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Research Article
Study on the Animal Feed Ingredients and Livestock Product Supply, Price and Market-Related Constraints in Ethiopia

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Abstract

Background and Objective: Animal feeds are the essential links in the livestock production chain that is between crop cultivation and animal protein production and processing which affect the supply of livestock input and output. Hence, this study was conducted from March-July, 2021 to assess the status and dimension of animal feed ingredients and livestock product supply and marketing constraints. **Materials and Methods:** Informant discussions were undertaken with relevant stakeholders and data were collected from flour, oil and animal feed industries on designed capacity and their annual performance from 2016-2020. A Generalized Linear Model (Proc GLM) procedure of SAS was used for the analysis. **Results:** This study revealed that the exported soya bean was higher than the soya bean brought to the market in most of the study periods. A large volume of maize was supplied to the market each year which was beyond the designed capacity of flour industries. However, due to the absence of maize for the industries, those flour industries were performed 30% of their capacity. Less wheat volume was introduced to the market in the study periods. **Conclusion:** From this study, it is possible to conclude that scarcity of wheat production and oil crops in the market, absence of maize for flour and animal feed industries, presence of illegal/informal marketing and repeated taxation along the value chain were some of the main factors for price increment of a feed ingredient, compound feed and livestock products.

Key words: Animal feed ingredients, animal feed tax, cereals crop supply, oil crop export, oil crop supply, informal marketing, livestock products

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

In developing economies, the livestock sector is evolving in response to rapidly increasing demand for livestock products due to human population growth, higher prosperity and urbanization[1]. Animal feed and nutrition are the essential links in the livestock production chain that is between crop cultivation and animal protein production and processing. The indirect relationship of demand and supply with higher demand and less supply affect the surroundings in which animal feed operators and farmers need to balance their activities continuously, taking into account animal performance as well as customer, consumer and societal demands[2].

The study[3] indicated that producing the additional food needed to feed all people and livestock in 2050 will require a 9% expansion of arable land, a 14% increase in cropping intensity and a 77% increase in yields.

Ethiopia is the country with the largest livestock population in Africa and with a huge livestock genetic diversity. However, due to various factors, the country is far beyond the utilization of these huge resources. In the second growth and transformation plan (GTP) of 2015, the Ethiopian government has identified the livestock sector as a new source of economic growth. The rationale in using the livestock sector as a growth driver emanates from the unexploited potential of the sector and a wide range of agro-industries to be created along the path of market-led economy and commercialization. To achieve the GTP plan on livestock sectors, the feed sub-sector is central for all livestock commodities and is a key pillar of livestock growth and transformation from various perspectives. From an economic point of view, about 70% of the cost of animal production is feed and suggesting the economic feasibility of animal agriculture is mainly a function of quantity and quality of nutrients and the science of feeding. Thus, feed is a point of convergence and a critical commodity for which all livestock species compete and it is a major pillar towards ensuring economic, social and environmental goals of livestock production[4].

Commercially manufactured feeds are an important input for market-oriented poultry, dairy and beef production systems in Ethiopia accounting for about 70-80% of the total cost of production. The share of commercial feed in the total supply of all feed sources in the country is increasing from time to time to satisfy the emerging sector of poultry, dairy and beef enterprises. Availability, quality and escalation of price of commercially manufactured feeds have been reported to be a major problem affecting the feed and livestock industries involved and consumers.

From[5] data on supply, demand and price over the last 5 years indicates that there has been a steady increase in demand, price and supply shortage of these commercially processed feeds. This situation is feared to reach a crisis proportion unless there is an emergent response to this very important demand and supply gaps that lead to high prices. This issue needs the attention of policymakers, development agencies and the private sector concerned to draft short and long term intervention plans to minimize the effects on the general economy, consumers and private sector to survive in the face of these harsh marketing realities.

In recent years, the supply and price situation of feeds and feed ingredients have shown a steady decrease and increase respectively but the dimension of this general trend was highly aggravated in the last one or two years probably due to current development related to the general inflation of food commodities in the country negatively affecting the feed and animal production sub-sector as well[3]. Commercial feed processors and modern poultry, dairy and beef farms which are seriously confronted by this supply and escalation of price are voicing their concern requesting the responsible government bodies to intervene to solve this issue through forming a positive environment that encourages both private sectors involved in feed manufacturing and modern animal production.

With the above background, this study was initiated to assess the current feed, feed ingredient, compound feed and livestock product supply, price and market-related constraints.

MATERIALS AND METHODS

The study was undertaken from March-July, 2021 in collaboration with a different governmental organization. In this study, data were collected from different private flour, animal feed and oil industries. Besides, data were collected from livestock farms like poultry, dairy, beef and others.

Type of data collection and data source: Basic information was collected by using a checklist. Informant discussions were used to understand details of particular issues regarding key challenges and strategic directions of feed processing plants. Desk reviews were made from print media including published and unpublished materials, websites and others. Feed Ingredient demand was estimated from the designed capacity of the company and demand of commercial feeds was estimated from the data on the number of poultry, dairy and fattening animals by calculating their requirement. Primary and secondary data were collected from feed

processors, feed ingredient suppliers, poultry, dairy and beef farms, Government organizations, different associations, previous studies, different reports, prospective plans.

Data were collected on production, consumption, market supply, seed and others for wheat, maize and oil crops from the production year of 2016/17-2020. Similarly, the design capacity and current performance of oil and feed industries for the past 5 years were collected. Feed ingredient and compound feed price, livestock product price data for the past 5 years were collected. Current data on direct employees on farms, feed industry and livestock product processing industries were included.

Statistical analysis: A generalized linear model (Proc GLM) procedure of SAS was used for the analysis of cereals and oil crops production and utilization from 2016-2020. The effects of year and crop type were included in the model. Then the analyzed data were organized using descriptive and inferential statistics. Frequency, graph and ANOVA were used to present the analyzed data. When there was a significant difference of dependant variables among independent variables mean comparison was undertaken using Tukey-test at a p-value of 95%. The model was:

$$Y_{ijm} = \mu + T_i + K_j + e_{ijm}$$

RESULTS AND DISCUSSION

Compound feed ingredient: The main compound feed ingredients for livestock were maize, mineral, vitamin, oilseeds, limestone, salt and flour industrial byproducts. The supplements can be further segmented into vitamins, amino acids and other supplements. Compound feed is used for dairy, beef, poultry and other farm animals. Agro-industrial by-products make the major inputs required to prepare compound feed by the feed processing plants. These include oilseeds and cereal ingredients supplied from the oil and flour industries. The production performance of the feed processors varies depending upon the supply of these inputs. This implies the importance of availing compound feed for better output of milk meat egg and other products from farm animals and reducing the cost of production. This was consistent with the description of the previous studies[4] which stated that compound feed can supply balanced nutrition (supply of nutrients based on physiological conditions of the animals and keeping in view the objective of raising an animal). This ultimately contributes to improving animal output in terms of milk yield and meat yield as well as reducing the cost of production per unit of animal product produced.

Trend of production and market supply (sale) of oil seeds feed ingredients in the study periods: Oilseed production, utilization and rate of production trend in the last 5 years are indicated in Table 1 and 2. In the base year (2016/17) of the study period 81243.1 t of soybean was produced in the country and of these 48204.8 t or 59% was brought to the market. In the same production year around a quarter of the produced soybean was consumed by primary producers and the rest were used for wage, animal feed, seed and others[2]. Similarly, in the production year of 2016/17 large amount of niger seed was produced followed by sesame and groundnut and the least produced was safflower and rapeseed in Ethiopia. From the above-produced oil seeds, a large amount of sesame was brought to the market followed by niger and soybean whereas the least brought to the market was safflower and linseed. This shows that soybean (which is the major feed ingredient from oilseeds in compound feed) ranked fifth in production but third in sell from all the seven oil seeds considered in this study. As observed in Table 1 the lower supply of linseed and safflower to the market is due to the higher consumption of these oilseeds by the primary producers or farmers.

From all oil seeds, the largest production increment in the 2017 production year in comparison to 2016 was observed on Soya bean followed by rapeseed and linseed. The largest production decrement was observed on sesame followed by sunflower and niger seeds (Table 2). With regards to oilseed brought to the market in 2017 in comparison to 2016, groundnut was increased in the largest percentage followed by soybean and niger seed. However, for the other oil seeds of rapeseed, linseed, sesame and sunflower were less supplied to the market in 2017 as compared to 2016. In this result production of safflower and linseed were increased in 2017 as compared to 2016 but those produced Safflower and linseed were not brought to the market. This implies that the scarcity of oilseed in the market could affect oil production and as a result would reduce oil seed cakes which are used as oil feed ingredients to prepare compound feed for animal feed.

In 2019 production of linseed was 18% less than in 2018 and it was the lower oilseed produced than the contemporary followed by soybean (the major oil cake used for poultry feed and most of the feed industries produce poultry feed) and niger seeds. On the contrary, sesame is produced in higher amounts followed by sunflower. In the same year of 2019 in comparison to 2018, the lower quantity of oilseed brought to the market was soybean followed by linseed. Similar to an increment of production sesame supplied in a higher percentage to the market in 2019 as compared to 2018 than

Table 1: Oilseed production and utilization in Ethiopia (2016-2020) (tone)

Oil types	Years	Production	Consumption	Sale	Wage	Animal feed	Other	Seed
Soya bean	2016	81243.1	18156	48204.8	1112.92	487.41	1015.44	12266.5
Soya bean	2017	88811.9	21641.3	53246.3	284.17	44.4015	1411.97	12183.8
Soya bean	2018	149470	34636.2	89157.4	1905.55	224.183	1987.75	21558.9
Soya bean	2019	125636	27611.9	74557.3	2801.39	314.058	1344.17	19006.8
Soya bean	2020	208697	45867.1	123849	4653.48	521.691	2232.84	31572.7
Noug	2016	302462	64508.7	196188	2298.48	30.2432	6562.77	32874.4
Noug	2017	323313	76600.4	205227	4332.82	55.231	3589.13	33563.2
Noug	2018	296486	70361.9	185735	3392.9	325.955	4548.56	32121.4
Noug	2019	291666	69409.6	180494	2770.55	320.801	5716.09	32955
Noug	2020	214819	51121.9	132938	2040.58	236.278	4210.04	24272.2
Linseed	2016	87912	48492.3	26224.1	439.56	26.3736	1643.95	11085.7
Linseed	2017	88210	53128.9	22184.8	564.544	43.121	1164.37	11167.4
Linseed	2018	98160.5	55111	27608.7	560.779	1546.98	1783.86	11549.1
Linseed	2019	79703	42852	25470.5	414.414	127.512	1888.77	8949.75
Linseed	2020	80464.7	43261.5	25713.9	418.375	128.731	1906.82	9035.28
Groundnut	2016	129636	30814.5	75642.6	1335.25	259.272	2255.67	19328.7
Groundnut	2017	145173	35683.5	86363.4	725.865	53.452	2250.18	20150
Groundnut	2018	144156	35309.5	85208.2	1102.3	158.5	2536	19841.3
Groundnut	2019	156548	38287.7	92009.5	1612.28	172.185	3083.68	21382.3
Groundnut	2020	205028	50098.3	120539	2112.21	225.576	4039.85	28012.4
Sunflower	2016	7954	4666.61	2331.32	23.0666	29.2618	178.965	754.039
Sunflower	2017	9577	6686.66	2077.25	1.9154	31.1423	159.936	651.236
Sunflower	2018	8054.27	5347.94	1905.24	1.6078	31.3521	159.172	608.954
Sunflower	2019	9378.62	6051.74	2269.28	1.9142	37.3269	219.176	799.179
Sunflower	2020	4287.37	2711.18	1102.39	0.85756	16.7224	98.1906	358.031
Sesame	2016	267867	51484	184882	2544.74	133.934	3160.83	25661.7
Sesame	2017	255903	65050.5	162422	2072.81	25.5903	3198.79	23133.6
Sesame	2018	201665	41059	136144	2873.73	30.2498	2309.06	19248.9
Sesame	2019	262654	40186.1	187929	5358.14	52.5308	2731.6	26396.7
Sesame	2020	262529	40094.8	187502	5345.98	524.115	2725.4	26336.8
Rapeseed	2016	43402	23554.3	15611.7	91.1442	8.6804	711.793	3424.42
Rapeseed	2017	32866	19637.4	9872.95	88.7382	16.433	430.545	2819.9
Rapeseed	2018	38216	22706	11489.6	80.2536	22.9296	617.188	3299.95
Rapeseed	2019	42046	24840.8	12651.6	63.069	29.4322	807.283	3653.8
Rapeseed	2020	12575.8	7429.78	3784.06	18.8637	8.80305	241.455	1092.84

Source: CSA

Table 2: Growth rate of production and sale of oil seeds from 2016/17-2020/21

	Annual growth rate (%)									
	Production (2016/17-2017/18)	Market supply (2016/17-2018/19)	Production (2017/18-2018/19)	Market supply (2017/18-2018/19)	Production (2018/19-2019/20)	Market supply (2018/19-2019/20)	Production (2019/20-2020/21)	Market supply (2019/20-2020/21)	5 years growth rate	
Oilseed									Production	Market supply
Soya bean	9.32	10.45	68.30	67.44	-15.94	-16.37	66.11	66.11	156.80	156.9
Noug	6.90	4.60	-8.30	-9.50	-1.63	-2.82	-26.34	-26.35	-28.90	-32.23
Linseed	0.34	-15.40	11.28	24.45	-18.80	-7.74	0.95	0.95	-8.47	-1.94
Groundnut	11.98	14.17	-0.70	-1.34	8.60	7.98	30.96	31.00	58.15	59.35
Sunflower	20.40	-10.89	-15.90	-8.28	16.44	19.10	-54.28	-51.42	-46.10	-52.71
Sesame	-4.46	-12.15	-21.19	-16.18	30.24	38.03	-0.05	-0.23	-2.00	1.42
Rapeseed	-24.27	-36.76	16.27	16.37	10.02	10.11	-70.09	-70.09	-71.02	-75.76

all the contemporary oil seeds followed by linseed. This implies that scarcity and in short supply of soybean and linseed oilseed and oil feed ingredients in 2020 production than the previous year for the oil and feed industries respectively. It is known that soya bean and linseed are the major oilseed feed ingredients used by poultry, dairy and beef respectively in comparison to the other contemporary oil seeds. This result was supported by previous stuides[6] stating that soybean meal has recently been used extensively in the poultry industry in Sub-Saharan Africa (SSA), because of its high protein content (>40%) and its excellent profile of highly digestible amino acids. This reduction of production and

Table 3: Least-square mean and mean comparison of oil production and utilization in the study period

		Mean comparison for oil crops production and utilization among the study periods				
		Variables				
Oil crops	Years	Production	Consumption	Market supply	Wage	Seed
	2016	131496.62[a]	34525.20[a]	78440.58[a]	1120.737[a]	15056.48[a]
	2017	134836.22[a]	39775.53[a]	77341.91[a]	1152.981[a]	14809.87[a]
	2018	133743.92[a]	37790.22[a]	76749.78[a]	1416.730[a]	15461.22[a]
	2019	138232.99[a]	35605.69[a]	82197.32[a]	1860.251[a]	16163.35[a]
	2020	141200.20[a]	34369.22[a]	85061.40[a]	2084.334[a]	17240.03[a]
		NS	NS	NS	NS	NS
Mean comparison for average cereals production and utilization in the 5 years						
Soya bean	2016-20	130771.55[bc]	29582.50[cd]	77803.03[b]	2151.50[abc]	19317.72[b]
Niger	2016-20	285749.28[a]	66400.51[a]	180116.50[a]	2967.06[ab]	31157.22[a]
Linseed	2016-20	86890.02[cd]	48569.13[b]	25440.42[c]	479.53[cd]	10357.45[c]
Groundnut	2016-20	156108.02[b]	38038.69[bc]	91952.62[b]	1377.57[bcd]	21742.94[b]
Sunflower	2016-20	7850.25[e]	5092.82[e]	1937.09[c]	5.87[d]	634.28[d]
Sesame	2016-20	250123.66[a]	47574.89[b]	171775.73[a]	3639.07[a]	24155.54[ab]
Rapeseed	2016-20	33821.15[de]	19633.65[de]	10681.99[c]	68.41[d]	2858.18[cd]

[a-e]Means in the same column without common superscripts are significantly different at $p<0.05$ and NS: Non-significant

market supply in major oilseeds may be a major cause of the supply shortage of oil feed ingredients and compound feed in 2020.

The major oilseed produced and brought to the market was sesame with an annual growth rate of 30 and 38.03%, respectively as compared to 2018. However, the increment of sesame in the market could not be benefited the animal feed sector because this oil seed cake is less utilized as an oilseed feed ingredient for compound feed. In this regard, scientists[3] described that the current domestic consumption and utilization is small as compared to production and consumption and is expected to rise in the future due to local and international demand.

This study indicated that the average 5 years growth rate for both production and market supply for niger, rapeseed, safflower and linseed seed were declined from the base year 2016/2017-2020/2021 (Table 2) and it implies that major oilseeds used for animal feed ingredient were in scarce supply for feed industries. The slow growth in the volume of production and lower market supply of oilseed directly contributes to the shortage of raw material for oil processing industries and as a result, may increase the competition between local oil processors and exporters.

In 2020 large quantity of soybean was produced and brought to the market as compared to the study period of the previous years (Table 1). Similarly, the average growth rate of soybean was very high between 2016 and 2020. Production and market supply of all oilseeds were non significantly different in the study periods of 2016-2020 (Table 3). This indicates that there was no significant production increment and market supply for all oil crops in the study periods. However, there was a significant difference in production and market supply among oil crops for the 5 years average and a large quantity of niger and sesame were produced and supplied to the market followed by groundnut and soya bean.

The lowest production and market supply was observed on sunflower and rapeseed. The higher attention given for sesame, niger, groundnut and soybean on production and supplied to the market by the farmers could be due to the high demand from the local and foreign markets. This implies that to improve the supply of oil crops for oil industries, animal feed industries and export, investment and stakeholders should give priority for the production of sesame, niger, groundnut and soybean than the other oil crops. In support of this, the study Ethiopian oil seed annual report[3] indicated that post expects production of soybeans and Niger seed to increase to meet the growing demand for cooking oil and livestock feed, most notably soybean meal for poultry production. The increment of soya beans for the last 5 years was supported by the study of Ethiopian oil seed annual report[3] and stated that soybean production has been rapidly increasing over the last two decades. Most of this production growth was due to an expansion in the area planted, especially from commercial farms and the demand from the international market. Soybean production, domestic utilization market supply and export in the country.

High soybean production and market supply in the study periods had responded to growing local demand for cooking oil, soy-based foods and livestock feed. Future production is expected to continue its upward climb to respond to rising demand. Soybean production has been rapidly increasing over the last 5 years (Fig. 1). Most of this production growth was

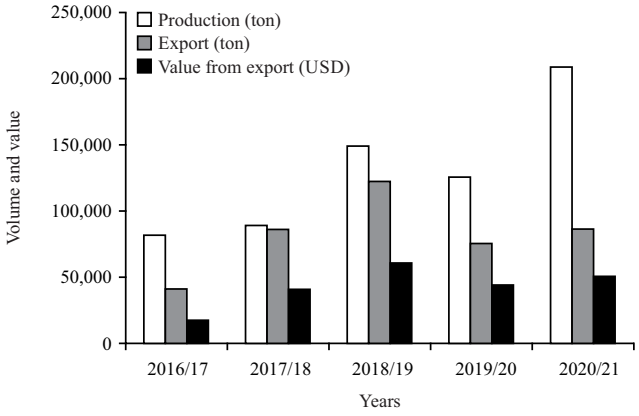

Fig. 1: Soya bean production, export volume and value

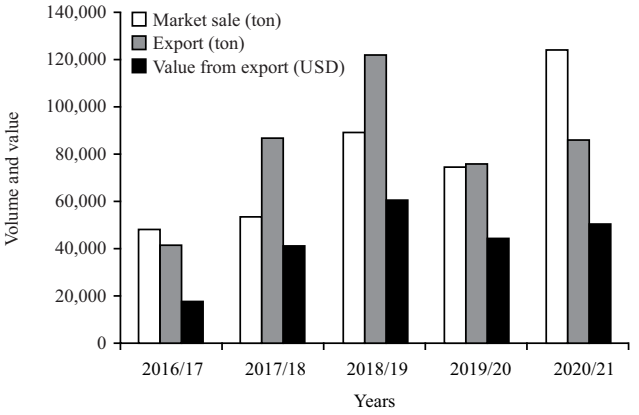

Fig. 2: Soya bean market sale, export volume and value

due to an expansion in the area planted[3]. National research extension supports improved local varieties and better yields contributed to the production increment[3]. However, from soybean produced by the primary producers on average only 59% was brought to the market in the study periods. The remaining 41% were used for consumption, preserved as seed for next year's farming, pay for wage, used as animal feed by farmers and others[3]. It is important to recognize that producers may bring additional soybean to the market from their consumption when they required money.

Soybeans contribute nearly about 15.4% (Table 1) to the country's total oilseed production. Soybean demand is expected to continue rising as consumers demand more soy-based edible oil and as the poultry sector demands more soybean meal. Expansion of integrated agro-processing industrial parks and the launch of new edible oil manufacturing plants will also expand soybean demand. In addition to oil, soybeans were used to make a variety of local foods as well as corn-soy blend. Similarly, the big feed industries in Ethiopia were mainly producing poultry feed in which soya bean and maize are the major ingredients. Inconsistent with this study[7] described that the increased hectare of land for the production of soybean as well as increased total production during the last 15 years has resulted from the increasing demand for soybean at the local and international market.

Soya bean production was in an increasing trend (except in 2019 which was decreased by -15% from the previous year) and from the produced soybean on average only 59% were brought to the market for the past 5 years. However, from the soybean brought to the market, 85% of them were exported in 2016/17. Similarly, the exported soybean was 62.4, 37.6 and 1.5% higher than the soybean brought to the market in the years of 2017, 2018 and 2019, respectively (Fig. 2). Only in 2020/21 largest amount of soybean was brought to the market and of these 69% of soybean was exported. This result shows that the exported soya beans were largely beyond its market supply in each year except 2016/17 and 2020/21 and it implies the scarcity of this seed for local oil and feed industries. The difference between market supply and export could be brought from the farmers kept for consumption and others. The deficit of market supply to export could bring its scarcity in the local market and the lower supply than demand would increase in its price.

As this study indicated most of the oilseeds production were lower in Ethiopia and the same is true for global oilseed production and explained by previous scientists[8,9] as falling short of the record-high output recorded in 2018/19, global oilseed production in 2019/20 is estimated at 584.3 million tone. The drop primarily reflects reduced yields as well as smaller harvested areas in several key producing countries following unfavourable weather conditions.

Exports would project to grow but could face scarcity in the local market, which has witnessed a rising demand for soya beans. Due to a rise in demand, local prices are expected to continue in an ascending owing to strong demand for the beans in domestic and overseas markets. The livestock industry is sensitive to changes in the price of raw materials as compared to compound feeds. Short market supply and competing for export markets for soya beans affect the growth of the animal feed industry negatively in short term. It is thus important to improve production, market supply and price competitiveness of raw materials produced. There is a comparative advantage in the production of oilseeds and processing as it's used as by-products for the production of

Appendix 1: Designed capacity and actual capacity of the flour and oil industries

	2016/17-2020/21									
	2016/17		2017/18		2018/19		2019/20		2020/21	
Ingredient types	Design capacity	Current performance	Design capacity	Current performance	Design capacity	Current performance	Design capacity	Current performance	Design capacity	Current performance
Niger seed	200,000.00	80,000	250,000.00	100,000	287,000.00	114,800	350,000.00	14,000	400,000.00	160,000
Ground nut	75000.00	30,000	100,000.00	45,000	125,000.00	55000	150,000.00	75,000	200,000.00	100,000
Linseed seed	100,000.00	20,000	125,000.00	30,000	150,000.00	75000	200,000.00	100,000	300,000.00	145,000
Sunflower	250,000.00	100,000	300,000.00	125,000	350,000.00	175,000	400,000.00	190,000	450,000.00	220,000
Soya bean	213,329	85,331.6	228,329	91,331.6	243,329	97,331.6	265,829	106,331.6	404,339	161,735.6
Wheat	2000,000	1,500,000	2500,000	1,625,000	2600,000	1,560,000	3000,000	1,500,000	3500,000	1400,000
Maize	317,100	158,550	317,100	110,985	317,100	80,460	347,100	95,460	412,200	131580

Table 4: Gap in design and current performance of oil industries (t)

Years	2016/17	2017/18	2018/19	2019/20	2020/21 (Gap)
Niger seed	120,000	150,000	172,200	210,000	240,000.00
Ground nut	45,000	55,000	70,000	75,000	100,000.00
Linseed seed	80,000	95,000	75,000	100,000	155,000.00
Sunflower	150,000	175,000	175,000	210,000	230,000.00
Soya bean	127,997	136,997	145,997	159,497	242,603.40
Total	522,997	611997	638197	754497	967603.4

Table 5: Production and utilization of cereal crops in Ethiopia (2016-2020) (t)

Cereal crops	Years	Production	Consumption	Supplied for market (sale)	Wage	Animal feed	Other	Seed
Maize	2016	7847174.60	5868901.88	970695.498	54145.50474	138894.99	188332.19	626204.5331
Maize	2017	8395887.20	6407741.11	1038571.25	46177.3796	90675.582	169596.921	643124.9595
Maize	2018	9492770.80	7153752.07	1218871.77	56481.98626	139069.09	206467.765	718128.111
Maize	2019	9304824.49	6839970.32	1281531.60	61621.35424	178124.23	224340.243	719236.744
Maize	2020	10556037.88	7608497.35	1699692.07	77066.78321	218531.84	261815.921	690433.9208
Wheat	2016	453739.85	258430.68	98652.909	4174.824116	816.81341	14611.8844	77052.73205
Wheat	2017	4642965.70	2720313.60	955058.044	46429.657	4178.6691	143003.344	773982.3822
Wheat	2018	4809045.55	2808743.86	1026881.21	19352.296	10159.955	149738.39	794169.8471
Wheat	2019	5582657.94	3324731.12	1162981.14	37206.8921	17540.392	165304.906	874893.4914
Wheat	2020	5780130.60	3231671.01	1408617.83	39882.90114	26588.601	156063.526	917306.7262

Source: CSA

animal feeds in long term. The high cost of oil-seed cakes and other ingredients would affect the quality and quantity of production of animal feeds which has a wider implication on the quality of animal source foods and public health.

Generally, the expansion of local edible oil industries and livestock feed industries in the country was anticipated to stimulate the rapidly growing local demand for oils seeds as well as their byproducts. When the new large-scale oil factories are to be operational in a few years, the country is likely to increase the production of oilseeds locally to meet the demand in the long term. In the short term, however, low local production and market supply of oilseeds cannot meet local raw materials demand. As indicated in Table 4, the difference of designed capacity and current performance of oil industries were grown in absolute terms in the last 5 years (2016/17-2020/21). In 2020/21 edible oil industries had a design capacity of 1.75 million tons with a current performance of 786,736 t and this revealed a gap of 967,603 tons per annum which was the highest from the previous four years (Table 4 and Appendix 1). From a feed perspective, the shortage of raw material production has a direct effect on the feed ingredient supply from the edible oil industries.

Trend of cereal crop production and market supply from 2016-2020

Maize production and utilization: Trends of cereal production and utilization from 2016-2020 are indicated in Table 5 and 6. As observed in the data maize production was increased from around 7.8 million tons in 2016/17-10.2 million tons in 2020/21. Maize consumption was increased from 5.8 million tons in 2016/17-7.6 million tons in 2020[3]. The data indicate that from the produced maize in each year on average 74-75% were consumed. The study[3] indicated that maize consumption in 2021/22 is projected at 8.65 million metric ton due to the growing demand for food and feed.

In the study periods, the lowest annual growth rate of maize supplied to the market was observed in 2019 followed

Table 6: Annual growth rate of cereal production and sale

Cereal crops	Annual growth rate of production (%) (2016/17 -2017/18)	Rate of sale growth (%) (2016/17 -2018/19)	Annual growth rate of production (%) (2017/18 -2018/19)	Sale change (%) (2017/18 -2018/19)	Annual growth rate of production (%) (2018/19 -2019/20)	Sale change (%) (2018/19 -2019/20)	Annual growth rate of production (%) (2019/20 -2020/21)	Sale change (%) (2019/20 -2020/21)	5 years growth rate	
									Production (2016-2020)	Sale (2016-2020)
Maize	7.00	6.90	13.06	17.36	-1.97	5.14	13.45	32.63	34.52	75.10
Wheat	923.26	868.09	3.58	7.52	16.09	13.25	3.53	21.12	1173.8	1327.8

Table 7: Gap in current performance of flour industries (tone)

Years	2016/17	2017/18	2018/19	2019/20	2020/21 (Gap)
Wheat	500,000	875,000	1,040,000	1,500,000	2,100,000.00
Maize	158,550	206,115	236,640	251,640	280,620.00

by 2017 with 5.14 and 6.90%, respectively (Table 6) whereas, the highest was in 2020 with 32.4%. Table 7, a large volume of maize was supplied to the market each year which was beyond the designed capacity of flour industries. However, due to the absence of maize for the industries, those flour industries were performed 30% (Table 7 and Appendix 1) of their capacity on average for the last 5 years. Concerning the unavailability of maize in the market as it is a major food crop in Ethiopia, any price instability in the domestic maize market is expected to harm other tradable and non-tradable goods[3]. Nevertheless, the export ban may also distort maize food availability and food security in the Eastern Africa region. Maize is the major staple crop consumed and traded in the region. It is the second most-traded commodity[9] next to sesame, in the East African cross-border area. Owing to low maize yields, recurrent wars and drought, several eastern African countries have relied on cross-border maize trade to fill their shortfalls. Countries such as South Sudan, Kenya, Rwanda and Somalia rely on formal and informal cross-border trade to import maize[6].

Wheat production and utilization: Most of the animal feed processing ingredients in the flour mill industries are produced from wheat. As a result and due to high demand, the average growth rate of wheat production for the past 5 years (2016/17-2020/21) was 1173.8% (from 453,739.85-5,780130.6 t) and the average growth rate for the market supply of wheat in the same years was 1327.8% (Table 5 and 6). From the average growth rate, the highest annual wheat growth was obtained in the production year of 2016/17. However, the annual growth rate of wheat market supply was lower at 7.5% in 2018 and the highest was 21% in 2020/21. Even though, there were increments of the annual growth rate of market supply for wheat in the study periods, the maximum market supply of wheat was 1.4 million tons in 2020.

As the market supply of wheat as compared with the design capacity and current performance of all flour industries in the country, there was an average deficit of 1,500,000 t of wheat from 2017-2020 with a minimum and maximum of 500,000 and 2,100,000 t in 2016/17 and 2020/21, respectively (Table 7 and Appendix 1). This implies that there was a shortage of wheat market supply in the country. In this regard, previously[9] explained that there are about 600 small and large flour mills in Ethiopia, with a total wheat utilization capacity of 2 million in 2016 and an increase to 3.5 million tons in 2020. However, due to wheat shortages, the mills work below 50% of their capacity. The major reason for the deficit of cereals is population growth and the increment of urbanization in the country. In this regard, earlier study[9] mentioned that rapid population growth could continue to be an important impediment to achieving improvements in food security in some countries. In addition, previously[4] described that the production of wheat in Ethiopia is tremendous of a subsistence nature and dominated by the country's numerous smallholder farmers that cultivate more wheat for consumption and less of it for the market. Similarly previously[4] explained that, except for some government-owned large-scale and commercial farms, wheat is produced predominantly by smallholder farmers under rain feed conditions.

The lower wheat market supply in Ethiopia is supported by the study[9] stated that wheat import has grown significantly over the past decade and Ethiopia remains a net importer of wheat, satisfying around 25% of the local demand with wheat imports. Wheat import increased by an average of 6.6% over the past decade. FAS/Addis Ababa forecasts that wheat consumption in 2021/22 will reach around 6.7 million MT. In Ethiopia, demand for wheat was growing, reflecting population growth and shifting dietary patterns linked to urbanization. The study[6] explained that population growth is still driven by developing countries, particularly Africa which is expected to exhibit the fastest growth rate at 2.5-3.5% and this will be related to consumption growth which leads to a deficit in the market.

The least-square means and mean comparison of the two cereal crops (maize and wheat) are indicated in Table 8. The

Table 8: Least square means and mean comparison for cereals production and utilization in the study periods

			Variables				
Overall mean	Cereals	Years	Production (t) LSM	Consumption (t) LSM	Market supply (t)	Wage (t)	Seed (t)
	Maize		9119338.99	6775772.55	1241872.44	59098.60	679425.654
	Wheat		4253707.93	2468778.06	930438.23	29409.31	687481.036
Mean comparison for cereals production and utilization among the study periods							
		2016	4150457.23[a]	3063666.29[a]	534674.20[b]	29160.16[a]	351629.63[a]
		2017	6519426.45[a]	4564027.36[a]	996815.65[ab]	46304.51[a]	708554.67[a]
		2018	7150908.18[a]	4981248.97[a]	1122876.49[ab]	37917.14[a]	756149.97[a]
		2019	7443741.22[a]	5082351.72[a]	1222256.37[ab]	49414.12[a]	797065.11[a]
		2020	8168084.24[a]	5420084.18[a]	1554155.95[a]	58475.84[a]	803870.32[a]
		NS	NS		NS	NS	
Mean comparison for average cereals production and utilization in the 5 years							
	Maize	2016-2020	9,119,339[a]	6,775,773[a]	1,241,872[a]	59099[a]	687,481[a]
	Wheat	2016-2020	4,253,708[b]	2,468,778[b]	930,438[a]	29409[b]	679,426[a]
				NS		NS	

[a-e]Means in the same column without common superscripts are significantly different at p<0.05 and NS: Non-significant

Table 9: Feed processing ingredient quantity demand by types in 2020/2021

Ingredient types	Amount (t)
Niger seed cake	45,656.5
Ground nut cake	45,686.6
Soya bean cake	74,480.4
Linseed cake	21,544.5
Sunflower	46,264.8
Wheat bran	67,816.5
Wheat middling	47,283.5
Cotton seed cake	23,978.5
Maize	141,973.3
Total	514,684.60

Source: Calculated from design capacity of feed companies

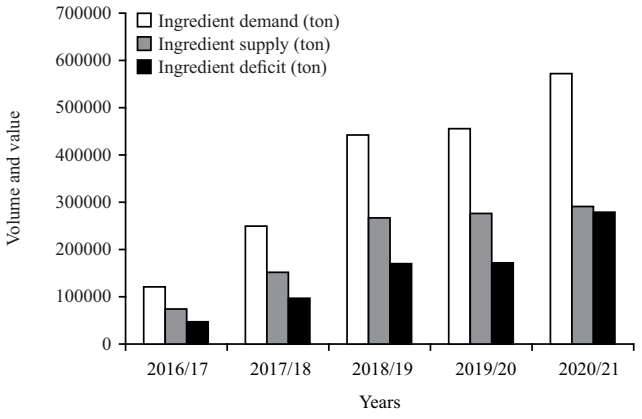

Fig. 3: Total feed ingredient demand, supply and deficit

data shows that production and consumption of both maize and wheat were non significantly (p>0.05) different among the 5 years. It implies that productions were similar or there is no difference in production among the 5 years. But market supply have a statistical difference(p<0.05) among the five years and a high supply was observed in 2020 than in 2016 production years, an otherwise similar volume of market supply were observed from 2016-2019 and 2017-2020 in both maize and cereal crops. On the other side, the production and consumption volume of maize and wheat was significantly different for the five aggregate years and more maize was produced and consumed than wheat. However, similar maize and wheat were supplied to the market in the 5 years of study periods. This indicates that, even though the demand for flour industries was increased for the past 5 years, the market supply of maize and wheat were stagnant in the country.

Livestock feed ingredients demand and supply dynamics: The major ingredients used to formulate compound feed for livestock include maize, sorghum, flour processing by-products (wheat bran, wheat short, rice bran), different kind of oilseed cakes (soybean meal, niger seed cake, linseed cake, groundnut cake, cottonseed cake, sesame seed cake and others), molasses and ingredients that are added in tiny quantities to boost production (vitamins, minerals, amino acids and premixes). A list of the ingredients demanded by the feed industry in 2020/21 is presented in Table 9. As indicated the highest amount of ingredient required by feed industries was wheat followed by maize and soybean. This is because compound feed for ruminants required more volume of maize and wheat by-products (wheat bran and wheat middling) and soybean is mainly required for poultry. Generally, demands for feed ingredients by feed processing industries were increased from 120,897-574,734 tons between the study periods. However, the supply of feed ingredients for feed industries was only around 50% (Table 10 and Fig. 3).

As Fig. 3 shows the demand of feed industries was increased at a faster rate than supply in the study periods. With this deficit, the feed industries had performed below their capacity. The deficit in feed industries is related to the

Table 10: Total feed ingredient demand, supplied and deficit quantity

Years	Ingredient demand (t)	Ingredient supply (t)	Ingredient deficit (t)
2016/17	120897	73,747.20	47,149.80
2017/18	250043.2	152,526.40	97,516.80
2018/19	443699.6	270,656.80	173,042.80
2019/20	457083.7	278,821.10	178,262.60
2020/21	574734.5	292,761.90	281,972.60

Source: Calculated from the feed company design capacity in the country

low market supply of wheat for flour industries to produce wheat bran and wheat middling, the absence of the produced maize for the industries and the lower local market supply of oilseeds. This shows that as livestock sectors intensify protein meal and cereal use would expand. This expansion should be supported by increasing oil seeds and cereal production and supply to the market. However as observed in Table 9 and 10 market supply (sale to the market) for all feed ingredients (oilseeds and cereals) were lower than the demand. The study[6] indicated that as livestock production intensifies in the coming years, protein meal use expands across most of SSA, with the fastest growth recorded in Western Africa (43%) and Eastern Africa (32%). This implies that the demand for oilseed and oilseed cake would be increased and it could be a good opportunity to produce more oilseed to utilize locally and to export market.

The production of cereal grain crops in Ethiopia is destined for human consumption. Consequently, only the milling by-products such as maize bran and wheat bran are available for livestock feed production. Maize bran and wheat bran are the most commonly used cereals. The most widely available oilseed cakes are Noug and sunflower. All the feed premixes are imported. The raw materials available to the animal feed industry are generally those that are produced within the country. These include oilseeds (soya, cotton and sunflower seeds maize, maize bran, wheat bran, soya cake and cotton cake). The livestock industry is a driving demand for animal feeds especially for poultry and poultry feed accounts for over 60-96% of the compound feed. The high demand for poultry feed is driven by increasing demand for poultry products especially due to population increase that is becoming urbanized and higher levels of disposable income.

The highest demand for livestock products would appear that growth in the animal feeds industry will be driven by growing demand for livestock products. However, this growth has been slow owing to the limited production of the major ingredients. The projected increase in demand for animal feed will put pressure on the availability of raw materials. It follows then that to meet this demand, there needs to be a corresponding increase in the production of raw materials such as maize, wheat and oilseeds and as a result, their by-products would be available for feed processing industries.

Feed and feed ingredient price: Compound feeds are the sole diet for semi-intensive and intensive poultry and are commonly used by dairy and fattening farms. The supply of these feed ingredients is challenged by the low production of feed ingredients, rising prices and quality. Consequently, affect the access and affordability of processed feeds to livestock producers.

Feed prices are determined mainly by the supply of feed, the number of animal units to be fed and the level of livestock product prices. In recent years there are several reports from feed processors, policymakers and farmers on the rise of livestock feed prices. According to producers associations, this situation is leading to the closing of some commercial farms both dairy and beef producers, due to low return on investment. This is supported by researchers[10] stating that when grain prices spike can be more production of red meat and poultry as herd sizes are reduced and/or as more animals and milk are sold to maintain cash flow to cover higher prices. This can depress farm (and wholesale) prices at least temporarily, further exacerbating the cost-price squeeze. If current market conditions persist, meat supplies will decline and prices rise through producer attrition and reduced capacity.

According to Fig. 4, the price of feed ingredients has shown continuous increment in the study periods. Comparing the feed ingredient increment rate between the base year 2016/17 and 2020/21 has shown 303.8, 244, 416, 443.5, 627.3, 112.5 and 211% for wheat bran, wheat middling, noug, groundnut, soya, linseed cake and maize respectively. The highest price increment was observed in soya bean followed by groundnut and niger seed cake. Similarly, compound feed price for different species was increased by 85.5,80, 89.6, 110.8, 239.4 and 148.8% for layer, broiler, chicken, dairy, beef and others respectively (Fig. 5). The highest average price increment of compound feed for 5 years was observed in beef and dairy farms which were negatively related with the highest gap for demand and supply of compound feed for

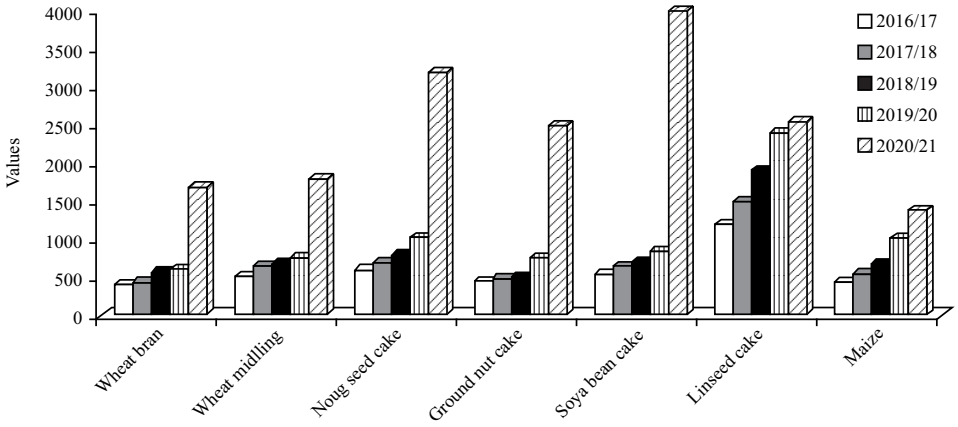

Fig. 4: Feed ingredients price (ETB/100 kg) or quintals

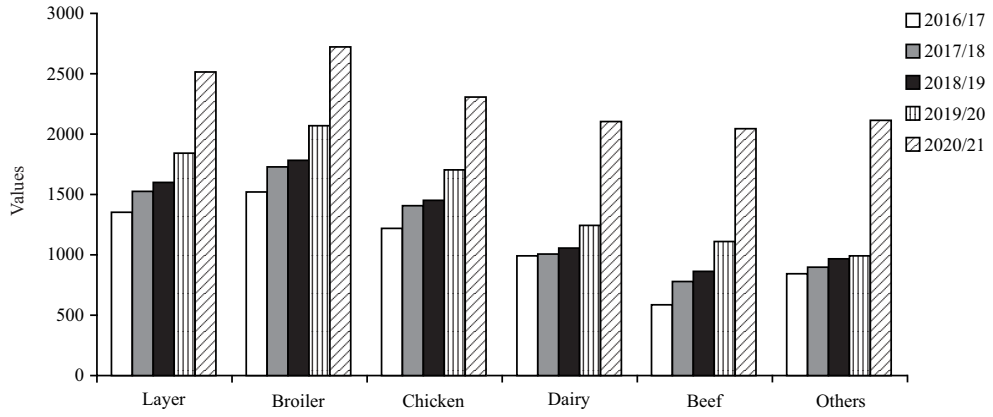

Fig. 5: Animal feed price (ETB/quintals)

dairy and beef farms. This implies both dairy and beef farms utilize a large amount of maize and wheat which were in short supply for livestock feed industries. The scarcity of feed supply would spike feed prices because they are negatively correlated.

The lower production of cereals and oilseeds in 2019 production years have brought the maximum inflation rate in 2020 on different feed ingredients and compound feed of different species. This price surge of animal feed was induced by significant rises in the price of feed ingredients due to supply shortage and other factors. From the point of view of the supply of compound feeds, the principal cost is that of raw materials, which account for as much as 80% of operating costs and additionally there were high transport costs. This result was supported by authors[11] who stated that removing the VAT would help reduce the cost of animal feed. Multiple taxations due to the unnecessary long supply chain could add the VAT imposed on feed ingredients up to 60% or more. The involvements of brokers along the marketing chain lead to multiple taxations and elevate the price of ingredients and compound feed.

Animal feed ingredients and compound feed inflation rate (price index) for different species: As observed in Fig. 6 the highest inflation rate (price index) for compound feed was observed in the year 2020/2021 as compared with the previous year on shoat farms followed by beef and dairy farms with the value of 55, 48 and 45% respectively. A lower price index with one digit was observed in the 2017/18 production year which result from the high production of oilseeds and cereals in the previous year. Feed ingredients of soya bean, inflation rate (price index) was higher (>50%) than all in 2020/21 followed by groundnut, noug cake and wheat products (Fig. 7). As previously[8] indicated, the country-level food inflation rate was 24.1 percent in July 2021 as compared to the previous year. This shows the animal feeds inflation rate

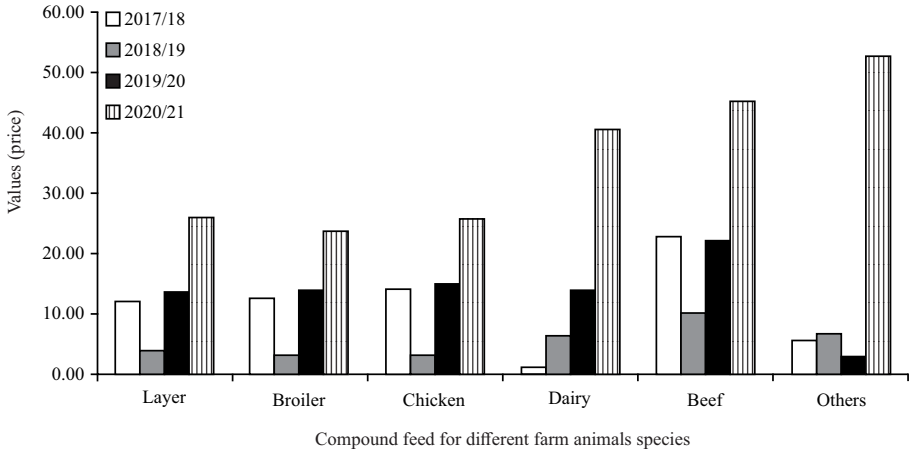

Fig. 6: Compound feed price increment index

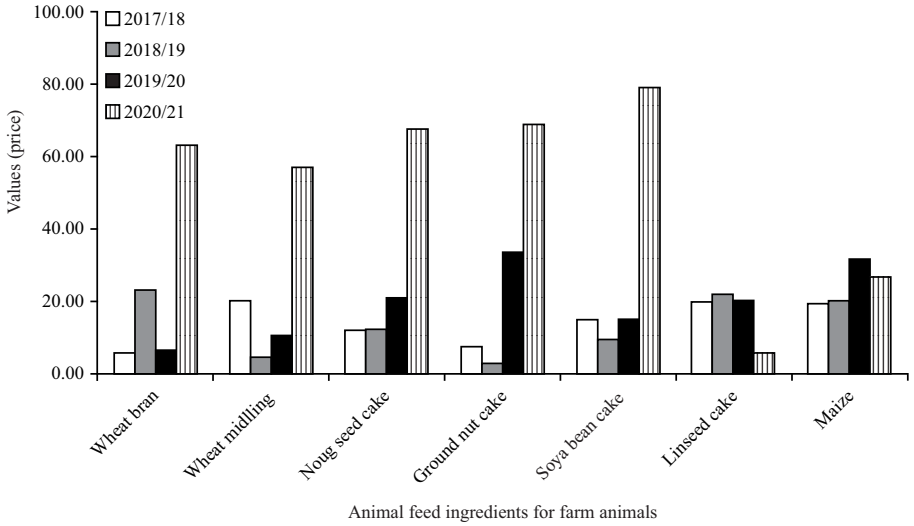

Fig. 7: Feed ingredient price increment index

(45-55%) was much higher than the food inflation rate in the same year in Ethiopia. This implies the abnormal inflation of animal feed which may be due to less production and scarcity of oilseed and cereals in the market. In addition, there are many factors including illegal marketing in the long value chain and others.

Price increment trend of animal source food: As Fig. 8 indicate the price of milk, beef, egg and poultry meat have raised at least three folds in the past four years with the highest increment in 2020. Feed is the largest single cost item for livestock production, accounting for 50–70% of the total cost although energy, labour and other inputs have increased in the last 5 years. The feed cost in the current study was consistent with[10]. The main driver in animal agriculture was feed, which may account for 60-70% of total livestock production costs.

As Fig. 9 indicated, the inflation rate between 2020 and 2021 for egg, milk, beef and chicken meat were 46, 37, 35.5 and 55.8%, respectively. As price takers in competitive markets, animal producers cannot simply pass their higher costs to consumers. To date, rising costs have largely been absorbed by livestock and poultry producers, often with significant financial loss. However, higher costs of production will ultimately be reflected in higher prices for meat, milk and eggs at retail counters. This reduces the affordability of livestock products by consumers and will reduce the purchasing power of consumers. This, in turn, reduces the demand for livestock products by the consumers and livestock producers reduce their supply and would go to bankruptcy or

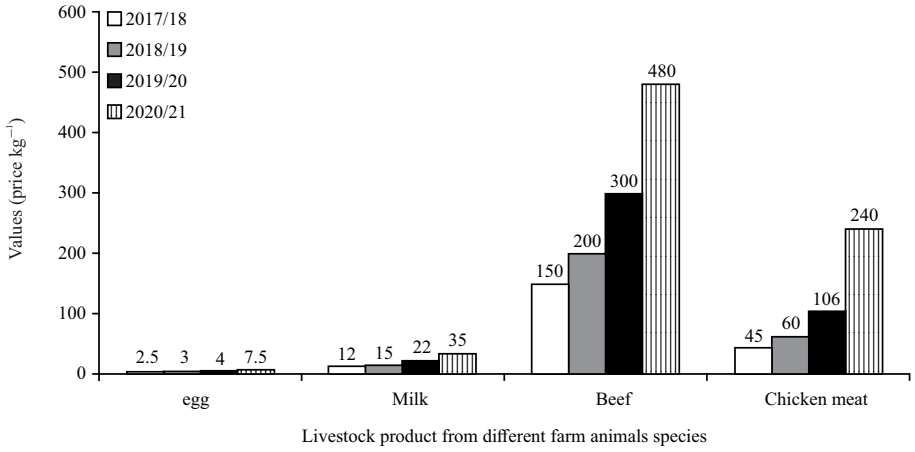

Fig. 8: Average Livestock product price

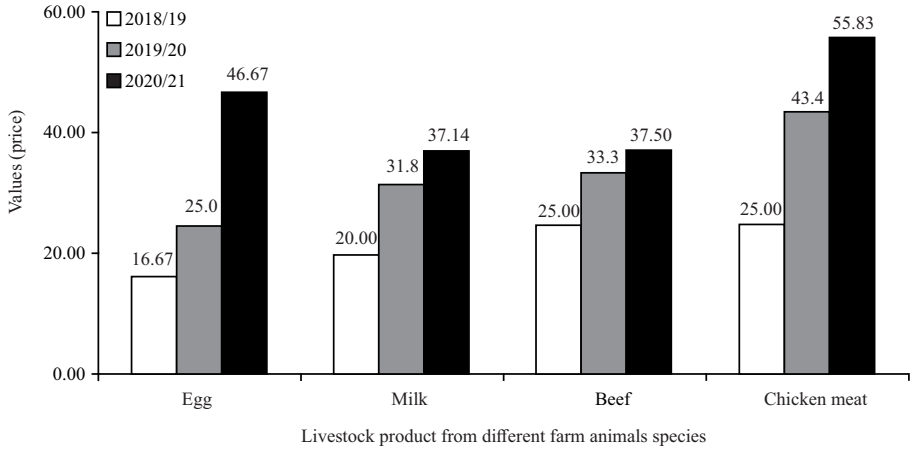

Fig. 9: Animal product price increment index (%)
Source: Trading economics.com: Central Statistics Agency of Ethiopia

financial loss. This would also affect the current per capita consumption of livestock products in Ethiopia, which is one of the lowest in the World (19 kg meat, 56.2 litres milk/year[12]).

In contrary to the current higher inflation rate on beef meat in Ethiopia which would reduce beef consumption and production, the study[10] described that beef consumption growth is strong across the Sub-Saharan African Region (SSA), expanding by 2.6% to 2025. Growth is particularly strong in Eastern and Western Africa, where rates exceed 4%. Within these regions, consumption growth is mainly driven by Kenya, Tanzania, Ethiopia, Zambia and Nigeria, all of which increase consumption by an annual average of at least 3%. The same study continued that notwithstanding the small base, the projected expansion of 35% in total meat consumption by 2025 outpaces any other region in the world. Underpinned by rising incomes, urbanization and sustained population growth, robust consumption growth is projected across most of SSA, with an expansion of more than 38% evident in Central, Western and Eastern Africa. Egg consumption provides an important alternative that reflects consumption growth of 36% over the ten years. Consumption growth is also robust across the region and exceeds 50% in Eastern Africa. This all shows the high demand for animal products in Africa which provide a high local and export market for Ethiopia.

The market value chain problem should be solved to improve the supply of maize for the flour and feed industries. The current price hike in feed ingredients and livestock products could be alleviated by preventing the export of oilseed by-products or imported oilseed specifically soybean. Removing VAT and other taxes from feed ingredients and compound feed would improve feed cost. Land should be provided for oil and cereal crop production.

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CONCLUSION

Wheat production was scarce in the country and as a result, a low volume of wheat was supplied to the market which cannot meet up the demand of the industries. Maize was produced and supplied to the market in large quantities but the industries did not get it for their utilization. Export of soybean and sesame seed were larger than supplied to the market in all the study periods. The highest gap between compound feed demand and supply was recorded for dairy compound feed followed by beef and poultry. Multiple taxes due to unnecessary long supply chain add the VAT imposed on animal feed ingredients up to 60% or more.

SIGNIFICANCE STATEMENT

This study shows the importance of creating appropriate and formal market linkage along the value chain from crop producers up to livestock product producers. Similarly, the importance of the export market cannot be ignored but it should be undertaken either by value addition on the oil crops or by importing raw materials like soybean and exporting the oil. Feeding contributes two-thirds of the price of livestock products. Hence, this study will help researchers and policymakers to unveil the critical areas in the field.

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