



Production and Trade Performance of Blackgram (*Vigna mungo*) and Greengram (*Vigna radiata*) in India and Myanmar

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Black gram and green gram are important legume crops in India and Myanmar. The largest producer of black gram and green gram is India but it does not meet domestic consumption. The study was conducted with time series data from the year 1970 to 2019 in order to work out the growth patterns in area, production, productivity, export and import of black gram and green gram. CAGR and instability was calculated in order to better understand fluctuations of black gram and green gram year by year. Area and production increased in both countries from the year 1970-71 to 2018-19. However, the yield of black gram and green gram was stagnant in India which was over 500 kg/ha in 2018-19 whereas the yield in Myanmar was more than 1000 kg/ha during the same period. The yield gap between India and Myanmar was about 800 kg/ha. With a growing population and often unfavorable seasonal conditions, the country's production regularly fell short of consumption needs requiring it to import large quantities of pulses. Cropping patterns like rice-pulses, intercropping with other crops and HYV can improve productivity and expand pulse areas in India. India is the largest importer of black gram and has greater bargaining power to dominate the black gram market in Myanmar. Trade agreement is needed to overcome the risks of price fluctuation between the two countries.

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1. INTRODUCTION

Black gram (*Vigna mungo*) or Urad is widely cultivated in India, Myanmar and other countries due to their tropical climates and the type of soil in which the black gram is grown. The largest producer of black gram is India but it does not meet domestic consumption. The insufficient production of pulses in India also makes it the largest importer of black gram. Urad can be found in various forms in Indian dishes. In Myanmar, black gram is the second largest cultivated and exportable crop, which in local term “mat-pe”, black gram is used in soups, fried snacks, curries, and various side dishes [1,2]. Moreover, black gram is profitable pulses crop in Myanmar because it is cultivated in both monsoon and winter seasons and mainly planted after monsoon paddy on residual moisture. Being a short duration crop, farmers’ awareness on black gram production is always high annually. High import demand from India is also a main factor why farmers want to grow black gram in Myanmar. Therefore, 80 per cent of overall production continued to be exported [3,4].

Green gram (*Vigna radiata*) is another staple pulse and important crop in India. It is also a short-lived leguminous crop that is mostly grown as a fallow crop in rotation with rice. Similar to leguminous pulses, green gram enriches nitrogen content. It is traditionally grown in the Asian region, while its cultivation has spread to Africa and America relatively recently. India is the world's largest green gram producer and this crop is grown in every state. Although the area and production had been high during the last five decades, the yield was stagnant (around 500 kg/ha) and the lowest yield among the major pulses crops in India. Because of global market demand; the green gram is a distinct export crop in Myanmar [5,6]. The Myanmar people called it “pe-di-sein”; green gram is locally consumed in the form of grain and flour. However, local consumption is significantly less than production. Therefore, it is important to know the gap between the production and trade between the two countries. For a better understanding of the production and trade scenario between the two countries, the present study was attempted with specific objectives: (1) to work out the trends in area, production and productivity of black gram and green gram and (2) to analyze the export-import scenario of black gram and green gram.

2. MATERIALS AND METHODS

Time series data were collected from 1970-71 to 2018-19 to show trends in area, production and productivity of black gram and green gram for both countries. Data from INDIASTAT for India, Indian Institute of Pulses Research (IIPR) and Department of Agriculture (Myanmar) for Myanmar were used to analyze compound annual growth rate and instability. Yet, the data from 1970 to 1990 for Myanmar was not able to access due to some restrictions. Similarly, data on the black gram and green gram trade from 1988 to 2019 was also collected for India and Myanmar from UN COMTRADE, APEDA and CSO to analyze growth rate of black gram and green gram export and import.

To study the decadal growth patterns, overall area, production and productivity growth patterns, and in order to better understand the fluctuations in the growth of black gram and green gram year by year, the study period (1970-71 to 2018-19) was divided into (1) period-I (1970-71 to 1979-80); (2) period-II (1980-1981 to 1989-90); (3) period-III (1990-1991 to 1999-2000); (4) period-IV (2000-01 to 2009-2010); (5) period-V (2010-11 to 2018-19); and (6) overall period (1970-71 to 2018-19).

3. RESULTS AND DISCUSSION

3.1 Trends in Area, Production and Yield of Black Gram in India and Myanmar

The area of black gram in case of India increased by a huge amount from 2,067 thousand ha to 5,602 thousand ha, which almost doubled during the study period (1970-71 to 2018-19). The area was increasing from the year 1970-71 to 1990-2000, but later it decreased in the year 2000-01, and then it increased again in the year 2010-11 and 2018-19 (Table 1). This was due to a high degree of substitution from gram to black gram [7]. Production also increased as the area expanded from 656 thousand tons in 1970-71 to 3,060 thousand tons in 2018-19. Although the area and production increased significantly, it is clear that the yield increased by a moderate amount from 317 kg/ha to 546 kg/ha between 1970-71 and 2018-19. Area, production and yield recorded the maximum in the recent year 2018-19, as it produced 3,060 thousand tons covering an area of 5,602 thousand ha with a yield of 546 kg/ha.

Table 1. Area, production and yield of black gram in India and Myanmar

		1970-71	1980-81	1990-91	2000-01	2010-11	2018-19	Percentage Change in 2018-19 over 1970-71
India	Area	2067	2830	3483	3011.3	3266.8	5602.47	171.04
			(36.91)	(50.04)	(-13.54)	(8.48)	(71.50)	
	Production	656	959	1646	1296.4	1778.8	3059.99	366.46
			(46.19)	(103.23)	(-21.24)	(37.21)	(72.03)	
	Yield	317	339	473	431	544.5	546	72.24
			(6.94)	(46.02)	(-8.88)	(26.33)	(0.28)	
Myanmar	Area	-	-	136.44	611	1055.27	946.82	593.95
					(347.82)	(72.71)	(-10.28)	
	Production	-	-	98.7	532	1558.8	1356.45	1274.32
					(439.00)	(193.00)	(-12.98)	
	Yield	-	-	723	870	1472	1432	98.06
					(20.33)	(69.20)	(-2.72)	

*Figures in parenthesis indicate decadal percentage change
Area – Thousand hectares, Production – Thousand Tons, Yield – kg/ha
Source: Indiatat,2019, DOA,2019*

The percentage change in area, production and yield of black gram in India was observed as 171.04 per cent, 366.46 per cent and 72.24 per cent, respectively during the period 1970-71 to 2018-19. The decadal percentage change in area, production and yield also showed an increase in the years 1980-81, 1990-91, and 2018-19. Decadal percentage change in yield was occurred decreasing (-13.54 per cent in the area, -21.24 per cent in production and -8.88 per cent in yield) in 2000-01. In 2010-11, the decadal percentage change in area, production, and yield was slightly lower than in other periods.

Compared to India, Myanmar recorded the highest in black gram production. There was a significant increase in the area during the period 1990-91 to 2018-19 (from 136.44 thousand ha to 947 thousand ha). In 2018-19, black gram production was 1,356 thousand tons, which was ten times higher than that of 1990-91. The black gram yield also showed gradual improvement from 723 kg/ha in 1990-91 to 1432 kg/ha in 2018-19. The maximum area (1,055 thousand ha), production (1,558 thousand tons) and yield (1,472 kg/ha) were found in 2010-11. The yields of the black gram were more than 1 ton/ha depending on soil type and availability of supplementary irrigation [8]. Obviously, the area under black gram was much less compared to India, as it produced half of India's black gram production in the recent year and the yield also showed twice as that of India in each decade. The increase in pulses production in Myanmar was driven not only by the area harvested, but also by the yield, which has also shown significant growth since 1989 [9].

3.2 Growth Rate of Black gram in India and Myanmar

The results of the growth rate of black gram from 1970 to 2019 for India and from 1990 to 2019 for

Myanmar showed that there was an increasing growth rate in India, except for the third and fourth decades (Table 2). The growth rate of area increased from 2.43 per cent in period-I to 7.79 per cent in period-V. Likewise, the growth rate of production also increased from period-I (2.66%) to period-V (8.77%) except in period-III and IV. The highest growth was found in period-V due to the significant expansion of area and production over the past forty-nine years. But yield growth was lower compared to period-II. The decreasing growth of production in period III was found at -6.93 per cent with declining area performance (-1.57%) and yield (-0.32%). The highest yield growth was observed in the period-II compared to the other periods. The growth rate in the overall period has been weak compared to the last decade which may be due to fluctuated area, production and yield.

The growth of performance of Myanmar for black gram showed high in area (14.98 %) and production (17.13%) in period-III where India had low growth in all the particulars during this period. The yield of the growth was not much high in this period. However, the yield growth increased in the next period (period-IV) up to the extent of 6.25 per cent while area and production growth declined. In the decade of 2010-19, the growth of area and production declined. But there was an opposite case in India. The growth performance of area and production was the highest in the last period (2010-19). When we examine in all the periods for both countries, despite India has vast area and production than in Myanmar as well as in the world, its yield showed very less compared to others. The yield of Myanmar was the highest among the major black gram producing countries including India from 1994 to 2008 [10]. CAGR of area, production and yield of black gram showed highly significant in all the periods in both countries.

Table 2. Growth rate (CAGR) of black gram in India and Myanmar

Period	India			Myanmar			Per cent)
	Area	Production	Yield	Area	Production	Yield	
Period-I	2.43*	2.66*	0.24*	-	-	-	
Period-II	2.12*	5.74*	3.54*	-	-	-	
Period-III	-1.57*	-6.93*	-0.32*	14.98*	17.13*	1.88*	
Period-IV	-1.55*	-1.39*	0.15*	5.62*	12.17*	6.25*	
Period-V	7.79*	8.77*	0.91*	-1.02*	-0.79*	0.20*	
Overall (1970-2019)	1.17*	2.43*	1.30*	6.27*	9.71*	3.24*	

* Significant at 1% level of significance, Source: Indiastat,2019, DOA, 2019

3.3 Instability of Black Gram in India and Myanmar

In the case of India, higher fluctuation was revealed across all periods. In the first period, area fluctuation showed noticeably 10.87 per cent but decreased in the next three periods as 7.11, 7.57 and 8.13 per cent, respectively. However, production variability increased between the first three decades, reaching 10.58, 18.24 and 26.76 per cent in the period-I, II and III. Between 1990 and 2010, the black gram area grew with replacement to the areas of other major pulses such as gram. As a result, production fluctuated with the unstable yield. The same situation was observed in the area in period-IV where the variability of the area, production and yield were the lowest in all periods (Table 3). During the fifth period (2010-19), a variation of 25.33 per cent in area, 29.12 per cent in production and 8.02 per cent in yield were noted.

The maximum fluctuation was found in period-V with 25.33 per cent in the area and 29.12 per cent in production while the maximum yield fluctuation (11.62 %) was found in the period-II. Yield variability also increased from 7.21 per cent to 11.62 per cent in the first two periods and again declined into 8.02 per cent in period-V. The variability of the black gram in the overall period recorded the highest level in production and yield, while the variability in the area was the highest in period-V. Since black gram is the most exportable pulse to India, import policy from India is one of the fact which leads to volatile instability and growth in production.

3.4 Trends in area, Production and Productivity of Green Gram in India and Myanmar

During 1980-81, the decadal percentage change in green gram's area in the case of India was 37.61 per cent. During the same period, production was 979 thousand tons (39.66%), with a yield of 344 kg/ha (1.47%). Table 4 shows an increase in the green gram area from 2066 thousand ha to 4,755 thousand ha with a percentage change of 130.15 per cent during the year 1970 to 2019, with an upward trend. Production also appeared with the expansion of the area during the study period. It was because the area under green gram in all the major producing states has sharply increased. Likewise, yield of green gram increased by a range of 339 kg/ha and 516 kg/ha with a

percentage change of 52.21 per cent. However, the yield performance of green gram was poor compared to other major pulses. Rawal and Navarro (2019) revealed that the reasons for lower yields in India were insufficient adoption of improved cultivars and agricultural practices. Mung beans and urd beans were often planted with corn, sorghum, cotton and pigeonpea. Due to the short ripening period of mung and rice, these are usually the first crops harvested from the field. The density of cultivation of urd and mung beans in such sown fields was lower than that of mono-cultivated fields with urd and mung. The usage of pesticides and irrigation was minimal on mung bean farms. Most farmers used local seeds and adoption of improved varieties was low. With the results of the lower yield, India has become increasing dependent on imports for its requirement. Decadal percentage change in area, production and yield was also declining in 2000-01 while other periods had increasing percentage change. The highest performance was recorded in the recent year (2018-19).

As with the black gram, green gram data are available from 1990 to 2019 as production has been increasing significantly with area and yield in Myanmar. In 2018-19, the area of green gram (1165.79 thousand ha) was increasing ten times higher compared to 1990-91. Production and yield increased significantly during the study period, as production increased from 61.9 thousand tons to 1454.87 thousand tons, and the yield increased from 568 kg/ha to 1239 kg/ha. This growth was made possible by the adoption of improved cultivars that enabled the cultivation of pulses after rice harvest, using residual soil moisture (Rawal and Navarro,2019). The cultivation of urd and mung in Myanmar was almost entirely rain-fed.

The percentage change of area, production and productivity of green gram in Myanmar was recorded as 970.51 per cent, 2250.36 per cent and 118.13 per cent during the period 1990-01 to 2018-19. Decadal percentage change of area, production and productivity was found to be declined during the study periods. It is noteworthy to observe that although area and production have been increasing, decadal percentage change was found to decrease during the observed years. When comparing with India, the decadal percentage in area, production and productivity of Myanmar was higher than that of India except in 2018-19, however, decadal percentage change of India was fluctuated from 1970-71 to 2018-19.

Table 3. Instability (CV) of black gram in India and Myanmar**(Per cent)**

Period	India			Myanmar		
	Area	Production	Yield	Area	Production	Yield
Period-I	10.87	10.58	7.21	-	-	-
Period-II	7.11	18.24	11.62	-	-	-
Period-III	7.57	26.76	5.57	37.85	42.38	60.80
Period-IV	8.13	8.77	4.42	16.73	33.70	18.56
Period-V	25.33	29.12	8.02	6.84	13.84	11.15
Overall (1970-2019)	23.05	44.69	21.11	42.82	61.71	28.48

Source: *Indiastat, 2019, DOA, 2019*

3.5 Growth Rate of Green Gram in India and Myanmar

It could be seen that the growth of green gram production has increased significantly from 3.60 per cent to 5.03 per cent in India during the aforementioned year except for the period-III (-3.01%) and the fourth (-1.44%). Yield growth was relatively stagnant upon examination of the period as decreasing yield growth was found in the third (-1.77%) and fourth (-1.64%) periods. The growth rate of area decreased from 3.41 per cent in period-I to 1.75 per cent in period-II and then declined in period-III. In period III, declining growth in production has been found due to declining area and yield growth. The growth rate was the highest in period-V, at 3.74 per cent in area, 5.03 per cent in production and 0.17 per cent in yield. The growth rate of area and production in the overall period (1970-2019) was not shown much higher than period-I, period II and period-V (Table 5).

In the case of Myanmar, the rate of growth of area and production was very high in the decade 1990-00 as yield growth showed lower performance compared to area and production. The opposite case was found with India where it has decreasing growth in period-III. This may be due to liberalization of the pulse marketing and production after 1988. There was a reverse case in India where the growth of all the particulars was the lowest in this decade. A gradual decline of area (5.49%) and production growth (11.87%) in period-IV excluding yield growth (6.17%) was the highest in this period. The lowest growth rate was examined in period-V as it was 1.37 per cent in area, 2.07 per cent in production and 0.23 per cent in yield. Myanmar's growth rate from 1990 to 2019 was higher than that of India, while India's growth rate was lower and weak. Myanmar's overall period showed remarkably

high but still below the growth rate in the decade 1990-00. The growth rate of green gram indicated significant at 1% level of significance in all the decades for both countries.

3.6 Instability of Green Gram in India and Myanmar

Instability in production (26.64%) and yield (19.88%) of green gram in the case of India showed the highest in the fourth period with the exception of area variability (8.41%) which was the highest in period-V (14.33%). Variability in the area was decreasing from period-I to the period-IV and increased again in period-V. However, variability in the case of production and yield was decreasing from period-I to period-III, then increased in period-IV and then decreased again in period-V. It is evident from the results between time periods, that variability in production was higher than area and yield. Variability in the overall period was marked with the highest with the exception of the yield which was the highest in period-IV.

When examining the results in case of Myanmar, the highest level of variability was found in period-III while the yield variability (13.44%) of this period was lower than period-IV (18.07%). It was interesting to note that production variability was higher than area and yield in all periods and was similar to India. It can also be seen that except for the period-V, variability in the case of Myanmar in all the particulars was much higher than that of India. However, there was an exceptional case where yield variability in India (19.88%) in the period 2000-10 was higher than that of Myanmar (18.07%). Both countries revealed that the reasons for the increased production variability were mainly due to the uncertainty in the area.

Table 4. Area, production and yield of green gram in India and Myanmar

		1970-71	1980-81	1990-91	2000-01	2010-11	2018-19	Percentage Change in 2018-19 over 1970-71
India	Area	2066	2843	3355	3008	3610	4755	130.15
			(37.61)	(18.01)	(-10.34)	(20.01)	(31.72)	
	Production	701	979	1384	1023	1862	2455	250.21
			(39.66)	(41.37)	(-26.08)	(82.01)	(31.85)	
	Productivity	339	344	413	340	516	516	52.21
			(1.47)	(20.06)	(-17.68)	(51.76)		
Myanmar	Area	-	-	108.9	706	1121.34	1165.79	970.51
					(548.30)	(58.83)	(3.96)	
	Production	-	-	61.9	519	1371	1454.87	2250.36
					(738.45)	(164.16)	(6.12)	
	Productivity	-	-	568	736	1259	1239	118.13
					(29.58)	(71.06)	(-1.59)	

*Note: Figures in parenthesis indicate decadal percentage change
Area – Thousand hectares, Production – Thousand Tons, Yield – kg/ha
Source: Indiastat,2019, DOA,2019*

Table 5. Growth rate (CAGR) of green gram in India and Myanmar (Per cent)

Period	India			Myanmar		
	Area	Production	Yield	Area	Production	Yield
Period-I	3.41*	3.60*	0.18*	-	-	-
Period-II	1.75*	2.81*	1.03*	-	-	-
Period-III	-1.27*	-3.01*	-1.77*	21.74*	25.09*	3.55*
Period-IV	0.21*	-1.44*	-1.64*	5.49*	11.87*	6.17*
Period-V	3.74*	5.03*	0.17*	1.37*	2.07*	0.23*
Overall (1970-2019)	1.09*	1.68*	0.64*	6.88*	10.38*	3.27*

* Significant at 1% level of significance

Source: Indiastat,2019, DOA, 2019

Table 6. Instability (CV) of green gram in India and Myanmar (Per cent)

Period	India			Myanmar		
	Area	Production	Yield	Area	Production	Yield
Period-I	11.33	16.76	10.20	-	-	-
Period-II	6.36	12.55	8.82	-	-	-
Period-III	7.40	13.71	10.92	51.14	55.17	13.44
Period-IV	8.41	26.64	19.88	16.59	33.23	18.07
Period-V	14.33	21.62	7.14	4.73	7.58	2.74
Overall (1970-2019)	18.52	34.14	18.32	43.54	61.27	27.39

Source: Indiastat.2019, DOA,2019

Table 7. Growth rate (CAGR) of black gram and green gram export and import from India (Per cent)

Period	Export		Import	
	Quantity	Value	Quantity	Value
1988-1998	-9.35*	-14.46*	16.6*	-5.00*
1998-2008	24.33*	25.67*	9.43*	13.27*
2008-2019	109.54*	122.23*	22.8*	17.42*
1988-2019	24.77*	28.94*	15.5*	17.62*

* Significant at 1% level of significance

Source: UN COMTRADE,2019

3.7 Export-import Scenario of black Gram and Green Gram in India

India exported a large quantity of pulses, around 10.16 thousand tons in 1988. Among these, the exported quantity and value of black gram and green gram was only 0.16 thousand tons and 0.14 US\$ million in 1988 (Appendix I). The export of black gram and green gram was lower compared to other major pulses. The export quantity and value of black gram and green gram was stagnant during the year 1988 to 2016 and it increased 21.75 thousand tons with a value of 24.87 US\$ million in 2019. It achieved a significant rise in 2019 due to the well-improved production in 2018. The share of exported quantity and value was 1.53 per cent and 1.79

per cent respectively in 1988 and of late 10.65 per cent and 12.98 per cent, respectively in 2019. USA ranked first in importing black gram and green gram from India during the study period followed by Canada, UK, UAE and Sri Lanka.

Myanmar ranked first in importing black gram and green gram to India. India has long been dominated as Myanmar's main pulses export destination, especially black gram, green gram. In addition, other African countries such as Tanzania and Mozambique stood behind Myanmar as their individual share of imports was 1-15 per cent. Unlike export, the import of black gram and green gram showed with an increasing trend during the study period (Appendix II). The

imported quantity and value was significantly increased from 2006 to 2019 with a quantity of 256.18 thousand tons and a value of 174.16 US\$ million. The highest imported quantity and value was found in 2018 indicating 487.11 thousand tons and 274.48 US\$ million. The imported quantity declined in 2019 due to restriction by the Government of India in the import of pulses with a strict quota for black gram and green gram. Although the imported quantity from Myanmar decreased, the import from other major sources was very less compared with Myanmar. The share of black gram and green gram in total pulses import was 2.29 per cent in 1988 and 20.35 per cent in 2018.

3.8 Export of Black Gram and Green Gram from Myanmar

From less than 1 million ton in 1990, exports increased to 1.2 million tons in 2019. Among the major pulses, black gram and green gram dominated huge amount in the international market where 70-80 per cent was shipped to India followed by Malaysia, Japan, China and Sri Lanka. The exported quantity was increasing annually with the largest volume reaching 754 thousand tons in 2014 (Appendix III). Although Myanmar had no place in the international market before 2000, it has become one of the largest exporters of black gram and green gram in the world. The share of black gram and green gram in total pulses export in Myanmar was around 23 to 60 per cent during the year 2006 to 2019.

3.9 Export-import Growth rate of Black Gram and Green Gram from India

To calculate the growth rate, data for exports and imports of black gram and green gram in India from 1988 to 2019 are used where the time periods are divided into (1) 1988-1998 (2) 1998-2008 (3) 2008-2019 and (4) 1988- 2019 (overall). The fluctuation in the quantity of exports can be seen clearly at the beginning from 1988 to 1998 where the growth rate of black gram and green gram export showed declining (-9.35%) in the first period 1988-1998 and increasing at the rate of 24.33 per cent in the second period (1998-2008). The growth rate of black gram and green gram export was the highest in period-III (2008-2019) (109.54%). The overall period showed with the growth of 24.77 per cent in volume and 28.94 per cent in value (Table 7).

The increase in quantity of imports can be witnessed from 1988 to 1998, when import was

found at a rate of 16.6 per cent in period-I (1988-1998). In this period, the growth rate of black gram and green gram imported value was declining (-5.00%). The growth rate of imported quantity and value showed increasing where period-III (2008-2019) had the highest growth rate (22.8 % in volume and 17.42% in value). The overall growth rate indicated with a volume of 15.5 per cent and 17.62 per cent in value. It should be noted that the growth rate of the exported value showed higher than the quantity exported whether decreased or increased. However, the imported value was less than that of volume in period-I and period-III whereas imported value was higher than that of imported quantity in period-II and overall period. The growth rate of black gram and green gram in terms of quantity and value was found significant at 1% level of significance in export as well as import in India.

4. CONCLUSION

India produced pulses based on needs. With a growing population and often unfavorable seasonal conditions, the country's production regularly fell short of consumption needs requiring it to import large quantities of pulses. However, during favorable seasonal conditions, their export needs diminished. India was able to significantly influence trade prices of pulses and Myanmar was highly dependent on Indian import decisions [9]. An example is a decision taken by India in August 2017 to place an import quota on imports of pulses from a number of countries. This decision represented 20 per cent decrease in green gram. With producer prices already low and heavy reliance on India for export, this is likely to have a significant impact on the livelihoods of Myanmar's pulse producers. India is likely to remain Myanmar's largest pulses export destination given India's dominance of global pulses imports as well as import growth. However, to reduce the risks associated with relying on a single export market, Myanmar can also focus on expanding its pulses export markets to Europe, China, Pakistan and Turkey as these countries are also sizable pulses markets.

Black gram and green gram are the two predominant legumes in Myanmar in terms of production and cultivated area. The increase in black gram and green gram production in Myanmar was not only driven by the area harvested, but also by the yield, which has also shown significant growth since 1989. The current

average yield is about 1432 kg/ha in black gram and 1239 kg/ha in green gram. This reported yield was higher compared to other pulse producing Asian countries including India. The yield gap between India and Myanmar was about 800 kg/ha. If crop patterns like rice-pulses, intercropping with other crops and high improved varieties can improve productivity and expand areas of pulses in India. India is the largest importer of black gram and has greater bargaining power to dominate the black gram market of Myanmar. Therefore, government of Myanmar and related institutions need to find alternative international markets. To penetrate other international markets, the quality and standards of black gram have become crucial factors for Myanmar farmers. Moreover, a trade agreement between the two countries would be needed to compensate for the risks to local farmers and traders.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Appendix I

Export of black gram and green gram from India

Quantity – Thousand tons

Value – US\$ million

Year	Black gram and Green gram export		Total pulses export		% share in total pulses export	
	Quantity	Value	Quantity	Value	Quantity	Value
1988	0.16	0.14	10.16	7.93	1.53	1.79
1989	-	-	13.14	90.85	-	-
1990	0.01	0.01	15.47	10.13	0.06	0.1
1991	0.05	0.04	25.86	15.91	0.20	0.25
1992	0.03	0.02	34.35	20.63	0.09	0.07
1993	-	-	43.62	23.47	-	-
1994	0.02	0.01	50.72	28.81	0.04	0.05
1995	0.01	0.0003	61.36	39.29	0.002	0.001
1996	0.03	0.01	55.15	37.06	0.05	0.02
1997	0.28	0.18	170.81	97.13	0.16	0.18
1998	0.01	0.01	103.92	53.00	0.01	0.019
1999	0.02	0.01	194.20	97.45	0.01	0.01
2000	0.01	0.01	228.40	111.83	0.004	0.01
2001	0.34	0.18	166.26	81.75	0.21	0.22
2002	0.68	0.24	161.72	77.8	0.42	0.3
2003	0.86	0.68	162.59	74.18	0.53	0.91
2004	0.04	0.02	207.82	101.98	0.02	0.02
2005	0.21	0.13	448.58	242.52	0.05	0.05
2006	0.64	0.46	316.73	206.15	0.20	0.22
2007	0.11	0.11	183.49	142.07	0.06	0.08
2008	0.06	0.04	112.05	101.42	0.05	0.04
2009	0.02	0.01	94.44	79.11	0.02	0.01
2010	0.002	0.002	232.62	193.3	0.001	0.001
2011	0.47	0.80	181.25	228.49	0.26	0.35
2012	1.54	1.90	150.27	190.82	1.03	1
2013	1.63	2.09	409.93	357.12	0.40	0.59
2014	2.77	3.91	236.72	208.41	1.17	1.88
2015	6.68	10.42	217.61	209.11	3.07	4.98
2016	9.08	16.64	175.53	217.27	5.17	7.66
2017	15.88	19.93	136.86	198.19	11.61	10.05
2018	17.62	19.01	315.96	291.92	5.58	6.51
2019	21.75	24.87	204.18	191.56	10.65	12.98

Source: UN Comtrade, 2019

Appendix II

Import of black gram and green gram from India

Quantity – Thousand tons

Value – US\$ million

Year	Black gram and Green gram import		Total pulses import		% share in total pulses import	
	Quantity	Value	Quantity	Value	Quantity	Value
1988	19.68	7.58	858.40	282.47	2.29	2.68
1989	8.39	3.45	536.78	154.42	1.56	2.23
1990	34.96	10.39	1361.07	295.21	2.57	3.52
1991	12.29	3.6	366.25	121.37	3.36	2.97
1992	10.19	3.91	388.59	130.93	2.62	2.99
1993	15.85	5.36	652.98	186.34	2.43	2.88
1994	43.93	16.87	582.12	198.74	7.55	8.49
1995	62.41	27.35	502.23	211.59	12.43	12.93
1996	12.55	5.11	692.43	264.76	1.81	1.93
1997	22.32	7.78	1084.38	343.88	2.06	2.26
1998	12.02	4.37	628.79	188.69	1.91	2.31
1999	12.69	5.14	269.26	89.37	4.71	5.76
2000	22.61	11.29	261.24	86.59	8.66	13.04
2001	25.41	9.89	1842.44	559.69	1.38	1.77
2002	33.87	12.27	2334.49	659.26	1.45	1.86
2003	168.81	58.68	2068.93	583.10	8.16	10.06
2004	116.05	40.03	1580.76	466.38	7.34	8.56
2005	45.51	22.82	1818.78	584.61	2.50	3.9
2006	256.18	174.16	2207.01	871.38	11.61	19.98
2007	394.29	267.34	2788.81	1273.76	14.14	21
2008	367.05	237.68	2623.22	1459.46	13.99	16.29
2009	673.97	560.38	3757.02	2062.01	17.94	27.18
2010	520.68	615.55	2999.91	1865.61	17.36	33
2011	414.87	387.20	3221.94	1850.67	12.88	20.92
2012	536.01	390.7	3815.74	2272.32	14.05	17.19
2013	655.15	469.77	3800.86	2291.17	17.24	20.5
2014	653.40	585.53	4517.34	2684.92	14.46	21.81
2015	595.15	687.60	5413.89	3637.61	10.99	18.9
2016	577.69	711.06	6185.09	4017.16	9.34	17.7
2017	437.58	366.34	7002.68	3947.3	6.25	9.28
2018	487.11	274.48	2393.98	1075.71	20.35	25.52
2019	373.67	251.07	3218.07	1553.17	11.6	16.17

Source: UN Comtrade, 2019

Appendix III

Export of black gram and green gram from Myanmar

Quantity – Thousand tons

Value – US\$ million

Year	Black gram and Green gram's export		Total pulses export		% share in total pulses export	
	Quantity	Value	Quantity	Value	Quantity	Value
2006	274.81	181.6	1156	609	23.77	29.82
2007	442.17	286.04	1141	628	38.75	45.55
2008	463.86	289.34	1451	744	31.97	38.89
2009	586.51	462.26	1232	930	47.61	49.71
2010	534	567.71	829	800	64.41	70.96
2011	427.68	415.27	1296	986	33	42.12
2012	524	380	1353	1484	38.72	25.63
2013	708	513	1132	743	62.56	69.01
2014	754	691	1242	951	60.70	72.63
2015	611	711	1020	990	59.86	71.80
2016	522	699	1033	1046	50.57	66.78
2017	495	449	1372	918	36.08	48.87
2018	529.23	364.78	1333	736	39.70	49.56
2019	517.07	427.41	1272	912	40.65	46.87

Source: APEDA,2019 and CSO,2019

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