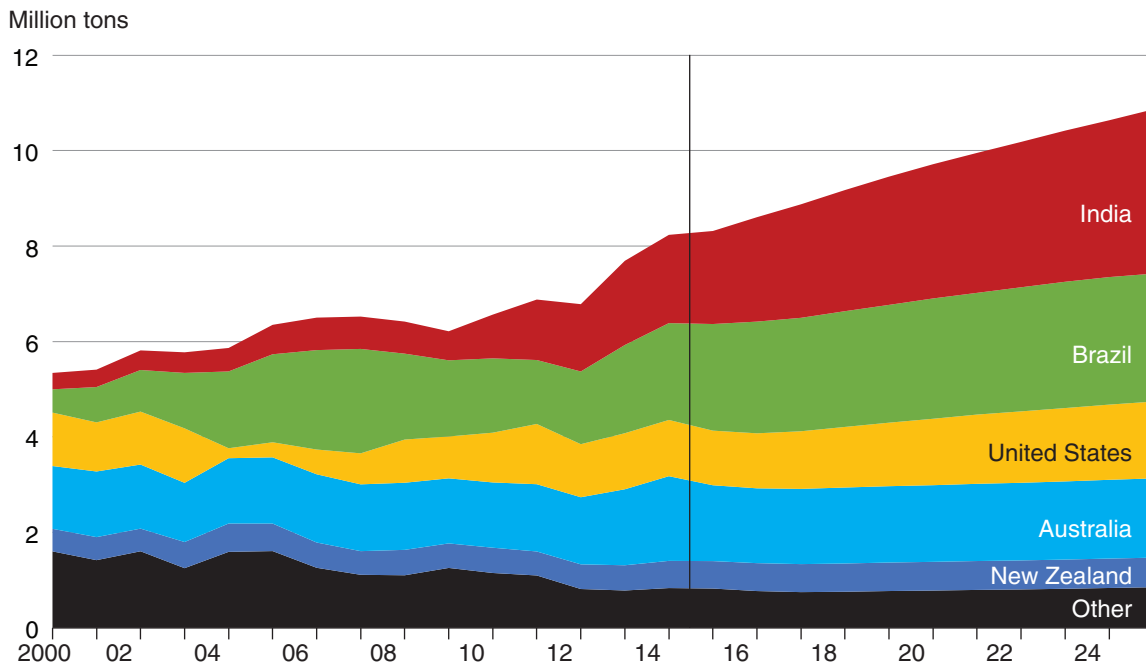
<sup>3</sup>Historical data from Department of Animal Husbandry, Dairying, and Fisheries data; projections assume continuation of linear trend.

Figure 8  
**USDA projections for India's beef sector<sup>1</sup>**



<sup>1</sup>Includes both cattle and water buffalo meat.  
 Source: USDA, Economic Research Service using data from *USDA Agricultural Projections to 2025*.

Figure 9  
**USDA projections for major beef exporters**



<sup>1</sup>Includes both cattle and water buffalo meat.  
 Source: USDA, Economic Research Service using data from *USDA Agricultural Projections to 2025*.

## Projections for water buffalo meat

The USDA projections include both cattle and water buffalo meat, so a necessary first step is to break out a consistent set of projections for water buffalo meat. This is accomplished by making two assumptions. First, since exports of cattle beef from India are illegal and unlikely to account for a significant share of exports, it is assumed that all beef exports are water buffalo meat. Second, the portion of all beef production that is not exported is split between cattle and water buffalo meat using the shares of these products in slaughter and production for the domestic market, as reflected in the DAHDF data. The trended water buffalo meat share is applied to the portion of total beef production that is not exported (Total beef production – Water buffalo meat exports) to derive an estimate of water buffalo meat produced for the domestic market.

The current USDA projections for supply and use of all beef in India, consistent with the trade projections found in *USDA Agricultural Projections to 2025* (USDA/OCE, 2016), along with the underlying projections for water buffalo meat, are shown in table 6. The projections show the relatively high rates of growth for production and consumption of water buffalo meat, compared with that for all beef.

## Examining herd dynamics

The expansion of Indian water buffalo meat exports will depend not only on export demand but on the sustained availability of animals for slaughter. So far, India's large water buffalo herd, which has been only minimally exploited for meat production, appears to be supplying animals to support rapid export growth without major constraint. There is, however, only sparse data on water buffalo prices that might signal supply conditions in domestic livestock markets. Here, the analysis tries to assess the sustainability of India's exports by using available data and information from the Government of India and other sources to examine the implications for water buffalo inventories over the 10-year projection period.

Table 7 summarizes three alternate scenarios for India's water buffalo herd between 2016 and 2025. The first scenario is constructed to reflect the continuation of recent trends in herd dynamics using an animal supply and use account, where beginning inventory and births are summed to obtain animal supplies; deaths and slaughter account for use; ending inventory is residual; and meat production is equal to slaughter times carcass weight. The first "trend herd dynamics" scenario is developed using the following key assumptions:

- Births: Sources indicate that female water buffalo calve once every 2 years, on average. Births are calculated as 50 percent of the female inventory across all years.
- Deaths (other than slaughter): Multiple sources report very high first-year mortality of male calves. The 70-percent mortality rate reported for male calves (Rabobank, 2012) likely includes some young animals that are slaughtered for meat. This analysis assumes a lower mortality rate for male calves at 55 percent of male births across all years in the base scenario. Since female dairy culls are the primary source of animals slaughtered for export, death rates are expected to be relatively low; female deaths are calculated as 4 percent of beginning inventory across all years.
- Slaughter: Available slaughter data only cover production for domestic use, so it is necessary to estimate slaughter rates. The analysis uses the historical animal inventory data to estimate historical slaughter rates that achieve rough consistency with inventories, then extrapolates

Table 7

**Alternative inventory and production scenarios for water buffalo in India<sup>1</sup>**

	Historical data				Projections									
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
<b>Scenario 1: Trend herd dynamics:</b>														
Buffalo inventory (1,000 head)														
Total	108,702	113,780	118,618	122,978	127,067	130,778	133,976	136,554	138,426	139,525	139,796	139,203	137,724	135,353
Male	16,103	14,620	14,233	14,355	14,690	15,111	15,548	15,961	16,322	16,615	16,824	16,942	16,961	16,875
Female	92,599	99,160	104,385	108,623	112,376	115,667	118,428	120,593	122,104	122,910	122,972	122,261	120,763	118,478
Buffalo slaughter (1,000 head)														
Total	24,141	26,556	28,735	30,368	31,942	33,501	34,993	36,380	37,627	38,702	39,579	40,231	40,638	40,781
Male	11,256	10,958	11,052	11,310	11,634	11,971	12,289	12,567	12,792	12,953	13,044	13,058	12,993	12,845
Female	12,885	15,598	17,683	19,058	20,308	21,530	22,705	23,814	24,835	25,749	26,535	27,173	27,645	27,936
Buffalo carcass weight (kgs) <sup>2</sup>														
	125	126	127	128	129	130	131	132	133	134	135	136	137	138
Net additions to herd (1,000 head)														
Total	5,078	4,838	4,360	4,089	3,712	3,198	2,578	1,872	1,099	272	-593	-1,480	-2,370	-3,247
Male	6,561	5,226	4,238	3,753	3,291	2,760	2,165	1,511	807	62	-711	-1,498	-2,285	-3,056
Female	-1,483	-387	122	336	421	437	413	361	292	210	118	19	-85	-191
Meat production (1,000 tons)														
	3,016	3,365	3,699	3,796	3,983	4,414	4,584	4,802	5,004	5,186	5,343	5,471	5,567	5,628
Difference from USDA projection														
	--	--	--	--	--	147	200	297	372	425	455	449	407	315
<b>Scenario 2: Increased rearing of male water buffalo:<sup>3</sup></b>														
Buffalo inventory (1,000 head)														
Total	108,702	113,780	118,618	122,978	127,067	130,667	133,683	136,031	137,640	138,452	138,421	137,516	135,722	133,043
Male	16,103	14,620	14,233	14,355	14,690	14,999	15,255	15,438	15,536	15,542	15,448	15,254	14,959	14,565
Female	92,599	99,160	104,385	108,623	112,376	115,667	118,428	120,593	122,104	122,910	122,972	122,261	120,763	118,478
Buffalo slaughter (1,000 head)														
Total	24,141	26,556	28,735	30,368	31,942	34,265	36,123	37,870	39,472	40,892	42,098	43,058	43,744	44,132
Male	11,256	10,958	11,052	11,310	11,634	12,736	13,418	14,057	14,636	15,143	15,563	15,885	16,099	16,196
Female	12,885	15,598	17,683	19,058	20,308	21,530	22,705	23,814	24,835	25,749	26,535	27,173	27,645	27,936
Buffalo carcass weight (kgs) <sup>2</sup>														
	125	126	127	128	129	130	131	132	133	134	135	136	137	138
Net additions to herd (1,000 head)														
Total	5,078	4,838	4,360	4,089	3,712	3,016	2,348	1,609	812	-31	-905	-1,793	-2,679	-3,544
Male	6,561	5,226	4,238	3,753	3,291	2,760	2,165	1,511	807	62	-711	-1,498	-2,285	-3,056
Female	-1,483	-387	122	336	421	255	183	98	5	-93	-194	-295	-394	-488
Meat production (1,000 tons)														
	3,016	3,365	3,699	3,796	3,983	4,455	4,732	4,999	5,250	5,480	5,683	5,856	5,993	6,090
Difference from scenario 1														
	--	--	--	--	--	41	148	197	245	293	340	384	426	462

Continued—



Table 7

**Alternative inventory and production scenarios for water buffalo in India<sup>1</sup>—continued**

	Historical data				Projections									
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
<b>Scenario 3: Increased carcass weights:<sup>4</sup></b>														
Carcass weight ( <i>kgs</i> ) <sup>4</sup>	125	126	127	128	130	132	134	136	138	140	142	144	146	148
Meat production ( <i>1,000 tons</i> )	3,016	3,365	3,699	3,796	3,983	4,422	4,689	4,948	5,193	5,418	5,620	5,793	5,933	6,036
Difference from scenario 1	--	--	--	--	--	8	105	146	188	232	277	322	366	408

<sup>1</sup>See appendix tables for detailed inventory-flow assumptions. <sup>2</sup>Yield of deboned meat. <sup>3</sup>Death rate of male animals reduced 1 percent per year and male animal slaughter rate increased by 3 percent per year. <sup>4</sup>Annual change in carcass weight increased from 1 kg to 2 kgs.

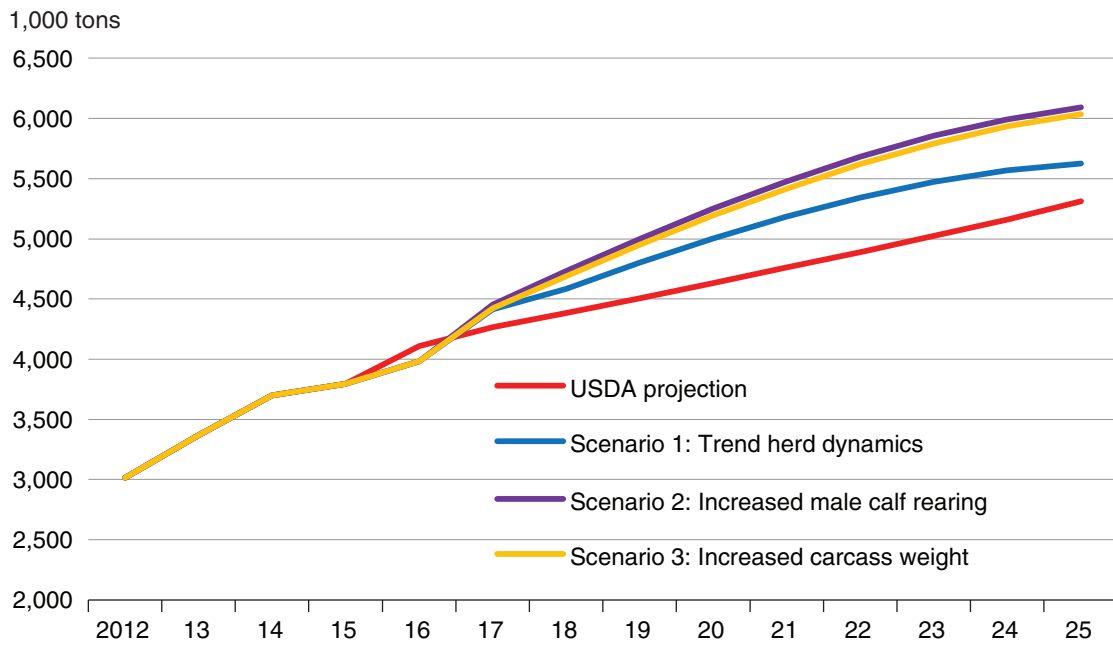
Source: USDA, Economic Research Service estimates.

those rates into the future. It is necessary to assume substantial male animal slaughter of 44 percent, likely of young calves, to maintain consistency with the relatively low male inventory levels. Female slaughter rates for 2012-15 are set at the levels needed to match up with historical production data for those years. For 2016-24 the female slaughter rate is increased 3 percent per year, consistent with the 2012-15 trend.

- Carcass weight (deboned meat): The DAHDF data indicate a yield of 122 kgs per head for municipal slaughterhouses that process meat primarily for the domestic market. The most recent study of India's beef exports (FICCI, 2013) gives examples of weights in export-oriented firms in 2012 ranging from 180-240 kgs per head. While it is reasonable that animals purchased for export are heavier than those made available for local slaughter, the higher examples provided by FICCI appear too far above the DAHDF estimates in the absence of any evidence of commercial feeding. Finally, it is not clear that either the DAHDF average for the domestic market or the higher weights for the export market incorporate the likely substantially lower average carcass yields from slaughtered male calves. The projections assume a 2012 average carcass yield of 125 kg per head, which is a weighted average of the DAHDF estimate (122 kgs), the lowest FICCI estimate (180 kgs) and an assumed average for male calves (45 kgs). The carcass yield of 125 kgs per head in 2012 is assumed to increase 1 kg per year in the base scenario, consistent with the trend in the DAHDF data.

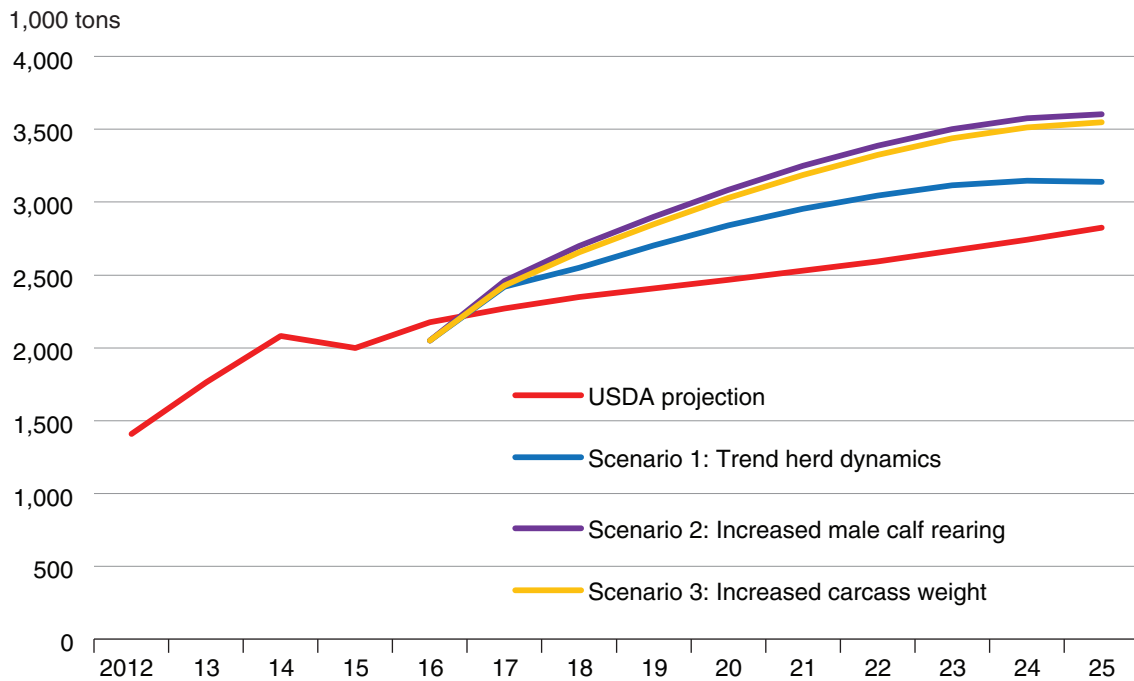
The key implication of the “trend herd dynamics scenario” is that, using assumptions calibrated to the available historical data, projections for water buffalo meat production and exports exceed the current USDA projections through 2025, but the two projections begin to converge toward the end of the period (figs. 10 and 11). However, the scenario results show that the size of the water buffalo herd, including the female herd, begins to shrink in the 2020s (fig. 12). With this result, additional gains in production based on increasing slaughter rates alone lead to further shrinkage of the herd that may prove unsustainable. Further, based on trend assumptions on herd dynamics, the results imply that, by the 2020s, there may be a tradeoff between maintaining growth in water buffalo meat exports at projected levels and maintaining growth in the water buffalo dairy herd.

Figure 10  
**Indian water buffalo meat production alternative scenarios**



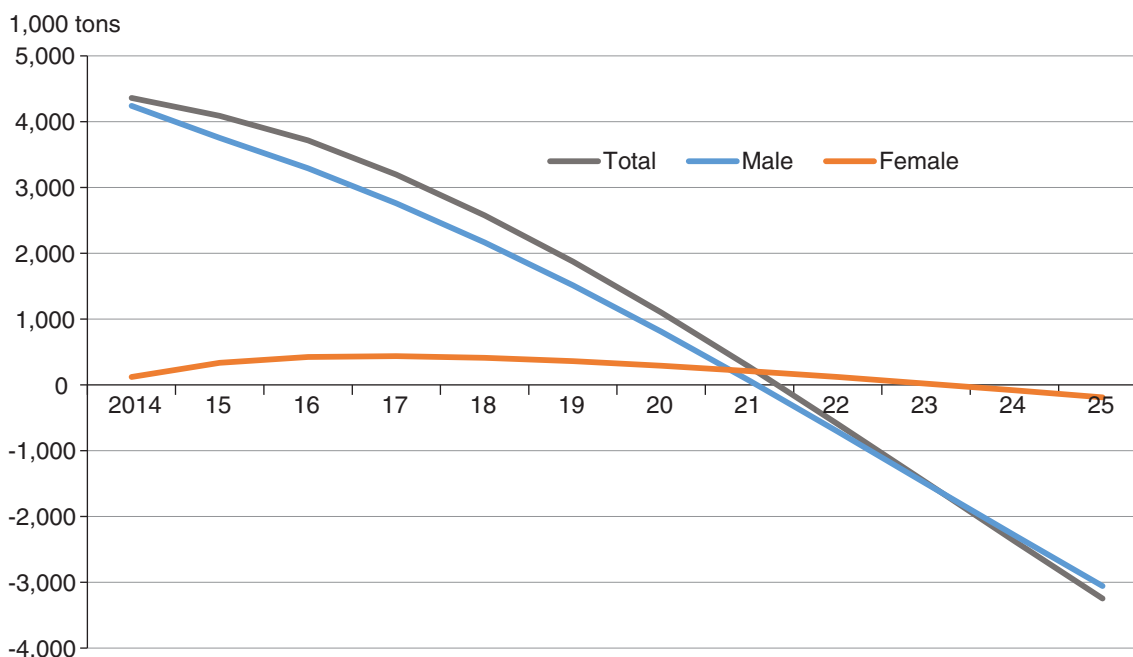
Source: USDA, Economic Research Service estimates.

Figure 11  
**Indian water buffalo meat exports alternate scenarios**



Source: USDA, Economic Research Service using *USDA Agricultural Projections to 2024* and authors' estimates.

Figure 12  
**Scenario 1 net additions to India's buffalo herd<sup>1</sup>**



<sup>1</sup>Net additions = births - deaths - slaughter.  
 Source: USDA, Economic Research Service estimates.

## Alternative scenarios

Two additional scenarios (see table 7, appendix II, table 1) assess the impacts of alternative assumptions for projecting two key variables: rearing of male calves and average carcass weights. The current practice of either disposing of male water buffalo calves or slaughtering them at low weights reflects the historically limited demand for beef in India but also a possibly significant loss of income-earning potential for farmers in the context of an expanding export market. While a Government initiative to encourage the rearing of male calves for meat production appears to have met little success so far, the increasing commercial incentives, aided by export-oriented processors, may eventually lead to increased rearing and feeding of male calves. Thus, the second scenario estimates the possible impacts of rearing male calves by reducing the death rate for male calves by 1 percent each year and also increasing the slaughter rate for male animals by a corresponding amount. By the end of the projection period in 2025, the result is an increase in production of about 460,000 tons that supports sustained growth in water buffalo meat production and exports (see table 7; figs. 10 and 11).

The potential for increased rearing of male calves for meat production will, at least in part, depend on the profitability of the enterprise considering the cost of the additional resources, particularly land and feed that may be required. Pasture land is in fixed supply, and crop residues suitable for feeding are already fully utilized. Government planning documents indicate that overall deficits from recommended levels of livestock feeding under current cropping patterns are about 11 percent for dry matter, 33 percent for green fodder, and 35 percent for grain and oil-meal concentrate feeds. However, only about 5 percent of India's gross cropped area is currently used for fodder production, suggesting that a relatively small adjustment in cropping patterns could lead to a significant

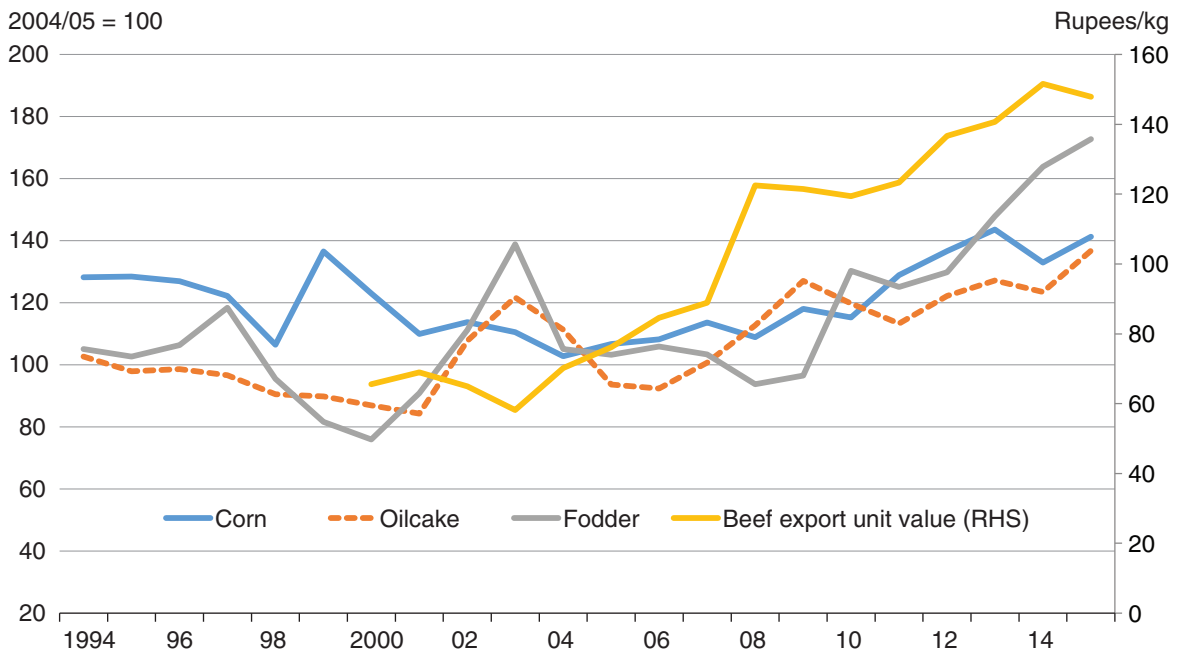
gain in supply. Further, India is currently producing exportable surpluses of corn and oil meals in most years. Price data indicate that, while prices of corn and fodder are now rising in real terms, the rupee-equivalent of India's beef export unit values are matching the rise in feed prices (fig. 13).

The deboned carcass-weight estimates used in the trend herd dynamics scenario (scenario 1) are low by international standards and may also become responsive to the commercial opportunity created by beef exports. At present, pre-slaughter fattening is not a common practice but may eventually become a viable commercial opportunity. The third scenario estimates the impact of faster increases in carcass weights by raising the rate of increase from 1 kg to 2 kgs per year. The results also show an increase in production by the last year of the projection period that would support further growth in production and exports above both the current USDA projection and the trend herd dynamics scenario (see table 7; figs. 10 and 11).

Overall, the scenario analysis indicates that the rapid projected growth in exports of water buffalo meat may lead to a tradeoff between maintaining the dairy herd and maintaining meat exports over the next 10 years. However, relatively minor changes in assumptions that could prove responsive to the expansion of the beef export industry could potentially sustain the expansion of Indian exports.

Figure 13

**Inflation-adjusted wholesale prices for feeds and export prices for beef**



Source: USDA, Economic Research Service (ERS) using estimates Government of India, Ministry of Commerce, Office of the Economic Advisor, World Trade Atlas; ERS Agricultural Exchange Rate Database.

## Outlook

The rapid growth in India's exports of water buffalo meat is predicated on three factors: (1) rising demand for relatively low-cost meat by consumers in low- and middle-income developing-country markets, (2) India's large water buffalo herd, which has been mostly untapped for meat production, and (3) the emergence of private sector, export-oriented processors that have been effective in meeting the requirements of their developing-country markets.

Growth in demand for water buffalo meat in India's export markets, largely in Southeast Asia, the Middle East, and Africa, has been strong relative to that in developed-country markets and is expected to remain so over the next decade. In addition, India may benefit from the opening of important new markets, particularly Russia and China. Shipments to Russia started in early 2015 following the certification of one Indian processing plant by Russian authorities, but four of the five plants initially approved for exports to Russia were reportedly suspended due to FMD concerns, and it is not clear if they will be reinstated (USDA/FAS, 2015). China and India signed a memorandum of understanding in May 2013 to negotiate terms for opening the Chinese market to Indian water buffalo meat. Those negotiations have been held up in the context of other bilateral issues, but an opening of the Chinese market, if and when it happens, could lead to some expansion of trade.

Despite India's large and underutilized water buffalo herd, there appear to be concerns about the sustainability of recent growth in meat exports from a supply perspective. Reliable inventory-flow analysis is hampered by limited data, but the available census inventory data and plausible assumptions for herd dynamics suggest that the current USDA supply and use projections will begin to lead to a decline in the female buffalo herd by the end of the 2015-25 projection period, creating the potential for a tradeoff between milk and meat production. The analysis indicates that export growth might be sustained if producers begin to respond to rising export demand by retaining and rearing male calves and/or feeding animals to higher weights, but there is not yet any evidence that this is happening. More data on live animal marketing, slaughter, and processing would clearly aid in this assessment.

India's private sector, export-oriented processors have been successful in identifying and serving a diverse set of export markets. They have a competitively priced product that matches with the standards and consumer preferences of the low- and middle-income consumers in developing-country markets. Indian Government regulation, by establishing and enforcing sanitary and quality standards for processors, appears to be enabling export growth. There also appears to be significant potential for export-oriented processors to expand into new, so far unexploited, areas of the country. There is, however, little data or information with which to assess the profitability of export-oriented processing and the incentives for further expansion.

So far, it appears that Indian water buffalo meat exports, although relatively low cost, are mostly noncompetitive with U.S. beef exports, primarily due to quality preferences and animal health regulations in the major markets that import U.S. beef. Indian exports of water buffalo meat do not comply with health standards, including FMD-free status, required by most high-income markets served by the United States; even in markets shared by the two countries, the products are likely to serve different customer segments. About 90 percent of U.S. beef exports go to markets closed to Indian beef. However, India's water buffalo meat exports are competing effectively in developing-country markets with a demand profile that favors India's relatively low-cost product, and where import demand is substantially outpacing that in traditional U.S. markets. Although U.S. beef suppliers may be able to compete for "high-end" consumer segments in India's developing-country

markets, especially as U.S. prices decline from their recent cyclical highs, it is unclear if they can compete for the faster growing, low-cost segments served by India unless Indian supplies begin to be constrained by the continued low productivity of its buffalo herd.

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**Indian exports of fresh, chilled, frozen, or prepared beef**

Partner country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
	Tons															
Vietnam	0	93	466	610	1,642	14,824	25,429	54,811	129,162	155,632	127,082	330,609	398,402	664,935	927,760	791,188
Malaysia	98,530	97,850	103,954	113,523	105,388	117,107	105,526	73,255	70,774	67,499	111,812	135,305	146,979	169,498	171,902	189,879
Egypt	33,922	51,220	38,167	553	0	35	8,276	37,184	60,993	40,026	97,690	94,925	97,342	129,039	203,932	147,507
Thailand	0	0	281	395	39	76	153	138	108	0	5,397	32,195	83,699	234,685	118,866	88,778
Saudi Arabia	1,480	528	224	82	28,974	51,160	37,943	49,435	35,839	33,984	66,688	87,574	98,087	98,863	102,004	95,763
Philippines	60,860	69,741	66,088	65,182	62,175	65,912	64,970	71,911	74,251	58,070	61,359	66,074	61,430	61,246	62,967	59,384
Algeria	0	0	0	0	0	0	0	42	0	0	25,421	46,734	64,690	60,428	63,662	55,245
United Arab Emirates	57,638	31,234	38,440	27,338	25,724	49,995	42,760	37,642	25,783	23,232	44,460	53,458	61,440	60,190	58,735	50,583
Iraq	0	0	0	340	1,663	4,089	2,254	7,517	4,174	10,411	24,713	33,463	33,541	39,130	33,097	58,029
Jordan	16,829	19,011	20,448	41,836	40,549	44,322	50,575	29,169	21,650	17,504	58,439	86,636	86,891	65,584	39,465	22,168
Kuwait	6,587	4,764	8,098	10,764	20,406	40,324	58,445	56,440	43,684	39,708	50,728	28,866	27,842	28,730	39,394	47,103
Angola	6,665	16,070	26,184	36,796	40,322	54,163	59,599	67,009	41,818	23,915	27,883	29,802	37,465	37,849	43,609	15,833
Iran	13,606	20,154	10,913	11,067	11,375	17,676	30,406	17,133	16,957	7,547	25,232	37,983	65,608	56,871	19,275	10,301
Congo	1,397	2,838	3,075	5,931	10,184	14,560	19,299	14,807	19,596	17,007	17,327	17,460	23,574	25,421	18,011	16,429
Oman	9,686	11,141	13,344	12,599	12,048	14,769	16,082	16,747	16,102	11,238	15,891	17,590	17,755	19,364	18,155	17,817
Turkmenistan	0	0	0	0	0	0	38	3,692	0	784	280	1,758	645	3,424	26,691	23,375
Gabon	5,459	6,238	5,000	4,288	6,311	8,144	10,077	10,714	8,728	8,171	11,000	10,443	9,707	14,027	7,679	10,149
Lebanon	5,842	3,395	5,443	7,300	3,035	1	2,364	7,096	9,027	9,562	12,352	10,231	7,793	9,526	13,878	7,403
Azerbaijan	0	0	589	813	2,465	9,577	10,196	4,579	5,938	3,953	5,346	6,964	10,385	12,593	10,283	5,709
Qatar	772	1,280	1,565	1,952	2,729	3,939	5,954	4,065	5,706	5,763	6,473	9,816	8,490	8,426	8,525	9,418
Laos	0	0	0	0	0	0	0	0	0	0	0	0	4,515	6,467	10,262	7,006
Syria	0	0	0	0	143	0	235	0	2,383	9,094	19,501	26,374	14,383	5,845	8,564	5,695
Tajikistan	0	0	0	0	229	240	1,093	3,906	2,467	3,075	2,353	2,301	2,652	4,446	6,751	4,655
Pakistan	0	0	0	0	38	4,663	32,276	18,268	5,181	4,115	4,154	5,371	4,315	4,245	5,709	4,699
Senegal	709	605	885	1,352	1,974	7,819	10,663	10,955	7,167	6,739	7,075	5,967	6,052	4,092	5,401	4,991
Other	24,464	28,761	67,532	89,622	114,355	93,731	86,006	81,784	64,986	51,557	88,323	89,636	76,662	55,991	57,269	56,627
World	344,446	364,923	410,696	432,343	491,768	617,126	680,619	678,299	672,474	608,586	916,979	1,267,535	1,450,344	1,880,915	2,081,846	1,805,734

Source: USDA, Economic Research Service using data from the World Trade Atlas; includes HS codes 0201, 0202, 021020, 160250.

**Details for Indian water buffalo herd projections for Scenario 1: Trend herd dynamics**

	Livestock census years											Projections										
	1992	1997	2003	2007	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025				
<b>Buffalo inventory (1,000 head)</b>																						
Total	84,206	89,919	97,922	105,342	108,702	113,780	118,618	122,978	127,067	130,778	133,976	136,554	138,426	139,525	139,796	139,203	137,724	135,353				
Male	17,351	18,625	17,888	19,597	16,103	14,620	14,233	14,355	14,690	15,111	15,548	15,961	16,322	16,615	16,824	16,942	16,961	16,875				
Female	66,855	71,294	80,034	85,745	92,599	99,160	104,385	108,623	112,376	115,667	118,428	120,593	122,104	122,910	122,972	122,261	120,763	118,478				
<b>Births</b>																						
Male	16,714	17,824	20,009	21,436	23,150	24,790	26,096	27,156	28,094	28,917	29,607	30,148	30,526	30,728	30,743	30,565	30,191	29,619				
Female	16,714	17,824	20,009	21,436	23,150	24,790	26,096	27,156	28,094	28,917	29,607	30,148	30,526	30,728	30,743	30,565	30,191	29,619				
Birth rate:	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%				
<b>Deaths (not slaughter, 1,000 head)</b>																						
Total	12,561	13,400	14,922	16,004	17,080	18,186	19,098	19,855	20,534	21,135	21,643	22,044	22,326	22,481	22,501	22,379	22,114	21,705				
Male	9,887	10,548	11,720	12,574	13,376	14,219	14,922	15,510	16,039	16,509	16,906	17,220	17,442	17,565	17,582	17,489	17,283	16,966				
Death rate/births:	55%	55%	55%	55%	55%	55%	55%	55%	55%	55%	55%	55%	55%	55%	55%	55%	55%	55%				
<b>Death rate/inventory:</b>																						
Female	2,674	2,852	3,201	3,430	3,704	3,966	4,175	4,345	4,495	4,627	4,737	4,824	4,884	4,916	4,919	4,890	4,831	4,739				
Death rate/inventory:	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%				
<b>Supply (1,000 head)</b>																						
Total	105,073	112,166	123,017	132,211	137,921	145,174	151,713	157,435	162,721	167,477	171,547	174,807	177,152	178,499	178,782	177,955	175,991	172,887				
Male	24,178	25,901	26,176	28,459	25,876	25,191	25,407	26,001	26,745	27,519	28,250	28,889	29,406	29,777	29,986	30,019	29,868	29,529				
Female	80,895	86,266	96,841	103,751	112,045	119,983	126,306	131,434	135,975	139,958	143,298	145,917	147,746	148,722	148,796	147,936	146,123	143,358				
<b>Slaughter (1,000 head)</b>																						
Total	15,187	14,240	17,681	23,585	24,141	26,556	28,735	30,368	31,942	33,501	34,993	36,380	37,627	38,702	39,579	40,231	40,638	40,781				
Rate	14%	13%	14%	18%	18%	18%	19%	19%	20%	20%	20%	21%	21%	22%	22%	23%	23%	24%				
Male	5,561	8,029	6,544	12,380	11,256	10,958	11,052	11,310	11,634	11,971	12,289	12,567	12,792	12,953	13,044	13,058	12,993	12,845				
Rate	23%	31%	25%	44%	44%	44%	44%	44%	44%	44%	44%	44%	44%	44%	44%	44%	44%	44%				
Female	9,626	6,211	11,137	11,205	12,885	15,598	17,683	19,058	20,308	21,530	22,705	23,814	24,835	25,749	26,535	27,173	27,645	27,936				
Rate	11.9%	7.2%	11.5%	10.8%	11.5%	13.0%	14.0%	14.5%	14.9%	15.4%	15.8%	16.3%	16.8%	17.3%	17.8%	18.4%	18.9%	19.5%				
<b>Assumed yield/animal (kgs)</b>																						
Production (1,000 ton)	66	58	84	82	125	126	127	128	129	130	131	132	133	134	135	136	137	138				
	1,002	826	1,485	1,934	3,018	3,346	3,649	3,887	4,121	4,355	4,584	4,802	5,004	5,186	5,343	5,471	5,567	5,628				

Continued—

**Details for Indian water buffalo herd projections for Scenario 1: Trend herd dynamics—continued**

	Livestock census years												Projections					
	1992	1997	2003	2007	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
End inventory ( <i>1,000 head</i> )																		
Total	89,885	97,926	05,337	08,626	113,780	118,618	122,978	127,067	130,778	133,976	136,554	138,426	139,525	139,796	139,203	137,724	135,353	132,106
Male	18,617	17,871	19,632	16,080	14,620	14,233	14,355	14,690	15,111	15,548	15,961	16,322	16,615	16,824	16,942	16,961	16,875	16,684
Female	71,268	80,055	85,704	92,546	99,160	104,385	108,623	112,376	115,667	118,428	120,593	122,104	122,910	122,972	122,261	120,763	118,478	115,422
Inventory change ( <i>1,000 head</i> )																		
Total	5,679	8,007	7,415	3,284	5,078	4,838	4,360	4,089	3,712	3,198	2,578	1,872	1,099	272	-593	-1,480	-2,370	-3,247
Male	1,266	-754	1,744	-3,517	-1,483	-387	122	336	421	437	413	361	292	210	118	19	-85	-191
Female	4,413	8,761	5,670	6,801	6,561	5,226	4,238	3,753	3,291	2,760	2,165	1,511	807	62	-711	-1,498	-2,285	-3,056

Sources: USDA, Economic Research Service using data from Department of Animal Husbandry, Dairying, and Fisheries, Livestock Census; and ERS estimates.