Report on

Buffer Stock Norms of Pulses

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1. Background

1.1. A meeting was held in Prime Minister's Office (PMO) on 16.09.2017 to review the progress of disposal of pulses. In the meeting, it was decided to constitute a committee under the Chairmanship of Prof. Ramesh Chand, Member, NITI Aayog, to deliberate and recommend the level of pulses buffer to be maintained by Government of India. The terms of reference (ToR) of the committee are :

a) The committee would recommend the level of buffer stock of Pulses to be maintained, and

b) The committee would suitably review, adjust and modify this level every year to suit the overall production, disposal, prices, and other such considerations as deemed appropriate.

1.2 Pulses play an important role in sustaining food and nutritional security as well as environmental sustainability in India. These crops provide quality and cheap protein to humans, improve fertility and physical structure of soil, and can be cultivated even under stress conditions with minimum use of resources. India is the world's largest producer and consumer of pulses constituting 23 per cent and 30 per cent share in total pulses production and consumption in the World, respectively(FAO, 2013).Since the beginning of green revolution production performance of pulses has lagged behind other staple crops except in the recent years. Between 1950-51 and 2015-16, production of pulses could increase only by 95.6 per cent as compared to 455 per cent increase in cereals production and 390 per cent increase in oilseeds production in the country. During the same period population grew at faster rate than the rate of increase in pulses production. Consequently, the per capita availability of pulses declined from 60.54 grams in 1950-51 to 43.83 grams in 2015-16 against the minimum requirement (based on ICMR norms for sedentary activity) of 68.49 grams. Further, slow growth in production of pulses is accompanied by wide regional variations, temporal fluctuations and unfavourable revenue terms of trade with fine cereals and oilseeds (Srivastava *et al*. 2010)[1].The poor production performance of pulses coupled with lack of assured market creates imbalance in demand and supply, and results in soaring import bills and unpredictable changes in prices.

1.3. The rise in pulses prices in the situation of lower production adversely affects consumption with negative consequences on nutritional security in the country. On the other hand, fall in prices during the period of bumper production (as happened in 2017) affects income of the pulses growing farmers. It is, therefore, necessary to maintain some stability in prices. There are two options to stabilise domestic supply and prices viz. buffer stock and export/import of pulses. Buffer stock involves procurement by public agencies when production is above normal and release of procured quantity when there is shortage.

[1]Srivastava, S.K., N. Sivaramane, and V.C. Mathur (2010), "Diagnosis of Pulses Performance in India", *Agricultural Economics Research Review*, Vol. 23, No.1, pp. 137-148.

1.4 The report is divided into the following sections. Second section discusses production and supply of pulses. Third section deals with demand for pulses in the country. The trends in wholesale and retail prices are discussed in the fourth section. Fifth section provides estimates on buffer stock norms for pulses in the country.

2. Production and supply of pulses

2.1. India produced 22.9 million tonnes (mt) of pulses during 2016-17 which constitutes about 6 per cent of total crop output in value terms. The production basket of pulses comprised of gram, arhar, urd, moong, lentil, and other minor pulses with their respective share of 42 per cent, 18 per cent, 12 per cent, 9 per cent, 5 per cent and 13 per cent in total pulses production. The top pulses producing states in the country are Madhya Pradesh, Rajasthan, Maharashtra, Karnataka, Andhra Pradesh and Uttar Pradesh. These six states produced 75 per cent of the total pulses in the country in year 2015-16.

2.2. The production performance of the pulses during the past two decades (since 1996-97) revealed that the production grew at annual rate of 0.71 per cent till the year 2009-10 and hovered around the level of 14 mt.In the subsequent period between 2009-10 and 2016-17, growth in pulses production accelerated to 3.2 per cent and production reached historically highest level of 22.9 mt in the year 2016-17.In India, pulses are cultivated primarily under rainfed conditions (only 19.7 per cent irrigation coverage) and on marginal or relatively poor soils with minimum use of resources. Consequently, production exhibits wide fluctuations, which is reflected from the deviation in production from the underlying trend (see Figure 1 for individual pulses and total pulses).

2.3. During 11 out of the past 20 years, pulses production remained below the average level of 15.24 mt (Figure 1 and Table 1). The average negative deviation from the trend was 14.19 lakh tonnes which is 9.3 per cent of the average production (1996-2017) in the country. The extreme negative deviation has been observed for the year 2002-03 when pulses production fell 20 per cent (27 lakh tonnes) below the estimated normal production (of this year). At the same time, pulses production was 22 per cent (41 lakh tonnes) higher than the estimated normal production in the year 2016-17. Among the individual crops, average negative deviation varied from 6.8 per cent in lentil to 17 per cent in moong with extreme negative deviation upto 50 per cent (in 2009-10) for moong. The extreme positive deviation varied from 15 per cent in lentil (in 1999-00) to 49 per cent (in 2016-17) in arhar. The large inter-year variation in production disrupts demand and supply equilibrium and results in unpredictable changes in prices with definite consequences for food and nutritional security in the nation.

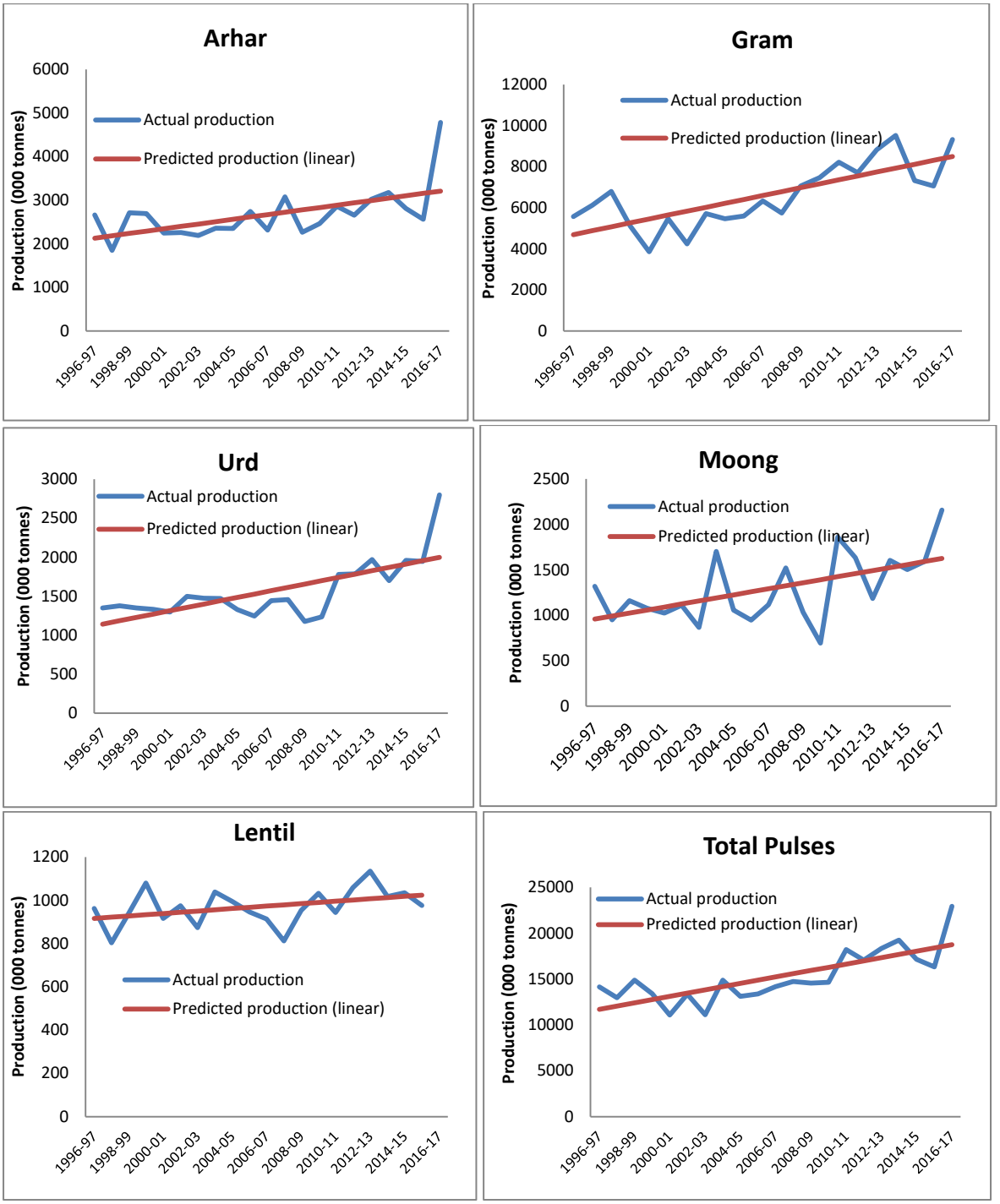


Figure 1. Trends in actual and normal production

Table 1. Deviation (000 tonne) in pulses production from trend (1996-97 to 2016-17)

Particulars	Arhar	Gram	Urd	Moong	Lentil	Total
Average negative deviation (% of normal production)	-278 (10.4%)	-795 (12%)	-207 (13%)	-223 (17%)	-66 (6.8%)	-1419 (9.3%)
Average positive deviation (% of normal production)	452 (17.0%)	875 (13%)	155 (10%)	245 (19%)	54 (5.6%)	1561 (10.2%)
Normal production	2668	6600	1570	1292	970	15238
Highest –ve deviation (% of normal in respective year)	-593 (19%: 2015-16)	-1602 (29%: 2000-01)	-481 (29%: 2008-09)	-699 (50%: 2009-10)	-167 (17%: 2007-08)	-2703 (20%: 2002-03)
Highest +ve deviation (% of normal in respective year)	1572 (49%: 2016-17)	1724 (34%: 1998-99)	802 (40%: 2016-17)	535 (33%: 2016-17)	146 (15%: 1999-00)	4187 (22%: 2016-17)

2.4. India is the world's largest producer of pulses. Although the production of pulses is increasing, its level remained insufficient to meet the growing demand. The deficit between domestic demand and production is, therefore, met through the import. During the past two decades, import of pulses has increased from less than one million tonnes during biennium ending (BE) 1996-97 to 6.66 million tonnes in 2016-17. The increase in pulses import is largely accounted by yellow pea which constituted 41 per cent share in total pulses import during quinquennial ending (QE) 2016-17. Yellow pea was followed by lentil and chickpea with the respective share of 17 per cent and 14 per cent. The major pulses supplying countries are Canada, Australia, Russia and Myanmar. Nevertheless, India also exports small amount of pulses, particularly chickpea to countries like Pakistan, Sri Lanka, USA, etc. The net availability of pulses in the country increased from 14.79 mt in BE1996-97 to 29.48 mt in 2016-17. During the recent years, the per capita availability of pulses hovered around 17 kg/capita/year, except in the year 2016-17 when bumper production as well as increase in import significantly raised pulses supply in the country. India's dependence on import (share of import in total availability) of pulses has increased from 4.7 per cent during biennium ending (BE) 1996-97 to 22.6 per cent in 2016-17.

Table 2.Supply of pulses in India

Year	Production (mt)	Import (mt)	Export (mt)	Total availability (mt)	Per capita availability (kg/year/capita)	Import dependence (%)
BE1996-97	14.15	0.69	0.06	14.79	16	4.7
BE2006-07	13.79	2.18	0.35	15.62	14	14.0
2013-14	19.26	3.66	0.35	22.57	18	16.2
2014-15	17.15	4.64	0.22	21.57	17	21.5
2015-16	16.35	5.88	0.26	21.97	17	26.8
2016-17	22.95	6.66	0.14	29.48	23	22.6

3. Demand of pulses

3.1. Pulses are an important constituent of Indian food basket. The latest available data from consumption Expenditure Survey (2011-12) of National Sample Survey office (NSSO) revealed that an average Indian spends 6 per cent of the total food expenditure on pulses which supplies 11 per cent of the total protein intake. Between 2004-05 and 2011-12, per capita household consumption of pulses has increased from 0.705 kg to 0.783 kg in rural areas and 0.824 kg to 0.901 kg in urban areas. A working group on *Crop husbandry, agricultural input demand and supply projections* set up by NITI Aayog estimated that by the year 2021-22, pulses demand (both direct and indirect) in the country would be 26.72 million tonnes, and there would be a deficit of around 5 to 7 million tonnes in the country. Any shortfall in production is reflected through the unpredicted changes in prices.

3.2. The pulses consumption is price sensitive. Kumar (2017)[2]has estimated that price elasticity of pulses varies from -0.699 for poor households to -0.349 for high income households with the average value of -0.456. This indicates that in the situation of price rise, pulses consumption would decline and relatively poor households will be adversely affected. Therefore, controlling prices of pulses within a fair range is warranted for addressing the issues of nutritional security.

4. Trends in prices of pulses

The impact of imbalance between demand and supply of pulses is reflected through the volatility in wholesale and retail prices.

4.1 Trends in wholesale prices of pulses

4.1.1. Figure 2 depicts the trends in wholesale prices of pulses and its comparison with the cereals pricesduring March 2004 to March 2017. The inflation rate based on the wholesale prices of pulses and cereals was almost at about 9 per cent level during March 2004 to March 2014 (Table 3). In the subsequent period till March 2017, inflation rate in pulses rose significantly to 20.1 per cent, whereas cereals witnessed deceleration in inflation rate to 4.5 per cent. The increase in prices during the recent years (March 2014 to March 2017) was registered across all the pulses crops except moong. Nevertheless the past few months have witnessed downward trend in prices of pulses.

[2] Kumar, P. (2017), "Food and nutrition security in India: The way forward", *Agricultural Economics Research Review*, Vol. (30), No.1, pp. 1-21.

Table 3. Average inflation and instability in wholesale prices during March 2004 to March 2017

Period	Cereals	Pulses	Arhar	Gram	Urd	Moong	Lentil
Average inflation (year-on-year)							
March 2004 to March 2014	8.6	9.2	9.6	9.6	11.4	13.2	9.7
March 2014 to March 2017	4.5	20.1	19.2	26.0	29.1	6.6	13.8
Instability Index (%)							
March 2004 to March 2014	1.33	2.68	3.68	3.48	3.81	3.59	3.18
March 2014 to March 2017	0.68	4.95	5.33	7.10	5.39	3.77	3.73

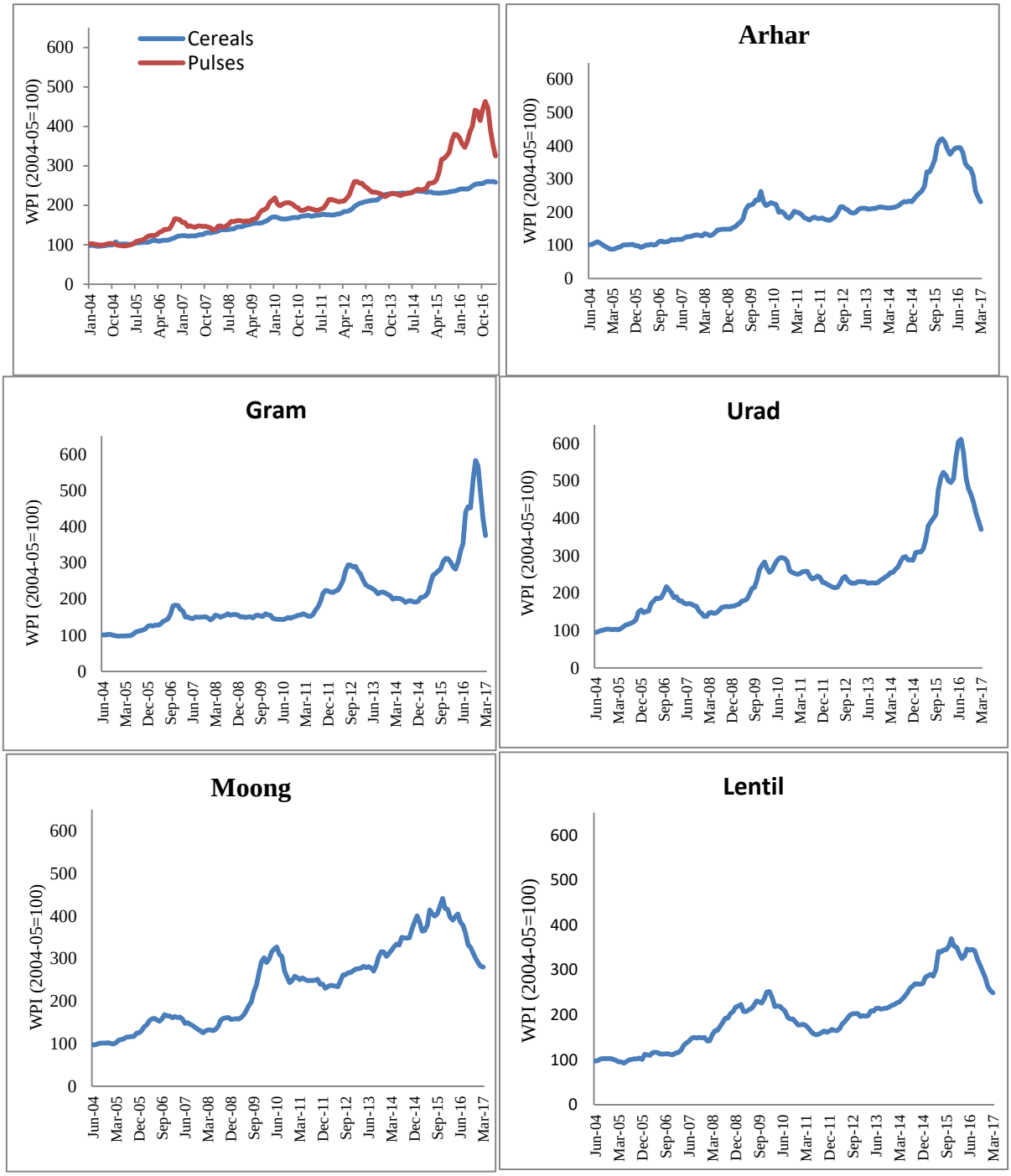
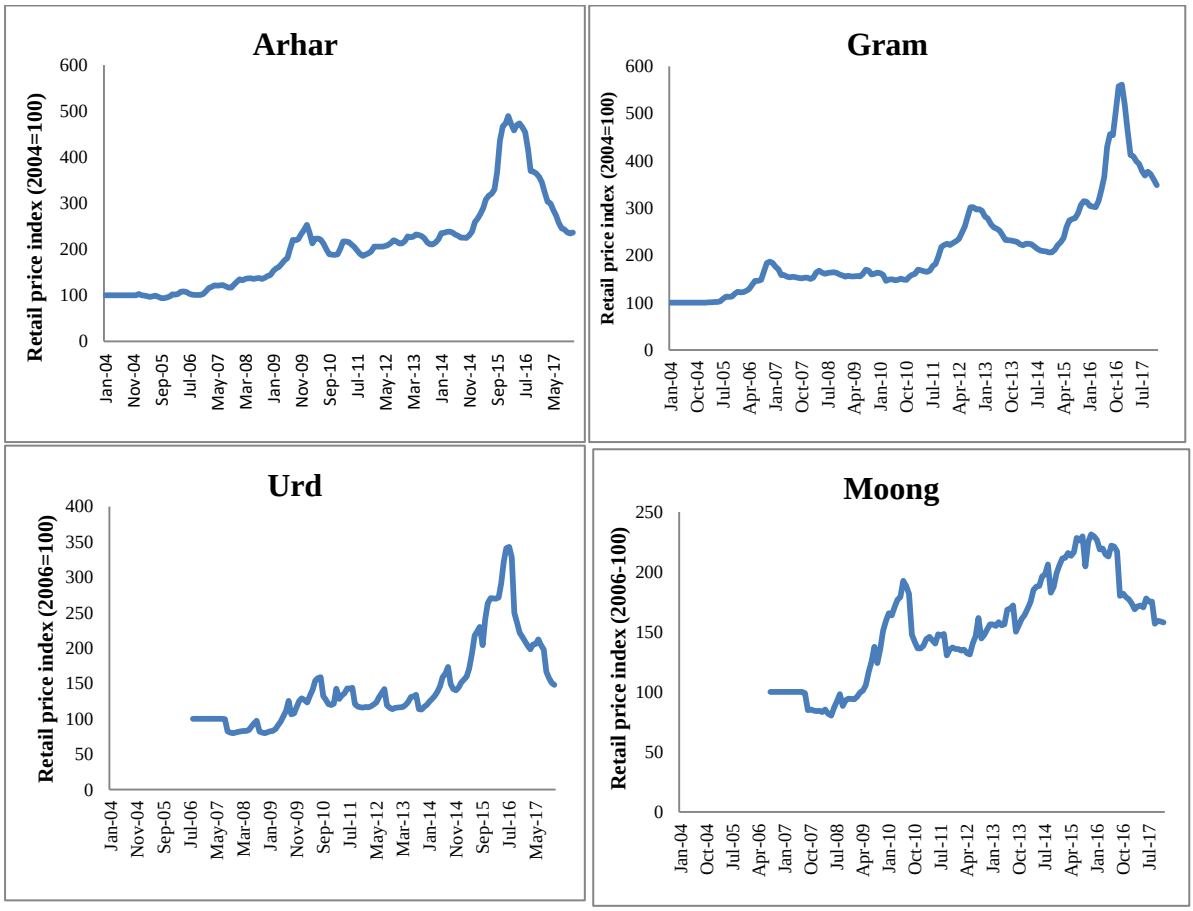


Figure 2.Trends in wholesale prices of pulses

4.1.2. The estimated instability indices indicate that rising trends in wholesale prices accompanied increasing instability across all the pulses crops during March 2014 to March 2017 as compared to the preceding period during March 2004 to march 2014 (Table 3). The relativelyhigher fluctuation in prices makes cultivation of pulses a riskier proposition as compared to the cereals and affects farmers' decision to grow pulses as a main crop.The cultivation of pulses under marginal conditions results in instability in production and farmer remains stranded in the vicious cycle of instable production- fluctuating prices-poor production environment-instable production. Regulating supply of pulses (through buffer stock) would go a long way in controlling prices within a fair range and signalling the farmers to cultivate pulses with improved practices.

4.2 Trends in retail prices of pulses

4.2.1. The underlying trends in wholesale prices gets transmitted to retail level with the predictable consequences on the consumption. The trends in retail prices of major pulses are presented in the Figure 3. The estimated retail price indices indicate the consistent rise in retail prices of pulses with varying rate across different pulses. The retails prices of most of the pulses were at peak level during the year 2016 which afterwards moved to downward side. The consistent rise in prices erodes affordability of consumers. Poor households who exhibit higher sensitivity to prices (higher price elasticity) are adversely affected by the price rise. As pulses demandis fairly stable in short run, the changes in prices are primarily driven by supply side factors.



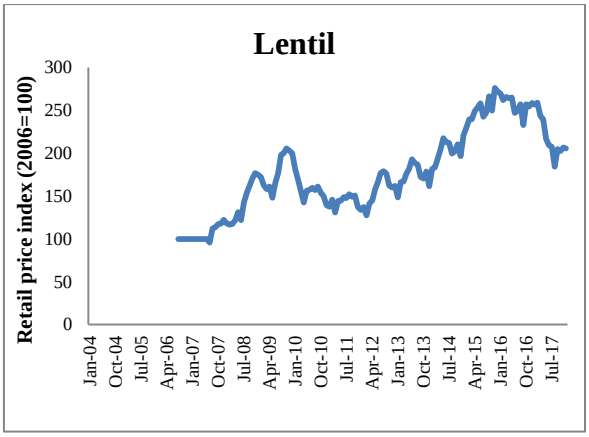


Figure 3.Trends in retail prices of pulses

5. Estimation of buffer stock norms for pulses

5.1. The primary purpose of maintaining buffer stock is to reduce sharp fluctuations in price of pulses and keeping prices in a fair range which is beneficial both for the farmers as well as for the consumers. The stock is built by procuring certain quantity of pulses from the domestic market during the period of high production or by importing and releasing during the period of deficit supply.

5.2. In the present context, buffer stock norm has been estimated based on the negative deviation of actual production from the normal (predicted from trend line) production at different levels of insulation during the reference period 1996-97 to 2016-17. The level of insulation is understood as the per cent of cases out of the number of years witnessing negative deviation in which buffer stock will augment domestic supply to make up for the fall in production. For instance, during the past 21 years, 11 years have witnessed negative deviation from the predicted production and the extent of deviation was highest (27.03 lakh tonnes) in the year 2002-03 (Appendix 1). Therefore, in order to provide a complete (100 per cent cases) insulation to the shortfall from the normal production, total quantity of 27.03 lakh tonnes is needed. If this shortfall is to be met entirely from domestic sources then buffer stock of 27.03 lakh tonne will be required (Table 4). Similarly, to cover the next insulation level of 91 per cent (10 out of 11 years witnessing negative deviation), 20.62 lakh tonnes buffer stock is required. The stock requirement for total pulses at different levels of insulation is presented in Table 4.

5.3. Buffer stock and trade are the two sources of stabilisation in supply and prices. Further, buffer stock can be built through procurement of domestic production and/or imports. Procurement from domestic market can be taken up during the years of higher production over the estimated normal level. The analysis reveals that extreme values of positive deviation in production were larger than extreme values of negative deviation in fifty per cent cases (Table 4). This implies that domestic market offers sufficient quantity to build the required buffer stock while the level of buffer stock would depend on level of insulation desired by the government. For instance, to provide 90 per cent level of insulation, buffer stock of 20.62 lakh tonnes can be built from the domestic

market during the year witnessing excess production. The evidences show that positive deviation crossed this level (20.62 lakh tonnes) during 30 per cent cases out of years of excess production. Assuming self-life of storage of pulses as two years, about 10 lakh tonnes of pulses can be released every year to the places of deficit supply/requirement and stock can be topped up with the fresh procurement from the places of excess production. In a few cases, possibilities of maintaining buffer stock through import can also be explored in the backdrop of higher demand over domestic production.

Table 4. Positive and negative deviation from predicted production at different insulation levels during 1996-97 to 2016-17

Negative deviation from trend line			Positive deviation from trend line		
Insulation level	**Stabilisation stock needed 000 tonnes**	**Year of occurrence**	**Incidence of occurrence (%)**	**Procurement potential 000 tonnes**	**Year of occurrence**
100	-2703	2002-03	10	4187	2016-17
91	-2062	2015-16	20	2489	1998-99
82	-2047	2000-01	30	2435	1996-97
73	-1634	2009-10	40	1593	2010-11
64	-1501	2005-06	50	1550	2013-14
55	-1403	2004-05	60	990	2012-13
45	-1377	2008-09	70	905	1997-98
36	-1040	2006-07	80	725	2003-04
27	-906	2014-15	90	648	1999-00
18	-829	2007-08	100	88	2011-12
9	-107	2001-02	-	-	-

5.4. During 1996-97 to 2016-17, average annual import of pulses in the country was 26.55 lakh tonnes which is 17.42 per cent of the average annual pulses production of 152.38 lakh tonnes during the same period. Past data shows that imports increased above the trend (normal level) in the event of fall in domestic production of pulses, and thus met a part of the shortfall. The average positive deviation in pulses import during the past two decades is estimated at 5.64 lakh tonnes. This quantity can be termed as 'imports meeting the stability requirement like buffer stock'. Thus role of buffer stock in maintaining price and supply stability is met to some extent by the increase in imports. As import is an important component of pulses supply, buffer stock can be augmented upto 5 lakh tonnes from increase in import above regular imports.

5.5. As discussed above it is possible to meet shortfall in domestic production to some extent by raising import above regular level. Import trend shows on an average, import exceeded trend by 5.64 lakh tonnes which implies that import can be raised to meet a part of increased shortfall in the domestic production from normal. Thus, buffer stock norms for pulses have been worked out by adjusting stabilisation quantity with positive deviation in import from trend import. Distribution of supply shortfall that needs to met using buffer stock and increase in import is shown in Table 5 for various levels of insulation. Possibility of meeting domestic shortfall arising out of production shortfall

through increase in import over the trend is kept at 564 thousand tonne. Accordingly, the remaining stability in supply has to be addressed through buffer stock. For perfect stabilisation India need total quantity of 2.7 million tonne. Out of this 0.564 million tonne can be met by higher import and remaining 2.1 million tonne need to be met through buffer stock. The stabilisation requirement change sharply at next level of stabilisation. India can maintain stability in domestic price in 91 per cent cases by maintaining buffer stock of 1.5 million tonne.

Table 5. Role of import and buffer stock to meet supply stabilisation of pulses, base 2016-17

000 tonnes

Insulation level	Quantity needed for stabilisation	Stabilisation quantity share in predicted production in 2016-17 (%)	Quantity available from increase in import for stabilisation	Buffer stock required for stabilisation
a	b	C	D	e (e=b-d if b≥ d else e=0 if b<d)
100	2703	14.4	564	2139
91	2062	11.0	564	1498
82	2047	10.9	564	1483
73	1634	8.7	564	1070
64	1501	8.0	564	937
55	1403	7.5	564	839
45	1377	7.3	564	813
36	1040	5.5	564	476
27	906	4.8	564	342
18	829	4.4	564	265
9	107	0.6	564	0*

* At 9 per cent level of insulation, positive deviation from import fully covers quantity needed for stabilization

5.6. The composition of buffer stock of pulses assumes a significant importance while deciding about procurement and other logistic requirements. To estimate composition of buffer stock of pulses above mentioned exercise of estimating stock at different insulation levels was repeated for individual pulses namely, arhar, gram, black gram, green gram, lentil and other pulses (Appendix 2 to Appendix 7). Composition of buffer stock was arrived at by estimating share of individual pulses in aggregated negative deviation at different levels of insulation. The shares of individual pulses were also adjusted with the share of respective pulses in total pulses imported during the past five years (2012-13 to 2016-17). The share of individual pulses in aggregate buffer stock of all pulses at different levels of insulation is presented in table 6.

Table 6. Composition of quantity needed to maintain stability in domestic supply at different levels of insulation

Insulation level	Buffer stock required for stabilisation (000, tonnes)	Share of individual pulses (%)					
		Arhar	Gram	Urd	Moong	Lentil	Others
100	2139	18	24	16	20	5	17
91	1498	19	30	19	12	4	16
82	1483	19	32	16	16	4	13
73	1070	22	33	12	18	3	12
64	937	24	29	13	20	3	10
55	839	25	34	15	15	4	7
45	813	27	35	13	15	3	7
36	476	45	26	3	11	4	11
27	342	46	29	2	12	4	7
18	265	49	29	0	13	0	9

Note: Level of insulation pertains to total pulses. For individual pulses, level of insulation would vary due to variation in extent and magnitude of negative deviation.

6. Projected buffer stock norms upto 2022

6.1 Quantity required for stabilisation will increase over time as domestic production and demand are moving on a rising trend. Buffer stock norms for various level of insulation against fluctuations in domestic production during 2017-18 to 2021-22 are presented in Table 7. In order to deal with any level of fluctuations the country requires total stabilisation produce of 2.75 million tonne in 2017-18 which rises to 2.96 million tonne by the year 2021-22. The buffer stock requirement works out to be 2.19 million tonne in year 2017-18 which rises to 2.4 mt by 2021-22 at 100 per cent level of insulation. In order to achieve 91per cent level of insulation, the stabilisation quantity is estimated to be 2.10 million tonnes for the year 2017-18 and 2.26 million tonnes for the year 2021-22. The buffer stock norm for 91 per cent insulation is estimated to be 1.5 million tonne during 2017-18 which increase to 1.7 million tonne by the year 2021-22.

Table 7. Projected buffer stock norms for the period 2017-18 to 2021-22, base 2016-17

000 tonnes

Insulation level	2016-17 (base)	2017-18	2018-19	2019-20	2020-21	2021-22
100	2139	2190	2240	2291	2342	2393
91	1498	1537	1576	1615	1653	1692
82	1483	1521	1560	1598	1637	1675
73	1070	1100	1131	1162	1192	1223
64	937	965	993	1022	1050	1078
55	839	865	892	918	944	971
45	813	839	865	891	916	942
36	476	496	515	535	554	574
27	342	359	376	393	410	427
18	265	281	296	312	327	343

7. Conclusions and Recommendations

7.1. Pulses production in India faces sharp year to year fluctuations causing violent price spikes and price crashes. Domestic trade has completely failed to address the issue of price stability and rather found to indulge in profiteering in such situations. India is regular importer of pulses while at the same time exporting small quantity of some pulses. Trade trend in pulses shows that imports generally meet regular shortfall between domestic consumption and production but could not address adequately the shortfall resulting from year to year fluctuations in domestic production. Thus the price shocks caused by shocks in domestic production need to be met by building buffer stock as done in the case of cereals.

7.2. Presently, country follows ad hoc policy of procurement of excess production for price stabilisation. Some procurement is also made to address price rise and concerns of consumers. As the need for maintaining stability in prices of pulses is rising there is a need for scientific basis for deciding reasonable level of stock to be used as a buffer for price stabilisation.

7.3. No country follows policy of complete or 100% stabilisation through buffer stock. As the level of stabilisation is raised the cost of stabilisation becomes higher. Therefore, it is suggested that India should go for the second highest level of stability instead of 100% stability. This implies that the proposed buffer stock are adequate to stabilise supply and prices in 91 per cent of the cases when domestic production falls short of normal production. It is important to mention that this level of insulation will be adequate for supply stability in 19 out of twenty years. Probability of production deviation from trend reveals that the need to have higher than 91% insulation will arise only once in 20 years and this raises buffer stock requirement by 31 per cent which is quite high. As such events are rare, they can be addressed through other means.

7.4. Trend in pulses production during the last 20 years show highest negative deviation of 2.70 million tonne which happened during the year 2002-03. The second highest deviation was 2.06 million tonne which corresponds to 11 per cent of normal production in the country for the year 2016-17.

7.5. The committee recommends that the country should target an arrangement for 2.06 million tonne of supply to address fluctuation in domestic production. Out of this 27.4 per cent (5.64 lakh tonnes) can be arranged by increase in imports and remaining 72.6 per cent need to be met by maintaining buffer stock build on procurement during above normal production.

7.6 The level of buffer stock of pulses to be maintained in the country for supply stabilisation during the next five years is estimated as under:

2017-18: 15.37 lakh tonne

2018-19: 15.76 Lakh tonne

2019-20: 16.15 lakh tonne

2020-21: 16.53 lakh tonne

2021-22: 16.92 lakh tonne

7.7 Major pulses produced in India include gram, arhar, urd, moong and lentil. These crops covered 85.9 per cent of pulses production in the country during biennium ending 2015-16. Pulses are the important source of protein for Indian and they are consumed as a general pulses and as a specific pulses. It is very difficult to estimate the extent of substitution among various pulses and demand for specific purpose pulses. Composition of buffer stock was estimated assuming some substitution among pulses and based on their share in aggregated estimated stock. The buffer stock should consist of gram, arhar, urd, moong, lentil and other pulses with their respective share of 30, 19, 19, 12, 4 and 16 per cent.

APPENDIX

Appendix 1. Deviation of actual production from predicted production in total pulses

(000 tonnes)

Year	Actual production	Predicted production (trend line)	Deviation
1996-97	14148	11713	2435
1997-98	12971	12065	905
1998-99	14907	12418	2489
1999-00	13418	12770	648
2000-01	11075	13123	-2047
2001-02	13368	13475	-107
2002-03	11125	13828	-2703
2003-04	14905	14180	725
2004-05	13130	14533	-1403
2005-06	13384	14885	-1501
2006-07	14198	15238	-1040
2007-08	14762	15590	-829
2008-09	14566	15943	-1377
2009-10	14662	16295	-1634
2010-11	18241	16648	1593
2011-12	17089	17000	88
2012-13	18343	17353	990
2013-14	19255	17705	1550
2014-15	17152	18058	-906
2015-16	16348	18410	-2062
2016-17	22950	18763	4187
Intercept	**11360**		
Slope	**353**		
Projected production			
2017-18		19115	
2018-19		19468	
2019-20		19821	
2020-21		20173	
2021-22		20526	

Appendix 2. Deviation of actual production from predicted production in Arhar

(000 tonnes)

Year	Actual production	Predicted production (trend line)	Deviation
1996-97	2660	2128	532
1997-98	1850	2182	-332
1998-99	2708	2236	472
1999-00	2694	2290	404
2000-01	2246	2344	-97
2001-02	2260	2398	-138
2002-03	2186	2452	-266
2003-04	2356	2506	-149
2004-05	2347	2560	-213
2005-06	2738	2614	124
2006-07	2314	2668	-354
2007-08	3076	2722	354
2008-09	2266	2776	-510
2009-10	2465	2830	-365
2010-11	2861	2884	-23
2011-12	2654	2938	-284
2012-13	3023	2992	31
2013-14	3174	3046	128
2014-15	2807	3100	-293
2015-16	2561	3154	-593
2016-17	4780	3208	1572
Intercept	2074		
Slope	54		

Appendix 3. Deviation of actual production from predicted production in Gram

(000 tonnes)

Year	Actual production	Predicted production (trend line)	Deviation
1996-97	5570	4696	874
1997-98	6132	4886	1246
1998-99	6801	5077	1724
1999-00	5118	5267	-149
2000-01	3855	5457	-1602
2001-02	5473	5648	-175
2002-03	4237	5838	-1601
2003-04	5718	6029	-311
2004-05	5469	6219	-750
2005-06	5600	6409	-809
2006-07	6334	6600	-266
2007-08	5749	6790	-1041
2008-09	7060	6980	80
2009-10	7476	7171	305
2010-11	8221	7361	860
2011-12	7702	7552	151
2012-13	8833	7742	1091
2013-14	9526	7932	1594
2014-15	7332	8123	-790
2015-16	7058	8313	-1255
2016-17	9330	8503	827
Intercept	4506		
Slope	190		

Appendix 4. Deviation of actual production from predicted production in Urd

(000 tonnes)

Year	Actual production	Predicted production (trend line)	Deviation
1996-97	1348	1142	206
1997-98	1378	1184	193
1998-99	1350	1227	123
1999-00	1331	1270	61
2000-01	1296	1313	-16
2001-02	1499	1356	143
2002-03	1474	1399	75
2003-04	1471	1441	30
2004-05	1327	1484	-158
2005-06	1245	1527	-282
2006-07	1443	1570	-127
2007-08	1457	1613	-156
2008-09	1175	1656	-481
2009-10	1236	1698	-463
2010-11	1779	1741	38
2011-12	1785	1784	1
2012-13	1971	1827	144
2013-14	1699	1870	-171
2014-15	1959	1912	47
2015-16	1945	1955	-10
2016-17	2800	1998	802
Intercept	1099		
Slope	43		

Appendix 5. Deviation of actual production from predicted production in Moong

(000 tonnes)

Year	Actual production	Predicted production (trend line)	Deviation
1996-97	1319	958	361
1997-98	950	991	-42
1998-99	1162	1025	137
1999-00	1077	1058	20
2000-01	1023	1091	-68
2001-02	1111	1125	-14
2002-03	867	1158	-291
2003-04	1702	1191	511
2004-05	1058	1225	-167
2005-06	946	1258	-312
2006-07	1115	1292	-176
2007-08	1523	1325	198
2008-09	1035	1358	-324
2009-10	692	1392	-699
2010-11	1862	1425	437
2011-12	1634	1459	176
2012-13	1186	1492	-306
2013-14	1606	1525	80
2014-15	1503	1559	-56
2015-16	1593	1592	1
2016-17	2160	1625	535
Intercept	924		
Slope	33		

Appendix 6. Deviation of actual production from predicted production in Lentil

(000 tonnes)

Year	Actual production	Predicted production (trend line)	Deviation
1996-97	962	916	46
1997-98	804	922	-118
1998-99	938	928	10
1999-00	1079	933	146
2000-01	915	939	-24
2001-02	974	944	30
2002-03	873	950	-77
2003-04	1038	956	82
2004-05	994	961	33
2005-06	946	967	-21
2006-07	913	973	-60
2007-08	812	978	-167
2008-09	953	984	-31
2009-10	1032	990	42
2010-11	944	995	-52
2011-12	1059	1001	58
2012-13	1134	1007	127
2013-14	1018	1012	5
2014-15	1035	1018	17
2015-16	976	1024	-48
Intercept	911		
Slope	6		

Appendix 7. Deviation of actual production from predicted production in Other Pulses

(000 tonnes)

Year	Actual production	Predicted production (trend line)	Deviation
1996-97	2290	1919	371
1997-98	1858	1938	-80
1998-99	1949	1957	-8
1999-00	2119	1976	143
2000-01	1739	1995	-256
2001-02	2051	2015	37
2002-03	1488	2034	-545
2003-04	2620	2053	568
2004-05	1935	2072	-137
2005-06	1909	2091	-182
2006-07	2079	2110	-31
2007-08	2146	2129	16
2008-09	2078	2148	-70
2009-10	1762	2167	-406
2010-11	2574	2186	387
2011-12	2254	2206	49
2012-13	2196	2225	-28
2013-14	2233	2244	-11
2014-15	2515	2263	252
2015-16	2216	2282	-66
Intercept	1900		
Slope	19		

Appendix 8. Negative deviation from normal production at different insulation levels

Arhar			Gram			Urd			Moong			Lentil			Others			Total
Insulation (%)	Stock[#]	Year	Insulation (%)	Stock[#]	Year	Insulation (%)	Stock[#]	Year	Insulation (%)	Stock[#]	Year	Insulation (%)	Stock[#]	Year	Insulation (%)	Stock[#]	Year	
100	-593	2015-16	100	-1602	2000-01	100	-481	2008-09	100	-699	2009-10	100	-167	2007-18	100	-545	2002-03	-4087
92	-510	2008-09	91	-1601	2002-03	89	-463	2009-10	91	-324	2008-09	89	-118	1997-98	92	-406	2009-10	-3422
85	-365	2009-10	82	-1255	2015-16	78	-282	2005-06	82	-312	2005-16	78	-77	2002-03	83	-256	2000-01	-2547
77	-354	2006-07	73	-1041	2007-08	67	-171	2013-14	73	-306	2012-13	67	-60	2006-07	75	-182	2005-06	-2114
69	-332	1997-98	64	-809	2005-06	56	-158	2004-05	64	-291	2002-03	56	-52	2010-11	67	-137	2004-05	-1779
62	-293	2014-15	55	-790	2014-15	44	-156	2007-08	55	-176	2006-07	44	-48	2015-16	58	-80	1997-98	-1543
54	-284	2011-12	45	-750	2004-05	33	-127	2006-07	45	-167	2004-05	33	-31	2008-09	50	-70	2008-09	-1429
46	-266	2002-03	36	-311	2003-04	22	-16	2000-01	36	-68	2000-01	22	-24	2000-01	42	-66	2015-16	-751
38	-213	2004-05	27	-266	2006-07	11	-10	2015-16	27	-56	2014-15	11	-21	2005-06	33	-31	2006-07	-597
31	-149	2003-04	18	-175	2001-02				18	-42	1997-98				25	-28	2012-13	
23	-138	2001-02	9	-149	1999-02				9	-14	2001-02				17	-11	2013-14	
15	-97	2000-01													8	-8	1998-99	
8	-23	2010-11																

*negative deviation of actual production from the trend line production in 000 tonnes