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IMPACTS OF UPSURGE PULSE PRODUCTION IN INDIA (2016-17): ECONOMIC SCRUTINY AND POLICY ADVOCACY

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AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration between all authors. Author MBD designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors KK and CSR managed the analyses of the study. Authors ASV, SS and YM managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The United Nations, declared 2016 as "International Year of Pulses" (IYP). Pulses are an integral part of many diets across the globe and they have great potential to improve human health, conserve our soils, protect the environment and contribute to global food security. India is the largest producer (25% of global production), consumer (27% of world consumption) and importer (14%) of pulses in the world. The study analyzed the production trends, growth rates, and instability its effect on food security, self-sufficiency, economic, trade, environmental and nutritional impact and the impact of government programs. Demand and supply, CAGR, Instability Index, Export import price elasticities of commodities & countries were estimated. India, the second most populous country in the world, leads all nations in terms of area and production of pulses and straggle in productivity, globally. The results show that during 2000-01 to 2021-22, India demands more than supply indicating food insecurity in pulses. The per capita availability of pulses has decreased considerably. The area under pulses is stagnant except for few years and the production and productivity has been increasing. The steep rise in production could be due to the technological and government schemes and programs contribution. Gram contributes the single largest share of 43% in India's total pulses production and in export basket of pulses registering 84.87% in 2015-16. Tur is procured in the maximum quantity at 590 MT by NAFED and the least procured is Urad at 11 MT by SFAC. The impact of increase in the production of pulses in 2016 -17 resulted in the decrease in the growth rate of imports. USA, Canada, UK and some of the Asian countries were major importers from India. It was observed that, India has comparative advantage in pulses with export prices being high over the import prices. Among the pulses, more export elasticity was noticed in peas (2.36%) followed by gram, lentil and pigeon pea. The terms of trade of India with other countries found to be improved for all pulses crops. Pulses improve the sustainability of cropping systems and are environmental friendly. Pulses in the diet

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are a healthy inclusion to meet dietary recommendations and is associated with reduced risk of several chronic diseases. The government programs, schemes impacted on increase in area and productivity of pulses. The study suggests that targeted research to be in pulses through "sustainable intensification" and focus on beans, chickpeas, and lentils which contributes to trade in future to meet the demand of pulses nationally and globally. Government procurement must be on war footing to tackle the rising gap between the demand and supply of pulses along with the promotion of trade through SEZ's.

Keywords: Impacts; upsurge; pulses; economic scrutiny; policy advocacy.

1. INTRODUCTION

The United Nations, declared 2016 as "International Year of Pulses" (IYP) to heighten public awareness of the nutritional benefits of pulses as part of sustainable food production aimed at food security and nutrition. The Year provides a unique opportunity to encourage global production of pulses, better utilize crop rotations and address the challenges in the trade of pulses as per UN 68th Session [1].

Pulses are an integral part of many diets across the globe and they have great potential to improve human health, conserve our soils, protect the environment and contribute to global food security. Pulses are considered to be 'poor man's protein'. It is estimated that pulses contain 20-25 per cent of protein by weight and have twice the protein available in wheat and thrice that is present in rice. The per capita net availability of pulses in India is 41.9 gm/day (2013) as against WHO recommendation of 80 gm/day. In addition to the nutritional advantage, pulses have low carbon and water footprints which make them an integral part of the sustainable farming systems. As per estimates, water footprints for producing one kilogram of meat is five times higher than that of pulses. Further, one kilogram of legume emits 0.5 kilogram in CO_2 equivalent whereas one kilogram of meat produces 9.5 kilogram in CO_2 equivalent as discussed by Smita and Sai [2].

1.1 Global Overview

India, China, Canada, Brazil and Myanmar are the top five countries accounting for 50% of global pulses production. The world acreage for pulses was estimated at 80.7 m ha in 2013. Global production of pulses in 2013 was 73 m tonnes. The global production of pulses has also remained practically stagnant over the last decade - primarily due to the flat growth in India's production. India consumes 30% of global pulses production. China and Brazil are a distant second in consumption, with 6% share each.

Canada is the largest exporter of pulses in the world with 26% share, valued at USD 1.2 billion in 2007. Nearly 27% of Canada's exports are to India. Other major pulses exporting countries include China, Myanmar, Australia and the US. The Indian Government has banned exports of pulses, except for a particular type of chickpeas, to ensure availability in the domestic market.

Average global yield was 819 kg/ha (average of 2005, 2006, 2007) with Canada and the US having yields of 1900 kg/ha – about three times the Indian average. Subsistence farming in developing countries versus a market driven approach in developed countries, as well as climatic conditions and level of mechanization and infrastructure development, have resulted in wide variation in yields across countries as per CII [3].

Global trade of pulse crops represents about 15% of global production. The total volume of imports and exports globally has increased by 50% over the last 14 years from 4.4 to 6.7 million. On the other hand, the value of imports and exports has more than doubled over the same time period representing a 6% annual growth rate. This means the price of pulse crops traded in the world is increasing at a much higher rate than the quantity as given by Akibode [4].

1.2 Indian Overview

India is the largest producer (25% of global production), consumer (27% of world consumption) and importer (14%) of pulses in the world as discussed by Smita and Sai [2]. Though pulses are grown in both Kharif and Rabi seasons, Rabi pulses contribute more than 60 per cent of the total production. In India Pulses are grown in around 24-26 million hectares of area producing 17-19 million tons of pulses annually. India primarily produces Bengal gram (chickpeas), Red gram (tur), Lentil (masur), Green gram (mung) and Black gram as identified by Gowda [5].

In India pulses are generally cultivated on marginal lands under rain fed conditions. Only 15% of the area under pulses has assured irrigation. Cash crops like Bt cotton, maize and oilseeds (mainly soybeans) which has better returns and lower risk attracts farmers over the pulses with fluctuating price trends. Consequently, area under these crops has increased over the years to the detriment of pulses. Nevertheless, improvement in yields, albeit modest, has contributed to higher pulse

production in recent years, however, most of the increase has been in gram. Low pulse yield in India compared to other countries is attributed to poor spread of improved varieties and technologies, abrupt climatic changes, vulnerability to pests and diseases, and generally declining growth rate of total factor productivity.

The NAFED (National Agricultural Cooperative Marketing Federation of India Ltd) and SFAC (Small Farmers' Agribusiness Consortium) are responsible to procure pulses under MSP but unfortunately they procure insignificant quantity [1% to 4% of output during 2012-13 to 2014-15] despite MSP for pulses in last five years being higher than rice and wheat as discussed by Smita and Sai [2]. The Santa kumar committee has aptly observed that although MSP is announced for 23 commodities substantial benefits accrue only to wheat and rice growers in selected States leaving pulse-growers and other farmers often receiving prices much below MSP. Absence of efficient procurement and marketing arrangement besides production constraints created huge gap between demand and supply resorting to imports as per Indian microfinance [6]. Volume of pulses production has increased from 12.02 million tonnes in 1991 to 18 lakh tonnes in 2015 as per Agristat [7].

Overall, India import requirements may be of the order of 3.8 million tonnes in the current year - National Bank of Agriculture and Rural Development as given by NCAER [8]. The total demand of India is around 23.5 MT and production is generally around 18 MT. So there is a gap of around 5.5 MT. Though the major pulses are imported from across 30 countries, Canada, Myanmar, USA, Russia and Australia have been the major sources of imports as discussed by Smita and Sai [2]. Peas, lentils, gram, chickpeas and pigeon peas constitute to bulk of the imports. India normally exports pulses (Peas, lentils, gram, and pigeon peas) to the Asian and African countries i.e. Pakistan, Algeria, Turkey, UAE and Sri Lanka, etc. and the total exports was around 0.30 million tonnes during 2013-14.

As per Indian Institute of Pulses Research (IIPR), Vision- 2050, the projected demand for pulses by 2050 at 50 million tonnes necessitates annual growth rate of 4.2 per cent with additional area of 3- 5 million ha under cultivation and augmenting productivity to 1500 kg/ ha and by significantly reducing post-harvest losses as per IIPR [9].

Many researchers conducted studies on pulses production and its impacts. Tuteja [10] said that pulses production grew at the dismal rate 0.70 per cent per annum during 1980-81 to 2001-02. He also found out that the area growth was stagnant while productivity increased by just one per cent. Reddy [11] revealed that India's net import of pulses has ranged between one to three million tonnes. Whereas, exports were one-tenth of the volume of import. Import of pulses increased from 0.58 mt in 1994-96 to 3.10 mt in 2007-09 and were expected to reach 4.00 mt by 2012. The share of peas, chickpeas, pigeon pea and moong was higher in total pulses imports as discussed by Reddy [12]. India has a comparative advantage in the export of lentils, as it has been the largest export item among pulses during the last 10 years as discussed by Reddy [13]. Reddy [11] also reported that the growth rate of pulses production was 1.52 per cent in the 1980s and 0.59 per cent in the 1990s.The productivity of pulses has remained virtually stagnant for the last 40 years.

Kumar [14] and Sawant [15] attributed the slow growth in pulses production for low growth in yield. The differential impact of technologies, high yielding varieties and irrigation substantially affected area under pulses as per Expert Committee on Pulses [16]. Reddy [12] studied instability in pulses and concluded that instability is more in production when compared to area and yield as discussed by Inbasekar [17]. The increasing shortage of pulses resulted in the need for more and more import which in turn has dampened the speed of rejuvenation of pulse sub-sector of agriculture sector. Due to inconsistent policies and lackluster support, the players in the value chain of pulses are hesitant to come forward to make investment decisions including those related to R&D, marketing and input supplies as given by Smita and Sai [2].

Government has initiated over the years several nation-wide programs to step up pulses productivity, production and profitability viz. All India coordinated pulses research Project [1965], intensive pulses development project [1969], central sector national pulses development project [1985], integrated scheme of oilseeds, pulses & maize [2002] and national food security mission [2007,2013]. Despite all these programs/ schemes, India has imported on an average 2.812 million tons [MT] of pulses amounting to Rs.5933 crores annually during 2001-02 to 2013-14 with 16% CAGR in terms of value as discussed by Indian microfinance [6]. The latest production and international trade trends of pulses are given in the below Table 1.

Table 1. Current status of India's pulses production, International prices, export and imports (2014-2017)

Year	Production (000 tonnes)	International Price (lacs/MT)		Exports		Imports	
		Export price	Import price	Qty (MT)	Value (Lacs)	Qty (MT)	Value (Lacs)
2014-15	17,152.30	0.55	0.36	220914.59	120949.68	4001965.79	1439551.75
2015-16	16,348.20	0.64	0.42	251644.34	160321.85	5318849.90	2218315.89
2016-17	22,400.00	0.91	0.41	124883.95	114013.52	5905393.38	2443257.91

Source: Ministry of Agriculture & Farmers Welfare, Govt. of India

Based on above background, this study analyses growth rates, trends of production, consumption of pulses, the impacts of increased production in India on food security, self-sufficiency, economic impacts, nutritional sufficiency, international trade, (exports, imports, and their prices), health impacts, environmental impacts, government schemes and assess the production, marketing and environmental problems of pulses.

1.3 Objectives of the Study

1. To analyze the production trends, growth rates, and instability its effect on food security, self-sufficiency and nutritional impact.
2. To analyze the impact of increase in production on exports, imports, and their prices.
3. To estimate the demand and supply of pulses.
4. To analyze the impacts on health, and environment.
5. To analyze impact of government programs on production, marketing and environmental problems.

2. METHODOLOGY

2.1 Growth Rate

The compound growth rate (r) will be calculated by fitting Exponential function to the variables as given by Gujarati and Sangeetha [18] of interest viz., exports, prices for the period 1990-91to 2014-15.

$$Y_t - Y_0 (1+r)^t \quad (1)$$

Assuming multiplicative error term in the equation1, model may be linearized by logarithmic transformation

$$\ln Yt = A + Bt + € \quad (2)$$

Where, A (=lnAo) and B (=ln (1+r)) are the parameters to be estimated by ordinary least square regression, t= time trend in year, r = exp (B) -1

2.2 Price Elasticity of Exports

$\sum P_e$ = % change in quantity exports/ % change in price

The percentage change in quantity exports is % ΔQ, and the percentage change in price is % ΔP. We calculate % ΔQ as ΔQ/Q*ave* and We Calculate % ΔP as ΔP/P*ave*

*So we calculate the price elasticity of exports as (*ΔQ/ Q*ave*)/ (ΔP/P*ave*)

2.3 Instability Index

Coefficient of variation = (Standard Deviation / Mean) *100

Terms of Trade calculation:

$$TOT = \frac{Average\ Price\ of\ Exports}{Average\ Price\ of\ Imports} = Px/Pm$$

$$\uparrow Price\ M\ or\ \downarrow Price\ X \rightarrow Deterioration\ ToT$$

$$\downarrow Price\ M\ or\ \uparrow Price\ X \rightarrow Improvement\ ToT$$

2.4 Demand and Supply Forecasting

ARIMA Model will be used to forecast the demand and supply of pulses or normative approach.

3. RESULTS AND DISCUSSION

3.1 Population Growth

The Indian historical population, percentage change, and its rank in the globe are shown in the Table 2. With an estimated 1.34 billion people during 2017, India has been historically the second most populous country in the world. The figures show that India represents almost 17.90% of the world's population, which means one out of six people on this planet live in India. China for decades has been the world's most populous country and India is all set to take the

numero uno position by 2030. With the population compound annual growth rate at 1.44% and a population density of 449 per km^2 India is predicted to have more than 1.53 billion people by the end of 2030.

Global Pulses Scenario: Globally chickpea ranked top (Table 3.) in pulses in terms of area and production with 135.4 lakh ha and 131.02 lakh tonnes respectively, while the productivity was 968 kg/ha. Lentil and pigeon pea accounted for 43.45 and 62.2 lakh ha of area under cultivation with production levels of 49.52 and 47.42 lakh tonnes respectively. Yield levels for lentil and pigeon pea stood at 1140 kg/ha and 762 kg/ha respectively. Other pulses accounted for 566.49 lakh ha of area under cultivation with production levels of 502.12 lakh tonnes.

India in Global ranking in pulses: Globally, India tops in the total area under pulse cultivation with 281.7 lakh ha which accounts for 34.88 % of the world area under pulses cultivation. Similarly, production wise, India ranks highest with production of 183.11 lakh tonnes which accounted for 25.08 % of total world's pulse production. Ireland topped in terms of productivity globally with 5333 kg/ha. Though India leads all nations in terms of area and production, but lags behind in terms of productivity of pulses due to technological and yield constraints as per FAO Statistics [19].

3.2 Food Security in Pulses

Demand and Supply: The results of demand, supply and gap shown in Table 4. The results show that during 2000-01 to 2021-22, India demands more than supply indicating food insecurity in pulses. But over the years the gap is increasing in spite of more pulse production. Driven by the factors such as rising population, growing economy, increasing urbanization and change in food preferences there is an increased demand for food production. Despite the reduction in population under the poverty line, the overall food security and nutrition has remained the focus of country's agriculture and food policy. Particularly pulses, known as "Poor man's meat" and "rich man's vegetable", contribute significantly to the nutritional security of the country. The production demand gap in pulses has remained over the years, leading to the import of pulses. Except during 2010-11, 2012-13 and 2013-14 the gap is higher and is increasing over the years. (Projections of XII Plan working group (Planning Commission).

Area, Production and Productivity of pulses: Data on season-wise Area, Production and Productivity of Total Pulses in India during 2001-02 to 2016-2017 is shown in Table 5. It shows that the area is stagnant except few years and the production and productivity have been steadily increasing. The results show that over the 18 years period, pulses production almost doubled from 13.37 Mt (2000-01) to 22.95 Mt (2016 - 17). Further, the compound annual growth rate of pulses was 4.66 %, as could be seen in Table 6. where the production of major pulses and growth rates are given. It implies that technological breakthroughs are there but they are slow in pulse production.

It may be noted that the CAGR essentially smoothens out the progress of various pulses production over a period of time, providing a clearer picture of annual production. Consequently, the CAGR of production of the gram is 5.68, followed by urad at 4.93, pigeon pea at 4.83, moong at 4.78 and the least being lentil at 0.43. The steep rise in production of pulses could be due to the technological and government schemes and programs contribution.

Gram contributes the single largest share of 43% in India's total pulses in 2015-16. The percentage share of Tur and Urad in total pulses is expected to increase with a slight decrease in the Gram and other pulses production.

Table 2. India population trend

Year	Population	Yearly % Change	Density (People/Km²)	Country's Share of World Pop	World Population	India Global Rank
2017	1,349,701,245	1.20%	449	17.90%	7,464,663,275	2
2016	1,312,457,832	1.20%	446	17.85%	7,432,663,275	2
2015	1,292,836,541	1.27%	441	18.92%	7,349,472,099	2
2010	1,230,984,504	1.47%	414	18.88%	6,929,725,043	2
2005	1,144,326,293	1.67%	385	18.68%	6,519,635,850	2
2000	1,053,481,072	1.86%	354	18.37%	6,126,622,121	2

Source: http://www.worldometers.info/world-population/india-population/

Table 3. Pulses global ranking crop-wise *{A-lakh ha, P-lakh tonnes, Y-kg/ha}*

Crop	Area	% to Total	Production	% to Total	Productivity
Chickpea	135.4	16.77	131.02	17.95	968
Lentil	43.45	5.38	49.52	6.78	1140
Pigeon pea	62.2	7.70	47.42	6.5	762
Other Pulses	566.49	70.15	502.12	68.78	886
Total Pulses	**807.54**		**730.07**		**904**

Source: FAO Statistics 2013.

Table 4. Target, domestic supply and demand for pulses in India (mt)

Year	Target production	Actual production	Estimated demand	Demand Gap = (Production– Demand)
2000-01	15	11.1	16.02	-4.92
2004-05	15.3	13.1	17.1	-4
2008-09	15.5	14.6	17.51	-2.91
2009-10	16.6	14.66	18.29	-3.63
2010-11	16.5	18.24	19.08	-0.84
2011-12	17	17.09	19.91	-2.82
2012-13	18.24	18.34	20-21	-1.66
2013-14	19	19.27	21-22	-1.73
2016-17	20.75	18-21	22	-1
2020-21	24	24	25	-1

Source: 1. Pocket Book of Agricultural Statistics, 2015, Ministry of Agriculture and Farmers Welfare, Government of India

Table 5. Season-wise area, production and productivity of total pulses in India (1949-1950 to 2016-2017)

Year	Area (In ' 000 Hectare)			Production (In ' 000 Tonne)			Productivity (In Kg./Hectare)		
	Kharif	Rabi	Total	Kharif	Rabi	Total	Kharif	Rabi	Total
2001-02	10772	11286	22008	4838	8530	13368	451	756	607
2002-03	9950	10546	20496	4151	6974	11125	417	661	543
2003-04	11683	11775	23458	6165	8741	14905	528	742	635
2004-05	11317	11446	22763	4717	8412	13130	417	735	577
2005-06	10680	11712	22391	4865	8520	13384	456	727	597
2006-07	10676	12516	22392	4795	9402	14197	449	751	612
2007-08	11490	12144	23633	6403	8358	14762	557	688	625
2008-09	9809	12285	22094	4686	9880	14566	478	804	659
2009-10	10582	12700	23282	4204	10458	14662	397	823	630
2010-11	12320	14082	26408	7120	11121	18241	578	789	691
2011-12	11190	13272	24462	6058	11031	17089	541	831	691
2012-13	9954	13303	23257	5916	12427	18343	594	934	789
2013-14	10328	14885	25213	5993	13260	19253	580	891	764
2014-15	9998	13555	23553	5731	11422	17152	573	843	728
2015-16	11314	13598	24911	5530	10818	16348	489	796	656
2016-17#	-	14959*	29.4633	9420	13530	22950	-	-	779

*Note: *: 2nd Advance Estimates. (Only Rabi Crop)*
#: 4th Advance Estimates, ##: In Million hectares.
Source: LokSabha Unstarred Question No. 1980, dated on 14.03.2017, Ministry of Agriculture & Farmers Welfare, Govt. of India. (ON1526) & Past Issues

State-wise productivity growth: State-wise Productivity Growth of Major Kharif Crops (2001-02 to 2016-17) is given in Table 7. It may be noted that there was on an average 0.7% and 2.75% annual growth in yield levels of Tur and Moong respectively, in the country. Gujarat lead the way in yield levels of Tur which registered 5.21% average growth annually followed by Karnataka (5.09%), Bihar (1.61%), Andhra Pradesh (1.24%), Chhattisgarh (1.12%) and Maharashtra (1.01%). whereas few states accounted

less than the national average viz., Jharkhand (-3.04%), Uttar Pradesh (-3.77%) and Madhya Pradesh (-3.79%).

Annual average productivity of Moong was higher in Uttar Pradesh (4.07%) followed by Rajasthan (2.89%) and Gujarat (2.82%). States viz., Karnataka (2.59%), Odisha (2.29%), Madhya Pradesh (1.16%), Andhra Pradesh (0.85%), Bihar (0.73%), Maharashtra (-0.49%), Chhattisgarh (-0.65%) and Tamil Nadu (-3.72%) were lagging behind the national average.

Over the period from 2011-2017, average annual yield growth rate in Tur was higher in Madhya Pradesh followed by Andhra Pradesh, Chhattisgarh and Karnataka. Lower growth rates were recorded in Jharkhand (0.81%) followed by Gujarat (0.52%), Bihar (-2.53%), Maharashtra (-5.05%) and Uttar Pradesh (-5.24%).

Similarly, average annual yield growth rate in Moong was led by Chhattisgarh (9.11%) followed by Madhya Pradesh (8.36%), Tamil Nadu (7.21%), Gujarat (3.47%) and Andhra Pradesh (3.31%). Growth rates were poor in Rajasthan (2.59%), Odisha (1.12%), Bihar (-1.05%), Uttar Pradesh (-4.91%), Karnataka (-7.54%) and Maharashtra (-9.84%).

Table 6. Production of Major Pulses and growth rates ('000 TONNES)

Year	Gram		Pigeon pea		Lentil		Moong		Urad		Total pulses	
	Prod	AGR (%)	Prod	AGR (%)	Prod	AGR (%)	Prod	AGR (%)	Prod	AGR (%)	Prod	AGR (%)
2000-01	3855	0.0	2247	0.0	915	0.0	1023	0.0	1296	0.0	11076	0.0
2001-02	5473	42.0	2260	0.6	974	6.5	1111	8.6	1499	15.7	13368	20.7
2002-03	4237	-22.6	2186	-3.3	873	-10.4	867	-22.0	1474	-1.7	11125	-16.8
2003-04	5718	35.0	2356	7.8	1038	18.9	1702	96.3	1471	-0.2	14905	34.0
2004-05	5469	-4.4	2347	-0.4	994	-4.2	1058	-37.8	1327	-9.8	13130	-11.9
2005-06	5600	2.4	2738	16.7	946	-4.8	946	-10.6	1245	-6.2	13384	1.9
2006-07	6334	13.1	2314	-15.5	913	-3.5	1115	17.9	1443	15.9	14197	6.1
2007-08	5749	-9.2	3076	32.9	812	-11.1	1523	36.6	1457	1.0	14762	4.0
2008-09	7060	22.8	2266	-26.3	953	17.4	1035	-32.0	1175	-19.4	14566	-1.3
2009-10	7476	5.9	2465	8.8	1032	8.3	707	-31.7	1237	5.3	14662	0.7
2010-11	8221	10.0	2861	16.1	944	-8.5	1862	163.4	1779	43.8	18241	24.4
2011-12	7702	-6.3	2654	-7.2	1059	12.2	1634	-12.2	1785	0.3	17089	-6.3
2012-13	8833	14.7	3023	13.9	1134	7.1	1186	-27.4	1971	10.4	18343	7.3
2013-14	9526	7.9	3174	5.0	1017	-10.3	1605	35.3	1699	-13.8	19253	5.0
2014-15	7332	-23.0	2807	-11.6	1035	1.8	1503	-6.4	1959	15.3	17152	-10.9
2015-16	7058	-3.7	2561	-8.8	976	-5.7	1593	6.0	1945	-0.7	16348	-4.7
2016-17	9330	32.2	4780	86.7	-	-	2160	35.6	2800	44.0	22950	40.4
CAGR (%)	5.68		4.83		0.43		4.78		4.93		4.66	

Prod- Production (in '000 tonnes). AGR-Annual Growth Rates. CAGR- Compound annual growth rate.
Source- Ministry of Agriculture & Farmers Welfare, Govt. of India

Table 7. State-wise productivity growth of major Kharif pulse crops compared to National Average Growth, 2001-02 to 2016-17

Crop	2001-02 to 2010-11		2011-12 to 2016-17	
	>National Average	<National Average	>National Average	<National Average
Tur (0.7%)	Guj (5.21), Kar (5.09), Bih (1.61), AP (1.24), CG (1.12), MH (1.01)	Jhar (-3.04), UP (-3.77), MP (-3.79)	MP (14.56), AP (12.57), CG (3.54), Kar (1.46)	Jhar (0.81), Guj (0.52), Bih (-2.53), MH (-5.05), UP (-5.24)
Moong (2.7%)	UP (4.07), Raj (2.89), Guj (2.82)	Kar (2.59), Odi (2.29), MP (1.16), AP (0.85), Bih (0.73), MH(-0.49), CG (-0.65), TN (-3.72)	CG (9.11), MP (8.36), TN (7.21) Guj (3.47), AP (3.31)	Raj (2.59), Odi (1.12), Bih (-1.05), UP (-4.91), Kar (-7.54), MH (-9.84)

1Shows all-India productivity CAGR during the period from 2001-02 to 2016-17
Source: CACP using DES Data

3.3 Policy and Institutional Support for Pulses

Besides the various schemes that promote pulses development in the country by of technology, area expansion and also productivity enhancement, the government, more specifically the Union government supports the various aspects related to implementation of MSP, trade more so of imports to sustain the domestic needs of pulses. The details on the same are presented and discussed in this section

Prices: NAFED plays a dominant role in pulses procurement besides Food Corporation Of India (FCI). Table 8. depicts the procurement of pulses by different agencies in 2016-17 in MT. It shows that the NAFED procures the highest quantity of pulses that is 770 MT, followed by FCI at 229 MT and SFAC at 102 MT. Among the pulses Tur is procured in the maximum quantity at 590 MT by NAFED and the least procured is Urad at 11 MT by SFAC. However Smita and Sai [2] quoted that the NAFED and SFAC are responsible to procure pulses under MSP but unfortunately they procure insignificant quantity [1% to 4% of output during 2012-13 to 2014-15] despite MSP for pulses in last five years being higher than rice and wheat.

Minimum Support Price (MSP): As per the CACP, in 2016-17, the MSP has increased for all the pulses, the highest MSP is given for moong at Rs. 4800/Quintal. The Minimum support price for Pulses (Fair Average Quality) in India as quoted by the Reserve Bank of India (RBI) for the period 2000-01 to 2017-18 are given in Table 9. It can be seen that, of all the pulses, the CAGR of MSP for Moong is maximum at 9.46 followed by Pigeon pea (9.31), Urad (9.25), Gram (8.40), and Lentil (8.03). The annual growth rate of all the pulses saw a sudden and significant rise in 2010-11.

Table 8. Procurement of Pulses by Different Agencies in 2016-17 (qty in MT)

Pulses	FCI	NAFED	SFAC	Total
Moong	64614	128953	26225	219792
Urad	18234	59394	11043	88670
Tur	146912	590664	65701	803277
Total	229760	779011	102969	1111740

Note: procurement as on 21.03.2017
Source: FCI

Table 9. Minimum support price for Pulses (Fair Average Quality) in India. (Rs. /Quintal)

Year	Gram		Pigeon pea		Moong		Urad		Lentil	
	MSP	AGR (%)	MSP	AGR (%)	MSP	AGR (%)	MSP	AGR (%)	MSP	AGR (%)
2000-2001	1100	0	1200	0	1200	0	1200	0	-	-
2001-2002	1200	9.09	1320	10.00	1320	10.00	1320	10.00	-	-
2002-2003	1220	1.67	1320	0.00	1330	0.76	1330	0.76	-	-
2003-2004	1400	14.75	1360	3.03	1370	3.01	1370	3.01	-	-
2004-2005	1425	1.79	1390	2.21	1410	2.92	1410	2.92	-	-
2005-2006	1435	0.70	1400	0.72	1520	7.80	1520	7.80	-	-
2006-2007	1445	0.70	1410	0.71	1520	0.00	1520	0.00	-	-
2007-2008	1600	10.73	1550	9.93	1700	11.84	1700	11.84	-	-
2008-2009	1730	8.13	2000	29.03	2520	48.24	2520	48.24	-	-
2009-2010	1760	1.73	2300	15.00	2760	9.52	2520	0.00	-	-
2010-2011	2100	19.32	3500	52.17	3670	32.97	3400	34.92	-	-
2011-2012	2800	33.33	3700	5.71	4000	8.99	3800	11.76	-	-
2012-2013	3000	7.14	3850	4.05	4400	10.00	4300	13.16	2900	0
2013-2014	3100	3.33	4300	11.69	4500	2.27	4300	0.00	2950	1.72
2014-2015	3175	2.42	4350	1.16	4600	2.22	4350	1.16	3075	4.24
2015-2016	3425	7.87	4625	6.32	4850	5.43	4625	6.32	3400	10.57
2016-2017	4000	16.79	5050	9.19	5225	7.73	5000	8.11	3950	16.18
2017-2018	-	-	5450	7.92	5575	6.70	5400	8.00	-	-
CAGR (%)	8.40		9.31		9.46		9.25		8.03	

MSP- Minimum Support price; AGR- Annual growth Rate; CAGR- Compound annual growth rate.
Source- Reserve Bank of India

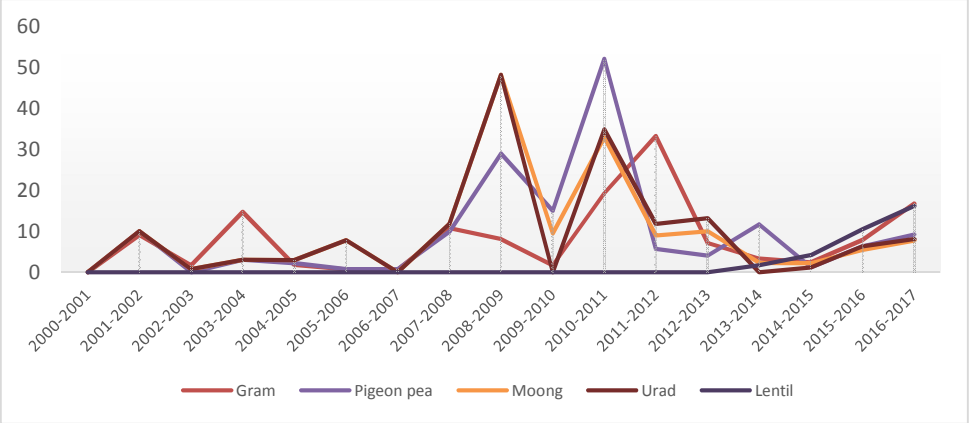

Fig. 1. AGR (%) of MSP of Pulses

Retail prices of Major Pulses and their growth rates calculated from the data given by India stat are given in Table 10. Gram retail prices showed a CAGR of 10.77 per cent which is the maximum among all the pulses. Other pulses such as Lentils, Urad, Pigeon pea and Moong have very low growth rates in comparison to Gram. In 2016-17 the prices of all the prices increased but in 2017-18, the prices decreased because of the impact of higher production during 2016-17.

3.4 Trade Impacts

Export and import of Pulses and their growth rates were estimated (Table 11). It reflects high fluctuations in the export and import quantity of pulses. However, the import quantity is not less than 4 Mn tonnes in the last decade. The CAGR of export of pulses is negative at -3.54% over the last 17 years and imports is positive at 17.52%, which could be due to the government ban on exports of pulses to meet the domestic requirement.

Import from other nations in last one and half decades increased consistently and since 2001 quantity imported doubled with a CAGR 19.72%. Importing quantity reached 5MT in 2016 even though domestic production is very high in this year. This is because of increased domestic demand and zero duties on importing pulses. The impact of increase in the production of pulses in 2016 -17 resulted in the decrease in the growth rate of imports.

As shown in table 12. Export and Import of various Pulses, among all pulse crops, lentil and chick peas are major crops which were exported. Lentil export decreased suddenly from 2007. This may be because of government ban on export or higher duties on export to meet domestic demand. USA, Canada, UK and some of Asian countries were major importers from India. The export of chick peas increased from 2004 and up to 2013 crop export was increased in increasing CAGR of 42%. The results are in coherence with Gowda [5] observations that India primarily produces Bengal gram (chickpeas), Red gram (tur), Lentil (masur), Green gram (mung) and Black gram.

Table 10. Retail prices of major pulses and growth rates (Rs./kg)

Year	Gram		Pigeon pea		Lentil		Moong		Urad	
	Price	AGR (%)	Price	AGR (%)	Price	AGR (%)	Price	AGR (%)	Price	AGR (%)
2011-2012	44.27	0	70.8	0.00	51.25	0	75.9	0	70.6	0
2012-2013	65.39	47.71	69.22	-2.23	54.55	6.44	72.46	-4.53	61.35	-13.10
2013-2014	50.92	-22.13	70.26	1.50	58.6	7.42	76.14	5.08	62.9	2.53
2014-2015	47.96	-5.81	69.92	-0.48	63.04	7.58	87.76	15.26	66.78	6.17
2015-2016	53.5	11.55	87.92	25.74	76.33	21.08	100.97	15.05	86.37	29.34
2016-2017	98.58	84.26	137.6	56.51	85.88	12.51	95.68	-5.24	149.86	73.51
2017-2018	81.77	-17.05	78.67	-42.83	68.35	-20.41	76.91	-19.62	90.47	-39.63
CAGR (%)	10.77		1.77		4.92		0.22		4.22	

AGR-Annual Growth Rates. CAGR- Compound annual growth rate.
Source-Indiastat

Table 11. Export and import of pulses and their growth rates

Year	Exports ('000 tonne)	Annual growth rate (%)	Imports ('000 tonne)	Annual growth rate (%)
2000-2001	244.26	0	499.08	0
2001-2002	161.62	-33.83	3066	514.33
2002-2003	151.38	-6.34	2726.28	-11.08
2003-2004	153.88	1.65	2277.45	-16.46
2004-2005	271.18	76.23	1776.56	-21.99
2005-2006	447.44	65.00	2450.76	37.95
2006-2007	250.71	-43.97	3881.27	58.37
2007-2008	164.2	-34.51	5369.81	38.35
2008-2009	136.27	-17.01	6192.37	15.32
2009-2010	100.125	-26.52	7499.976	21.12
2010-2011	209.019	108.76	5555.501	-25.93
2011-2012	173.503	-16.99	6991.684	25.85
2012-2013	202.665	16.81	8026.449	14.80
2013-2014	345.553	70.50	6355.627	-20.82
2014-2015	222.104	-35.73	4584.852	-27.86
2015-2016	255.602	15.08	5797.706	26.45
2016-2017	137.177	-46.33	6608.951	13.99
CAGR (%)	-3.54%		17.52%	

CAGR- Compound annual growth rate.
Source - Ministry of Agriculture & Farmers Welfare, Govt. of India and APEDA

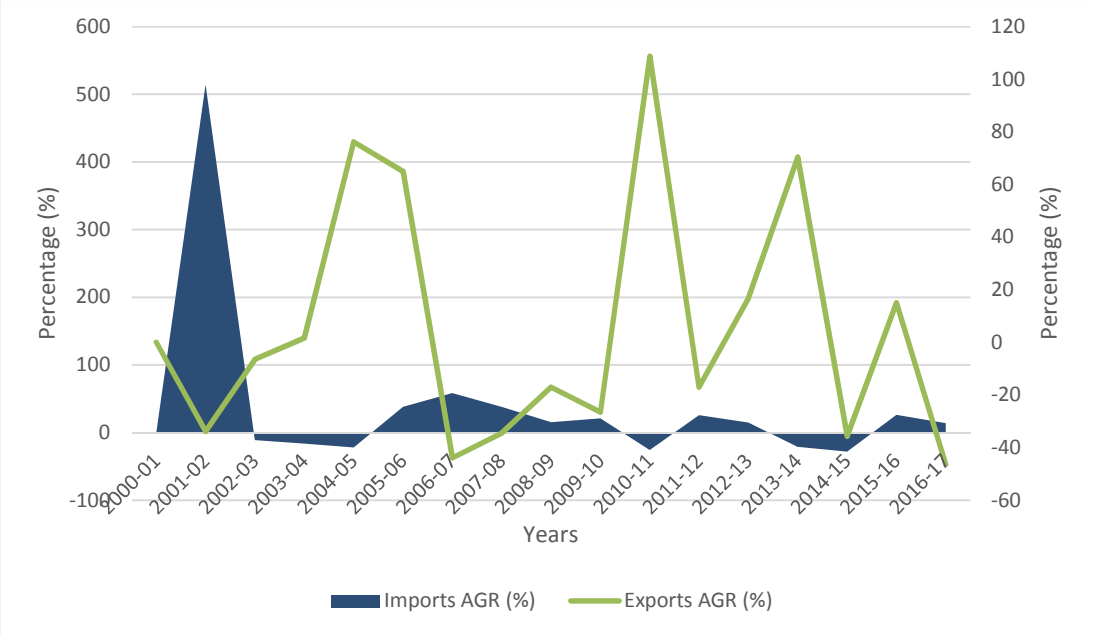

Fig. 2. Export and import growth rates

The export prices were fluctuating from 2008 to 2013 (Table 13.) due to government intervention (high export duty) and changes in rupee value against US$(USA recession 2008). We can infer that export prices are highly fluctuating than import prices although they are higher than import prices. Export & Import prices CAGR were 1.20% & 2.11% for 1990 to 2013 and for 2010 - 2014 the CAGR were 13.40% & -0.7%, respectively (Table14.). Import of pulses increased suddenly in 2000 due to government policies support (FOB) and lower or zero import duties on pulses. India being a net importing country with 3-4 million tonnes of pulses every year and import prices lower than export prices

generally encourage imports. Lower average import prices obviously is due to the type of pulses imported such as peas and pigeon pea. Import prices of chickpeas were high fluctuating than other pulses because of inconsistency in domestic production.

Table 12. Export and Import of various Pulses

	Import in '000' tonnes				Export in '000' tonnes			
Year	**Lentils**	**Chickpeas**	**Beans dry**	**Peas dry**	**Lentils**	**Chickpeas**	**Beans dry**	**Peas dry**
1990	11.595	160.116	154.327	282.23	5.257	5.49	2.335	0.075
1991	3.184	98.751	79.319	116.18	5.593	3.424	0.133	0.39
1992	3.941	77.012	24.878	106.405	7.877	3.563	0.076	0.545
1993	2.351	150.181	54.177	198.525	12.397	0.858	0.014	0.457
1994	60.817	58.127	110.576	144.964	16.633	0.171	0.039	0.446
1995	26.736	13.662	92.847	173.038	22.718	0.445	0.001	1.188
1996	66.483	122.061	70.184	154.53	23.504	0	0.025	0.214
1997	5.063	380.867	114.577	281.633	130.728	0.01	0.303	0.282
1998	21.98	110.132	96.708	257.462	67.265	0.24	0.028	0.304
1999	31.015	11.025	38.978	145.932	147.289	4.071	0.075	3.902
2000	21.019	63.976	43.473	137.383	191.134	2.57	0.477	0.942
2001	86.975	516.819	163.741	849.019	106.109	1.427	0.726	0.887
2002	66.981	217.553	249.305	869.803	86.395	2.226	1.605	2.795
2003	37.949	259.239	486.039	700.017	83.053	2.901	4.89	2.948
2004	26.569	132.518	281.424	643.178	136.922	12.244	3.587	2.085
2005	36.114	281.756	304.112	810.069	281.276	44.06	7.369	8.676
2006	58.935	127.318	620.527	1388.577	121.01	61.304	4.953	2.2
2007	230.557	145.605	486.159	1738.283	0.051	161.772	6.481	0.298
2008	33.21	198.215	604.518	1215.663	0.11	127.101	0.643	0.117
2009	288.077	338.391	1031.324	1655.602	0.602	95.264	0.255	0.642
2010	150.186	56.211	495.368	1334.712	0.324	216.049	0.963	0.846
2011	102.365	142.776	630.677	1866.735	0.293	177.449	0.918	0.427
2012	441.264	471.974	788.811	1497.913	0.779	143.712	2.162	0.158
2013	679.662		885.754	1230.249	0.839	400.562	3.682	0.583

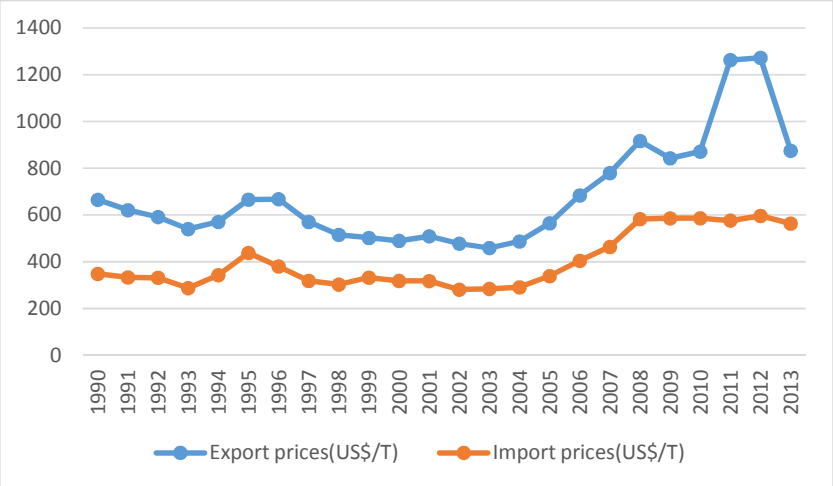

Fig. 3. Total pulses trade price trends

Table. 13 Export and Import prices trends of Pulse crops

Year	Export prices(US$/T)				Import prices(US$/T)			
	Lentil	Chickpeas	Drybeans	Drypeas	Lentil	Chickpeas	Drybeans	Drypeas
1990	753	520	706	880	393	376	344	356
1991	784	473	586	685	545	329	315	349
1992	770	428	434	585	578	350	360	323
1993	594	459	714	556	457	340	292	276
1994	514	374	744	565	340	468	366	271
1995	646	569	700	400	509	939	456	332
1996	666	528	670	584	510	337	388	324
1997	580	500	630	340	363	330	323	308
1998	504	496	571	438	436	314	329	254
1999	506	309	613	307	496	465	393	251
2000	475	395	499	392	430	323	420	222
2001	484	397	701	335	361	371	341	244
2002	464	372	389	361	342	325	298	228
2003	451	400	518	332	421	336	317	231
2004	480	647	376	378	458	387	307	242
2005	525	776	489	309	430	431	445	227
2006	587	783	836	359	397	618	682	258
2007	1255	777	851	832	529	561	627	387
2008	1264	915	812	846	990	546	660	521
2009	983	849	929	771	776	519	855	324
2010	787	873	942	807	834	574	1109	324
2011	1198	1265	1404	993	668	764	900	421
2012	1056	1279	1133	924	596	754	754	450
2013	1166	870	1079	585	640	750	754	456

Source: Food and Agriculture Organization-2015

The Average Export-Import Price of Pulse crops, Growth rate and instability of Export-Import quantity and Price of Pulses, Export-Import Price Elasticity of pulses crops (1990-2016) are presented in Table 14. During the period 1990-91 to 2015-16, the export price of all pulses viz, Pigeon pea, Gram, Lentil and Peas are more than import prices indicating that India has comparative advantage in pulses. The export import quantity growth of all pulses crops were found to be positive. The exports quantity growth rate of Gram and Peas was more than the imports quantity growth rate, while remaining crops has showed a reverse trend quantity growth.

The exports and imports price growth rate of all pulses were found to be positive, except peas exports price growth rate. It indicates that imports price growth rate of all pulses were more than compared to exports price growth. It is also noticed that pigeon pea exports and imports price growth rate was more.

The results of Coefficient of variation of export import prices and quantity of India's major pulses showed that during the period 1990-91 to 2015-16, variation in imports price of all pulses were found to be more than exports price, while similar pattern was observed in imports quantity of all pulses except lentil where export quantity (76.36%) variation is more than compared to imports quantity (58.54%). It is noticed that export as well as import prices of all pulses were found to be unstable. The export quantity of all pulses were found to be stable than compared to imports quantity, except lentil where both export as well as imports were found to be stable. During the same period, all pulses has witnessed positive and more export price elasticity than compared to imports. Among the pulses, more export elasticity was noticed in peas (2.36%) followed by gram, lentil and pigeon pea. The terms of trade of India with other countries found to be improved for all pulses crops.

Tariffs and Duties of Pulses

Tariffs and duties of pulses during 2016-17 are shown in Table 15. It shows that bound duties are more than statutory duties of pulses. The bound duty for peas is low compared to other pulses. Duty free import of all pulses has been extended without an end date vide Department of Revenue's Notification No. 61/2015-Customs dated 30th Dec, 2015.

3.5 Environment Impacts

Pulses improve the sustainability of cropping systems. Pulse crops produce a number of different compounds that feed soil microbes and benefit soil health. Pulse crops have a significant impact on soil biology, increase soil microbial activity even after such pulses are harvested. Pulses also have been shown to exude greater amounts and different types of amino acids than non-legumes and the plant residues left after harvesting pulse crops have a different biochemical composition (e.g. Carbon/Nitrogen ratio) than other crop residues. The ability of pulses to feed the soil different compounds has the effect of increasing the number and diversity of soil microbes. Crops grow better in soils that are more "alive" with a diverse array of soil organisms, as these organisms break down and cycle nutrients more efficiently, feeding the crops as they grow. In addition, a large, diverse population of soil organisms acts to 'crowd out' disease-causing bacteria and fungi, making for healthier plants.

The amount of N fixed by a pulse crop is largely influenced by how well that crop grows. More crop biomass is equivalent to more N fixed by that crop provided it is well nodulated. The range of N fixed varies between 20 (navy bean) to 66 (peas) per cent. On average, this equates to about 110 kg of N per hectare per year, however the range of values can be from zero to 400 kg N/ha as per Grains Research and development Corporation [20]. In Australia, legume-rhizobia associations are estimated to fix approximately 2.7 mt of nitrogen (N) per year, which is worth about $4 billion.

The valuation of eco-services provided by pulses is depicted in Table 16. The value of nitrogen fixed by pulses @ 40kg and 60kg N/ha works out to Rs.1792 and Rs.2688, respectively when the market price of Nitrogen (sale price + subsidy) is taken at Rs.44.80.

Pulses in India are mostly grown in rainfed conditions. Pulse crops also use water in a different way than other crops grown in rotation, extracting water from a shallower depth, leaving aside more water deep in the soil for the following year's crops.

Further agriculture alone accounts for 10-12% of global greenhouse gas emissions. As explained in the statement "Pulses use half the non-renewable energy inputs of other crops", pulses require little to no nitrogen fertilizer, due to their ability to biologically fix nitrogen from the air. The manufacturing of essential nitrogen fertilizer is energy intensive, and natural gas is used to drive this process[2]. Knowing this, it is obvious why growing nitrogen-fixing pulses would result in less greenhouse gas emissions to the atmosphere. Farmers growing nitrogen fixing pulse crops are doing their part to reduce global greenhouse gas emissions as per Pulse Canada [21]. By fixing nitrogen in the soil, pulses also help reduce the footprint of other crops that are grown following pulses season, so that the benefits extend much further into the food production cycle.

Compared to crops like Rice that emits 2.7 kg CO_2, pulses such as lentils emit just 0.9 kg CO_2 per kg of consumed food in their full lifecycle as per Global Pulse Confederation [22]. Which in consistence with the Smita and Sai, 2015 estimates, one kilogram of legume emits 0.5 kilogram in CO_2 equivalent whereas one kilogram of meat produces 9.5 kilogram in CO_2 equivalent.

As far as water footprint is concerned pulses require water to the tune of 4055 l kg^{-1} compared to 1644 and 962 l kg^{-1} for cereals and fruits as discussed by Mekonnen. et.al [23]. But on protein source, the pulses are much more water use efficient with just 19 l g^{-1} of protein compared to 21 and 180 l g^{-1} in case of cereals and fruits.

Compared to high water use by wheat, canola, and mustard pulses such as chickpea, lentil consume medium water use and peas still lower level of water use (34 and 13 mm less water than high and medium users) as reported by Angadi. et.al [24]. Compared to wheat and Brassica oilseeds, pea and chickpea were able to adjust better to moderate and severe water stress.

3.6 Nutritional Composition and Security

Per capita availability of pulses in India, as depicted in Agricultural statistics at glance- 2014 are given in Fig. 6. Due to stagnant pulse production and continuous increase in population, the per capita availability of pulses has decreased considerably until 2010 and a slight increase since the 2011 could be observed, which could be due to increase in area and productivity. The Proximate composition of pulse grains (per 100 g) in Table 17. The nutritional security of the country in pulses is insecure. The total daily requirement increases with the age and the requirement of proteins is higher in Boys compared to Girls as per ICMR Reports [27].

Table 14. Average Export-Import Price of Pulse crops, Growth rate and instability of Export-Import quantity and Price of Pulses, Export-Import Price Elasticity of pulses crops (1990-2016)

Crop	Variables	Variables	1990-91 to 2000-01	2001-02 to 2015-16	1990-91 to 2015-16
Pigeon Pea	**Average Export**	Export	0.68	0.87	0.79
	Import Price US$ /Kg	Import	0.35	0.56	0.47
	Quantity Growth rate (%)	Export	17.36	-5.28	4.53
			(-251.9)	(-77.01)	(-85.08)
		Import	7	1.8	12.71
			(-136.7)	(-352.93)	(-140.88)
	Price Growth rate (%)	Export	-3.76	8.79	3.25
			(-672.32)	(-165.74)	(-192.71)
		Import	-0.92	9.34	4.5
			(-543.63)	(-232.07)	(-221.69)
	Export Import Price elasticity	Export	1.71	-0.98	0.35
		Import	1.22	0.08	0.31
	Terms of Trade (%)		1.94	1.55	1.68
Gram	**Average Export**	Export	0.37	0.79	0.62
	Import Price US$ /Kg	Import	0.41	0.52	0.47
	Quantity Growth rate (%)	Export	3.03	39.79	20.11
			(-108.92)	(-121.4)	(-75.78)
		Import	-8	4.71	7.43
			(-111.83)	(-130.7)	(-104.79)
	Price Growth rate (%)	Export	-4.54	6.81	1.44
			(-180.55)	(-300.51)	(-193.87)
		Import	-1.49	4.32	2.21
			(-233.66)	(-373.62)	(-291.04)
	Export Import Price elasticity	Export	-2.33	0.37	0.69
		Import	0.91	0.36	0.53
	Terms of Trade (%)		0.9	1.52	1.32
Lentil	**Average Export**	Export	0.6	0.88	0.76
	Import Price US$ /Kg	Import	0.44	0.59	0.53
	Quantity Growth rate (%)	Export	38.63	-13.63	3.15
			(-85.12)	(-69.25)	(-76.37)
		Import	5.56	19.51	19.76
			(-103.11)	(-80.34)	(-58.54)
	Price Growth rate (%)	Export	-4.12	5.9	1.45
			(-574.87)	(-214.72)	(-222.83)
		Import	0.79	5.98	2.89
			(-688.23)	(-309.35)	(-318.74)
	Export Import Price elasticity	Export	1.61	1.21	0.55
		Import	0.83	0.4	0.47
	Terms of Trade (%)		1.36	1.49	1.43
Peas	**Average Export**	Export	0.57	0.56	0.57
	Import Price US$ /Kg	Import	0.27	0.34	0.31
	Quantity Growth rate (%)	Export	25.86	14.14	18.69
			(-73.64)	(-90.54)	(-77.41)
		Import	-14.63	6.7	4.14
			(-118.18)	(-266.97)	(-126.45)
	Price Growth rate (%)	Export	-9.88	3.58	-3.19
			(-194.05)	(-232.8)	(-218.08)
		Import	4.99	3.28	4.19
			(-444.24)	(-354.57)	(-351.28)
	Export Import Price elasticity	Export	3.85	0.55	2.36
		Import	1.18	0.5	0.25
	Terms of Trade (%)		2.11	1.65	1.84

Note: Values in the parenthesis indicates CV (%)

Table 15. Tariff schedule for different commodities

HS Code	Commodity	Tariff Schedule		
		Bound Duty	Statutory Duty	Applied Duty*
0713 10 00	Peas (PisumSativum)	50%	50%	Nil
0713 20 00	Chickpeas (Garbanzos)	100%	30%	Nil
0713 31 00	Moong/Urad	100%	30%	Nil
0713 40 00	Lentil (Mosur)	100%	30%	Nil
0713 60 00	Pigeon Peas (Tur)	100%	30%	Nil

Source: Directorate General of Foreign Trade (DGFT), Department of Revenue and World Trade Organization (WTO)
** Duty free import of all pulses has been extended without an end date vide Department of Revenue's Notification No. 61/2015-Customs dated 30th Dec, 2015.*

Table 16. Valuation of Eco-services provided by Pulses

S. No.	Variable	Value (Rs)
1.	Retail Price of N (Rs/kg)	11.65
2.	Subsidy on N (Rs/kg)	33.15
3.	Market Price (without subsidy) of N (1+2)	44.80
4.	Value of Nitrogen fixed by Pulses @ 40 kg N/ha (3x4)	1792
5.	Value of Nitrogen fixed by Pulses @ 60 kg N/ha (3x5)	2688

Note: N prices are based on Urea (46 percent N) prices
Source: Commission for Agricultural Costs and Prices, Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare

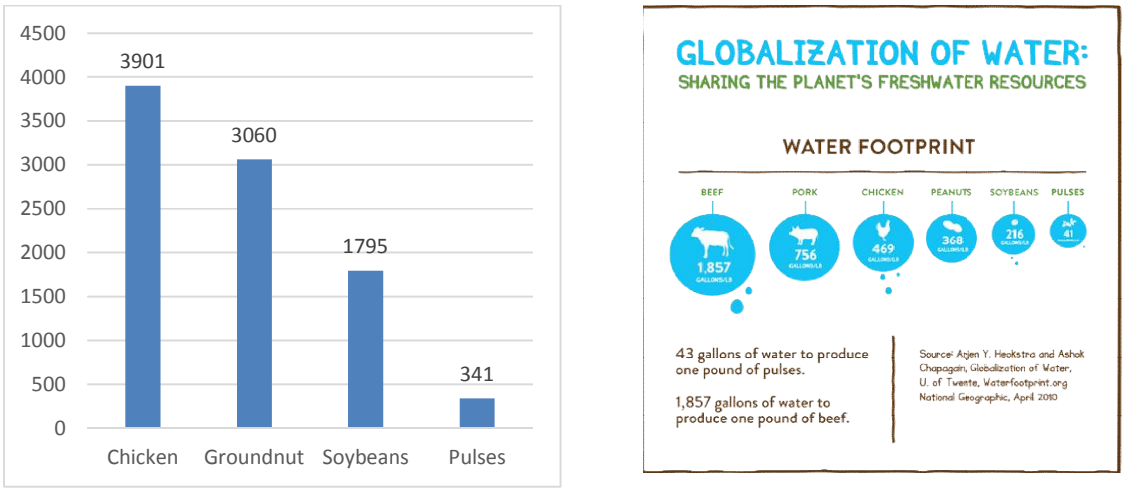

Fig. 4. Water footprint of different enterprises (l/kg)
Source: Adapted from Hoekstra, A.Y. and Chapagain, [25]

Pulses maintained positive turgor (i.e., combined strategies of cell wall elasticity and osmotic adjustment) and metabolic activity over a wide range of water potentials as per Cutforth. et.al [26].

The Table 18. exhibits the recommended Protein-intake across different age groups and also the protein energy ratio.

The Table 19. shows the Examples of the Derivation of Protein Allowances for Children and Adolescents by a Factorial Procedure.

3.7 Nutrition and Health Impacts of Pulses

Eating foods like pulses that are high in fibre can help bring down blood glucose and insulin levels, which is crucial for people who are diabetic or pre-diabetic. Pulses provide protein and fibre, as well as a significant source of vitamins and minerals, such as iron, zinc, folate, and magnesium, and consuming half a cup of beans or peas per day can enhance diet quality by increasing intakes of these nutrients. In addition, the phytochemicals, saponins, and tannins found in pulses possess antioxidant and anti-carcinogenic effects, indicating that pulses may have

significant anti-cancer effects. Pulse consumption also improves serum lipid profiles and positively affects several other cardiovascular disease risk factors, such as blood pressure, platelet activity, and inflammation. Pulses are high in fibre and have a low glycemic index, making them particularly beneficial to people with diabetes by assisting in maintaining healthy blood glucose and insulin levels. Emerging research examining the effect of pulse components on HIV and consumption patterns with aging populations indicates that pulses may have further effects on health. In conclusion, including pulses in the diet is a healthy way to meet dietary recommendations and is associated with reduced risk of several chronic diseases as discussed by Mudryj et al. [28]

In recent years, the consumption of pulses has gone down from approximately 10 kg/person/year in the '60s to the current levels of just above 6 kg/person/year—and people are not eating the recommended amount of fibre. Increasing the consumption of pulses and other legumes can improve the quality of people's diets and their overall health. One of the ways governments can encourage this is by issuing food-based dietary guidelines as per FAO [29].

3.8 Government Schemes and Incentives Impact

The Directorate of Pulses Development (DPD) is one of the eight Commodity Development Directorates (CDDs) namely Jute, Cotton, Wheat, Millets, Rice, Sugarcane and Oilseeds in the Ministry of Agriculture & Farmers Welfare, under the administrative control of Department of Agriculture, Cooperation & Farmers Welfare (DAC&FW). The DPD coordinates and implements all the Central Sector and centrally sponsored schemes that promote pulses development. Some of the schemes that promote pulses development in the country are –

Pulses Development Scheme – Initiated in the sixth five year Plan (1969-70 to 1973-74).

National Pulses Development Project (NPDP) – From seventh five year plan was implemented in 17 major states of the country. Special Food Grain Production Program (SFPP) on Pulses – to supplement NPDP was also operationalized during 1988-89 on a 100% Central assistance basis. GOI-UNDP Cooperation – During 1997-2003, Pulses Sector was identified as Priority Sector to be strengthened. Technology Mission on Oilseeds and Pulses (TMOP) – Based on the success of Oilseeds Mission (TMO), pulses was added to this mission in 1990. Integrated Scheme of Oilseeds, Pulses and Oilpalm (ISOPOM) – From 2004-05 onwards all the commodities viz pulses, oilseeds and oil palm were brought under this scheme. The focus of this scheme was on new technologies, timely input supply, extension support, remunerative price, marketing infrastructure and post-harvest technologies etc.

National Food Security Mission (NFSM) – in the beginning of 11th plan, based on the recommendations of National Development Council's 53rd meeting this scheme was initiated. Besides Rice and wheat, pulses promotion was also included in this with Accelerated Pulses Production Programme (A3P) as cluster demonstration approach, special incentives for pulses besides oilseeds, pulses villages in as many as 60000 villages by converging with Rashtriya Krishi Vikas Yojana

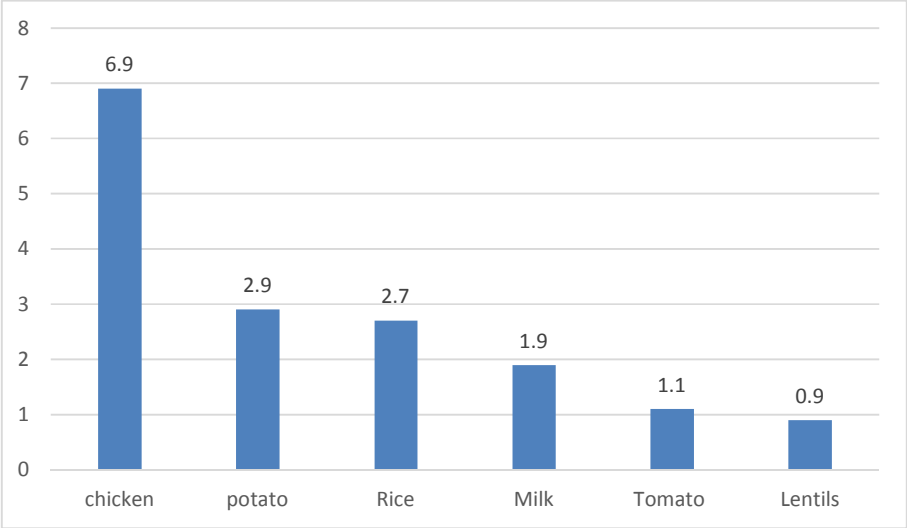

Fig. 5. Full life cycle GHG emissions (kg consumed food)

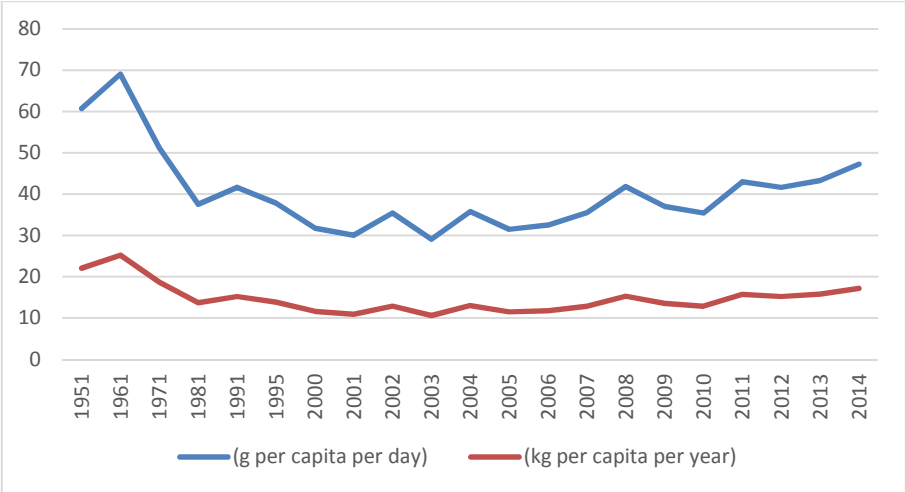

Fig. 6. Per capita availability of pulses
Source: Agricultural Statistics at a glance-2014

National Mission on Sustainable Agriculture (NMSA) – The main focus is on promoting composite and integrated farming through natural resources conservation. Convergence with other pulse programmes for promoting various crops including pulses.

National Mission on Agricultural Extension and Technology (NMAET) – Comprises of four sub missions like agriculture extension (SAME), seed and planting material (SMSP), agriculture mechanization (SMAM) and plant protection and quarantine (SMPP).

National Mission on Oilseeds and Pulses (NMOOP) – It is part of RKVY. An amount of Rs.300 crores was provided under Rashtriya Krishi Vikas Yojana (RKVY) to organize sixty thousand "Pulses and Oilseeds Villages" in Rainfed areas to provide an integrated intervention of water harvesting, watershed management and soil health for enhancing the productivity of the dry land farming areas.

Table 17. Proximate composition of pulse grains (per 100 g)

PU LSES	Energy (K.Cal)	Protein (g)	Fat (g)	Carbohydrate (g)	Total dietary fiber (%)
Pigeon pea	342	21.7	1.49	62	15.5
Urad bean	347	24 .0	1.6	63.4	16.2
Moong bean	345	25.0	1.1	62.6	16.3
Lentil	346	27.2	1.0	60	1 1.5
Field pea	345	25. 1	0.8	61.8	13.4

Source: pulse for human health and nutrition, Indian institute of pulse research.

Table 18. Recommended Protein-intake across different age groups

Age group (yr.)		Recommended protein intake (gm/day)	Recommended energy intake (Cal/day)	Protein energy ratio (%)
Preschool children				
1-3		21	1240	6.8
4-6		29	1690	6.9
7-9		40	1950	8.2
Adolescents				
13-15	Boys	67	2450	10.9
	Girls	62	2060	12.0
16-18	Boys	75	2640	11.4
	Girls	60	2060	11.7

Adapted from ICMR Report (12)

Table 19. Examples of the derivation of protein allowances for children and adolescents by a factorial procedure

Age	Growth						
	Nitrogen Increment (mg/kg per day)b	Nitrogen Increment × 1.5 (mg/kg per day)	Nitrogen Increment × 1.5, plus Correction for at 70% (mg/kg per day)	Nitrogen Maintenance Level (mg/kg per day)	Total Nitrogen (mg/kg per day)	Allowance of Reference Protein (gm/kg per day) Mean	+ 2 SD
Both sexes Months							
3–5.9	47	70	100	120	220	1.38	1.73
6–11.9	34	51	73	120	193	1.21	1.51
Years							
1	16	25	36	119	155	0.97	1.21
5	9	13	19	116	135	0.84	1.05
9	8	12	17	111	128	0.8	1
Males, years							
12	9	13	19	108	127	0.79	0.98
17	3	5	7	103	110	0.69	0.86
Females, years							
12	7	10	14	108	122	0.76	0.95
17	0	0	0	103	103	0.64	0.8

A From WHO (1985: Tables 32–34). These figures are examples of the derivation of requirements at various ages. For methodological details and a complete listing of ages, consult the WHO report.

B Increment for growth.

C 50% Additional nitrogen increment to allow for daily variation in growth rate and inability to store amino acids to be available when maximum growth occurs.

D Assuming a 70% efficiency of dietary protein utilization for growth.

E Data from WHO (1985).

F High-quality, highly digestible protein such as egg or milk. Protein is total nitrogen × 6.25.

G Individual variability. The coefficient of variation for both maintenance and growth was assumed to be 12.5%.

Rashtriya Krishi Vikas Yojana (RKVY) – Started in the year 2008. A National Mission on Oilseeds and Oil Palm (NMOOP) has been approved for XII Plan period.

4. CONCLUSIONS

India leads all nations in terms of area and production, but lags behind in terms of productivity of pulses due to technological and yield constraints. The results show that during 2000-01 to 2021-22, India demands more than supply indicating food insecurity in pulses. The production demand gap in pulses has remained over the years, leading to the import of pulses.

Due to stagnant pulse production and continuous increase in population, the per capita availability of pulses has decreased considerably until 2010 and a slight increase since the 2011 could be observed, which could be due to increase in area and productivity. The results of season-wise Area, Production and Productivity of Total Pulses in India during 1949-1950 to 2016-2017 shows that the area is stagnant except few years and the production and productivity has been increasing. It is also found that over the 18 years course of time, pulses production doubled that is 11.07 Mt in 2000-01 to 22.95 Mt in 2016 -17. It implies that technological breakthroughs are slow in pulse production. The steep rise in production could be due to the technological and government schemes and programs contribution. Gram contributes the single largest share of 43% in India's total pulses production and in export basket of pulses registering 84.87% in 2015-16.

Among the pulses Tur is procured in the maximum quantity at 590 MT by NAFED and the least procured is Urad at 11 MT by SFAC. As per the CACP, in 2016-17, the MSP has increased for all the pulses, the highest MSP is given for moong at Rs. 4800/Quintal. The CAGR of MSP for Moong is maximum at 9.46. Gram retail prices show a CAGR of 10.77 and is the maximum among all the pulses. Other pulses such as Lentils, Urad, Pigeon pea and Moong have very low growth rates in comparison to Gram. In 2016-17 the prices of all the pulses increased but in 2017-18, the prices decreased because of the impact of more production in 2016-17.

The impact of increase in the production of pulses in 2016 -17 resulted in the decrease in the growth rate of imports. USA, Canada, UK and some of Asian countries were major importers from India. During the period 1990-91 to 2015-16, the export price of all pulses viz, Pigeon pea, Gram, Lentil and Peas are more than import prices indicating that India has comparative advantage in pulses. During the same period, all pulses has witnessed positive and more export price elasticity than compared to imports. Among the pulses, more export elasticity was noticed in peas (2.36%) followed by gram, lentil and pigeon pea. The terms of trade of India with other countries found to be improved for all pulses crops.

Pulses improve the sustainability of cropping systems and are environmental friendly. The quantity of nitrogen fixed by pulses is @ 40 kg and 60 kg N/ha. Compared to crops like Rice that emits 2.7 kg CO_2, pulses such as lentils emit just 0.9 kg CO_2 per kg of consumed food in their full lifecycle. As far as water footprint is concerned pulses require water to the tune of 4055 l kg^{-1} compared to 1644 and 962 l kg^{-1} for cereals and fruits. But on protein source, the pulses are much more water use efficient with just 19 l g^{-1} of protein compared to 21 and 180 l g^{-1} in case of cereals and fruits.

The nutritional impacts of pulses show that the pulses are high in nutrition, however, the nutritional security of the country in pulses is insecure. And health impacts are positive. In conclusion, including pulses in the diet is a healthy way to meet dietary recommendations and is associated with reduced risk of several chronic diseases. The government programs, schemes impacted in increase in area and productivity of pulses.

The study suggests that targeted research to be in pulses for better nutrition and climate change adaptation through "sustainable intensification". As pulses are climate smart crops substantially contribute to soil health and water use efficiencies need of the preference. Focus on three common types of pulses: beans, chickpeas, and lentils which contributes trade in future to meet the demand of pulses nationally and globally. Improved policies and investments in pulses research and technology transfer are of high-priority. Government procurement must be on war footing to tackle the rising gap between the demand and supply of pulses. Promotion of trade through SEZ's, easing out export procedures and restrictions timely will improve trade in pulses. An enabling policy environment in pulses to meet the current and future food security challenges must be provided.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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