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Trends and prospects of pulses and implications for nutrition

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Abstract

The ratio of per capita availability of cereals and pulses has changed from 1: 0.152 during 1961-1965 to 1: 0.108 during 2011-2013. This implies that for every kg of cereals consumed in the country, the amount of pulses consumed has reduced to 71 per cent during the last fifty years. The decline in status of pulses production has distorted the dietary balance, aggravating the already existing under nutrition and malnutrition. Through this paper we try to explore the causes for the slow growth in the production of pulses and its role in the Indian agrarian economy. We also try to understand whether the changes in dietary balance have been voluntary or forced by availability. Lastly, we try to investigate whether pulses help in addressing the issues of under nutrition and malnutrition in the country, or should we be complacent with food security based on rice and wheat alone.

Key words: Pulses, production, nutrition, Indian agrarian economy

Introduction

Pulses play an important role in the Indian diet and in India's agrarian economy. The average Indian meal constitutes wheat or rice in combination with pulses. Pulses, being a rich source of protein, complement cereals in the diet, and, in a country where the vegetarian diet is common practice, pulses are essential in providing the necessary amino acids required for the development of human body and maintenance of health. For the agrarian economy, pulses constitute 7 per cent of output of crop sector in value terms, and are cultivated on more than 12.9 per cent of the country's total cultivated area. In addition to their importance in production, pulses are valued for their special characteristics and benefits of being legume crops. Pulse crops are able to utilize limited soil moisture and nutrients more efficiently than cereals. Further, their ability to fix atmospheric nitrogen enhances their significance as crops suited for dry and rain-fed areas, and for improving soil fertility, which has been displaying slow deterioration. Pulses are especially suitable for areas that require low external inputs, and form part of sustainable agriculture.

The production of pulses, however, has faced a big setback since the onset of green revolution in the country. The average annual production of pulses was 11.7 million tonnes during the five years ending with 1965-66, the years preceding green revolution, and it merely increased to an average of 17.52 million tonnes per year, during the recent five years ending with 2013-14. This shows that the production of pulses increased by about 49 per cent during the past nearly 50 years from the onset of the green revolution. In comparison, the population of India increased by 167.47 per cent, during the same period. Consequently, per capita availability of pulses fell from about 69 grams per day in 1961 to about 40.1 grams in the past five years ending 2013 including large quantity of imported pulses.

In contrast, India was able to raise cereal production substantially during the same period. The increase in cereal production was about 327.6 per cent during the same period, significantly higher than the growth witnessed in the population. Within cereals, the highest increase was witnessed in the case of wheat, whose production increased by 771 per cent during between 1960 and 2013. The magnitude of difference in growth of production of pulses and wheat can be sensed from the fact that presently, the total wheat production, which is now about five times the quantity of pulses in production, was lower than the production of pulses in the pre-green revolution period.

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This increase in cereal production has helped India eliminate its dependency on imports, achieve self-sufficiency in staple foods, improve per capita availability of cereals and emerge as a net exporter of cereals. The main source of this growth in cereal production has been the high yielding varieties, which gave much higher yield as compared to the traditional varieties, and, which also induced shift in area under production, in favour of wheat and rice. There was, however, no similar breakthrough in pulse technology, and yields remained at low levels. In fact, the imports of pulses was one of the highest in the past few years, still indicating a strong domestic demand as well as scarcity of the same. Meanwhile, this change in the production mix of cereals and pulses has had important implications for the nutritional requirements of people of this country. Hence, a relook is required in understanding the existing gaps in pulse production and where they are coming from, while identifying their future role in insuring for nutritional requirements of the Indian population.

Agrarian significance of pulses in India: Key macro trends

With the onset of green revolution in the mid-sixties, farmers in India started growing new high-yielding varieties (HYVs) of wheat, which were much more profitable than the traditional varieties and as compared to other competing crops. This set the stage for shifting the area under production in favour of wheat, where conditions were favourable for adoption of HYV of wheat (Mohanty and Satyasai 2015). This was followed by the adoption of HYV of paddythat spread across the country. This breakthrough in food production technology, lead to a significant shift in area from pulses thereby hampering its production, and the associated lag in the improvement of yield, over the years.

National level trend in pulse production

Broad trends in area under pulses, production and productivity since 1960-61 are shown in Table1 based on five yearly averages. The pattern differs for kharif and rabi season. Pulses were cultivated on 14.5 million hectare area during rabi season during five years preceding onset of green revolution. In the next five years area under pulses declined to 13.1 million hectares, which further dropped to 12.8 million hectares during 1971-75. There was some recovery in area under pulses during 1976 to 1980 but afterward, the area under pulses either stagnated or declined. Only in the past decade has the trend been encouraging, when the area grew to 12.7 million hectares during 2006-10 and 13.7 million hectares during 2011-14, in the *rabi* season.

In contrast to what has been experienced in rabi season, the area under kharif pulses followed a rising trend during 1971 to 1995. Total area under pulses dropped by 1.87 million hectare in the beginning of green revolution but did not show any clear trend after that. During this period, total cropped area in the country increased by 18 per cent, and consequently pulses lost their share in total crop area by about 3 percentage points.

Table 1. Area, production and yield in *kharif, rabi* and total pulses during 1961 to 2014

	Area (m ha)			Production (m t)			Yield (Kgs/ha)		
Period	*Kharif*	*Rabi*	Total	*Kharif*	*Rabi*	Total	*Kharif*	*Rabi*	Total
1961-65	9.57	14.48	24.03	3.39	8.30	11.7	355	574	487
1966-70	9.06	13.10	22.16	3.12	7.39	10.5	343	565	474
1971-75	9.43	12.8	22.22	3.52	7.05	10.57	374	551	476
1976-80	10.22	13.15	23.37	3.98	7.45	11.43	389	564	487
1981-85	10.55	12.54	23.09	4.48	7.29	11.77	424	582	509
1986-90	10.91	12.20	23.10	4.84	7.67	12.51	442	628	541
1991-95	11.10	11.86	22.96	5.01	8.20	13.21	451	690	575
1996-00	10.30	12.14	22.44	4.85	8.71	13.57	472	718	605
2001-05	10.88	11.35	21.22	4.95	8.23	13.19	454	724	592
2006-10	10.97	12.74	22.71	5.44	9.84	15.29	492	771	643
2011-14	10.31	13.70	24.31	5.92	12.03	17.96	572	885	751

Source: Directorate of Economics and Statistics, Ministry of Agriculture, Government of India

Production of pulses show somewhat different trend as compared to the trend in area because productivity of pulses as a group show some definite trend over time. During the first decade of green revolution, productivity of rabi pulses showed a decline. After this, productivity of both rabi as well as kharif pulses kept increasing till late 1990s, which set off adverse impact of decline/stagnation in area on production.

Broadly, four distinct phases can be observed for pulse production: A phase of stagnation during 1961 to 1975, a phase of growth during 1976 to 2000 and again the phase of stagnation after 2000, followed by an increase since 2006. During the first phase, the area as well as yield of total pulses witnessed a decline. The combined effect of these led to a decline in total production, from 11.7 million tonnes in 1961-65 to 10.57 million tonnes in 1971-75. During these 15 years, the green revolution had gained momentum and the focus was primarily on cereals. Thereafter, for the next 25 years, pulse production in India witnessed steady growth, peaking at 13.57 million tonnes in 1996-2000. This period was marked with a significant increase in productivity, overcoming the impact of reduction in area under cultivation in the later years. The early 2000s, again witnessed a short period of stagnation, with an average produce of 13.19 million tonnes and a slight decline in yield. Since 2006, the production has picked up, reaching its peak in 2011-14 at 17.96 million tonnes and the highest yield of 751 kg per hectares. Nonetheless, even the highest yield of pulses falls well below that of cereals, as explained in the following section.

Yield of pulses vis-a-vis key cereals

To understand the trend of profitability of pulses as compared to cereals, the trend in their respective five-year averages of yield was plotted in Fig 1. As it can be seen, the steepest incline in terms of yield has been for wheat, reaching productivity levels above 3000 kg per hectares in the recent years. Rice has also followed wheat's trajectory in terms of yield, reaching a peak of about 2500 kg per hectares during 2011-14. Gram, which is the most popular pulse in the country, still lagged by a significant margin of about 2000 kg per hectares even at its peak in the past five years. Thus, even though the pulse has witnessed a steady increase in its productivity over the past 50 years, the productivity margin (as compared to wheat) which has only been increasing over the years, has led to gram being competed out in the now wheat rich states,

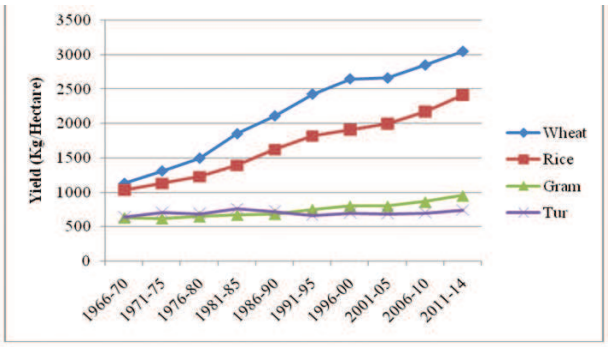

Fig. 1. Trend in yield of major cereal crops and pulse crops during 1966-2014. Source: Directorate of Economics and Statistics, Ministry of Agriculture, Government of India

primarily in the northern belt. Tur has in fact suffered in this regard, as its yield has stagnated over the years, not allowing its cultivation to spread in the country.

An important aspect that needs to be mentioned here is that the price of pulse usually increased faster and remained higher than cereals, compensating for its low yield in total returns to the farmer. However, the very fact that the total amount of pulse production has not grown at the same pace as of wheat indicates that despite higher prices, lower yield and higher costs involved in cultivation often impacts the farmer's choice during cultivation.

Another aspect that influences area allocation to pulses is it its associated risk in productivity. At all India level, there is a significant decline in instability of yield of paddy and wheat over time. This can be attributed to the improvement in cultivation technology of wheat and rice, which was the focus of the green revolution. Table 2 estimates the 'risk' associated with yield in terms of instability index which captures deviations from the underlying trend.

A comparison of instability since the onset of Green Revolution shows that instability in yield of wheat declined from 8.6 percent in the first 15 years since the beginning of green revolution to below 6 per cent in the subsequent periods. Similarly, instability in yield of paddy also declined from 12.5 per cent to less than 8 per cent. Though the instability in chickpea yield shows much higher decline as compared to any other crops but it remained much higher than wheat, which is the competing crop for gram. Risk in arhar production has also declined over time, but it remained more than double the risk seen in rice production.

Table 2. Risk in production of major cereals and pulses as revealed by inter year fluctuations in productivity

	1967-68 to 1982-83	1983-84 to 1998-99	1999-00 to 2014-15
Wheat	8.60	5.94	5.13
Rice	12.50	6.74	7.60
Gram	23.17	10.92	9.80
Tur (Arhar)	18.58	16.82	13.23
Jowar (sorghum)	9.03	20.89	9.70
Bajra	33.99	36.12	29.37

Source: Computed by the authors using data from: Directorate of Economics and Statistics, Ministry of Agriculture, Government of India

Instability in productivity of sorghum increased from 9 per centduring 1967-1982 to 20 per cent during 1983 to 1998. Last 15 years again witnessed a sharp decline in risk in sorghum,which made it more stable as compared to arhar. Bajra has displayed the highest instability in its yield as compared to the other given crops.

These estimates indicate that the high level of yield associated with wheat and rice, accompanied with their lower instability in comparison to Gram and arhar, favoured the cultivation of the former. Thus, although pulses may have gained an edge over Jowar and Bajra, they were competed out by Wheat and Rice during the last 50 years. However, reducing instability in yield of both the major pulses indicates a growing shift towards pulse cultivation, going forward.

India's pulses status in global production and trade

The total production of pulses in the world was around 77.59 million tonnes in 2014. Out of this, 19.98 million tonnes or about 25 per cent was produced in India alone. Meanwhile, Canada ranks second with 5.82 million tonnes production followed by Myanmar and China with production of 4.99 million tonnes and 4.51 million tonnes respectively. Meanwhile, production of pulses was above 3 million tonnes in Brazil and Australia. Ethiopia, United States of America and Russian Federation all produce 2-3 million tonne of pulses each. These ten countries account for 64 per cent of world production of pulses while India alone produces close to one fourth of global output.

Table 3. Global scenario of pulses production

Country	Production (m t)	Share in world production (%)	Yield (kg/ha)
India	19.98	25.75	654
Canada	5.83	7.51	2,031
Myanmar	4.99	6.43	1,325
China	4.51	5.82	1,550
Brazil	3.31	4.26	1,030
Australia	3.07	3.96	1,408
Ethiopia	2.61	3.37	1,724
United States of America	2.40	3.10	1,943
Russian Federation	2.32	2.98	1,448
World	77.60	-	906

Source: FAOSTAT (FAO Statistics)

Among the top ten pulses producing countries, per hectare productivity of pulses is lowest in India after Brazil. As against world average of 906.2 kg per hectare, India delivers a lower yield of 654.4 kg per hectare. India's productivity level is only about 42.2 per cent of the productivity in China and 49.4 per cent of that witnessed in Myanmar, which are neighbouring countries of India and which figure among top 10 producers of pulses in the world.

India is the largest importer with close to 28 per cent share in world import of pulses. Following India, China and Bangladesh are the largest importer of pulses with 8.79 per cent and 6.11 per cent respectively share of total global imports. Fourth and fifth position is held by Pakistan and Egypt, importing an annual of nearly 430 thousand tonnes of pulses each.

Canada tops the list of exporters, contributing to 35.7 per cent of the total global export of pulses. After Canada, the three key exporters of pulses are Australia, Myanmar and U.S.A. contributing a total of 29 per cent the global pulses export. India ranks 8th in pulses export, with an export quantity of 409.93 thousand tonnes and share of about 3 per cent. However, as the country imported about 3.8 million tonnes of pulses as of 2013, it is a net importer of pulses, contributing significantly to the global demand.

Table 4. Major exporters and Importers of Pulses in 2013

Country	Export Quantity (000 tonnes)	Share (%)	Country	Import quantity (000 tonnes)	Share (%)
Canada	4,994	35.70	India	3,801	28.45
Australia	1,417	10.13	China	1,174	8.79
Myanmar	1,388	9.93	Bangladesh	817	6.11
U.S.A.	1,199	8.57	Pakistan	434	3.25
China	843	6.03	Egypt	433	3.24
Russian Federation	528	3.78	UAE	391	2.93
France	419	3.00	Brazil	374	2.80
India	410	2.93	U.S.A	361	2.70
Ethiopia	360	2.57	Turkey	336	2.51
United Kingdom	268	1.91	Italy	296	2.22
World	13,988	100.00	World	13,358	100.00

Source: FAOSTAT; Abbreviations - USA: United States of America; UAE: United Arab Emirates

The global pulses scene indicates that production of pulses is concentrated to few countries, India and Canada being the largest producers. However, the imports or global pulses demand is concentrated to the Indian subcontinent and China, owing to similar dietary habits. In 2014-15, India's net import of pulses stood at about 4.4 million tonnes. Due to stagnant production and increasing population, India's dependence on global markets is only set to increase in the future. This will offer opportunities to countries like Myanmar, Australia and Canada to export pulses to India. Going forward, it would be necessary to increase productivity to not only cater to domestic pulse demand, but also to reduce import dependency in the coming years.

Role of pulses for nutrition security

The trend witnessed in the consumption of pulses vis-à-vis the available supply since the Green revolution era throws light on the consumer preferences in the country. As mentioned earlier, pulses form an essential component of the Indian diet for both rural and urban Indian population. They form the cheapest source of protein and are consumed along with cereals to compliment the nutritional intake. However, due to lower per capita availability of pulses, the level of malnourishment has been reported to be significantly high according to several studies. In fact, it has been noted that income poverty and nutritional deprivation has been moving in the opposite directions despite poverty lines being initially associated with calorie intake (Chand and Jumrani 2013). Hence it is important to understand the various aspects of the nutritional intake decline to further understand the importance of pulses in resolving this issue.

Calorie and protein intake

The per capita dietary energy intake in the country has declined from 2,153 kcal per person per day in 1993-94 to 2,099 kcal per day in 2011-12 for rural, and from 2,071 kcal per day to 2,058 kcal per day in urban India, during the same period. This has been primarily on account of a decline in the intake of cereals. The per capita annual consumption of cereals in urban areas has declined from 155.26 kg in 1993-94 to 129.16 kg in 2011-12. Similarly, the per capita consumption of cereals in rural areas declined from 163.03 kg to 136.51 kg, during the same period. Under cereals, only the consumption of wheat has not witnessed a significant change in the given period.

Meanwhile, there was a marginal increase in the per capita annual consumption of pulses, which grew from 10.46 kg in 1993-94 to 10.96 kg in 2011-12 in urban areas and from 9.25 kg to 9.53 kg, in rural areas, during the same period. These trends are evident in the following Table 5 that indicates the annual consumption of cereals and pulses respectively, over a period of two decades (1993-94 and 2011-12). Meanwhile the per capita consumption of other food items like fruits, vegetables, edible oil, sugar, eggs, meat and milk witnessed moderate to high increase in the same period.

Table 5. Per capita intake (kg per annum)

	1993-94			2011-12		
	Rural	Urban	Total	Rural	Urban	Total
Cereals	163.03	128.97	155.26	136.51	112.91	129.16
Pulses	9.25	10.46	9.53	9.53	10.96	9.98
Wheat	52.56	54.02	52.89	53.85	52.82	53.53
Rice	82.61	62.42	78.01	74.62	56.73	69.05
Other cereals	27.86	12.53	24.36	8.03	3.65	6.67

Source: Agricultural Statistics at a Glance 2015, Ministry of Agriculture, Government of India

These increases however did not help in setting off the decline in dietary energy intake and protein intake caused due to decline in cereals. In fact, as per the 66th round of the NSS, the protein intake at the all India level has fallen by 8.6 per cent from 60.2 grams to 55.0 grams per person per day in the rural sector and by 6.4 per cent from 57.2 grams to 53.5 grams in the urban sector in the period 1993-94 to 2009-10. The sharpest decline has been felt in the rural areas of Rajasthan, Haryana, Uttar Pradesh and Punjab. As a result of these issues, the level of undernutrition (deficiency of energy intake and protein intake) as well as the proportion of undernourished population, based on the dietary norm recommended by ICMR and NIN, have remained high and are also showing deterioration.

Prevailing levels of malnutrition and undernutrition

According to recently released data by Ministry of Health under its fourth National Family Health Survey(NFHS), even though there was a marked decline in the instances of malnutrition between 2005-06 (NFHS-3) and 2015-16 (NFHS-4), the present levels of malnutrition in India are high (Rukmini and Bansal 2016). Under the findings of NFHS-4, 37 per cent of children under the age of five in 15 states have been reported to be stunted. This marks a decline of five percentage points since the previous survey. The states with the highest level of stunting were Bihar and Madhya Pradesh, having rates of 48 per cent and 42 per cent, respectively. Meanwhile, the proportion of underweight children presently stands at 34 per cent, with highest levels witnessed in Bihar and Madhya Pradesh. Other studies on the subject also suggest that child under-nutrition rates are amongst the highest in the world with about 50 per cent of children under the age of 3 years being either underweight or stunted. While the overall picture suggests an improvement over the past decades, there is visible variability in the rates of malnourishment observed across the country. For instance, while states such as Mizoram, Delhi and Arunachal Pradesh have observed improvements in the given indicators, states such as Bihar, Uttar Pradesh, West Bengal and Jharkhand have not seen improvement despite an increase in incomes.

The NFHS-4 survey also suggests that wasting is still very high as against the international standards in all states/union territories of the country. Apart from this, the incidence of anaemia has declined, but nonetheless remains widespread. Presently, more than half of the children in 10 of the 15 states/union territories are anaemic and more than half of women are anaemic in 11 states/union Territories. This goes to show that the marginal improvement has likely been on account of factors such as better provision of health care and improvement in incomes. However, the high rates of under nutrition have remained prevalent primarily due to the decline in nutritional intakes. The provisioning of affordable pulses can thus play an important role in reducing the level of undernourishment, and even support in reducing the instance of anaemia, due to its various nutritional properties.

Significance of pulses as highlighted by FAO

The Food and Agriculture Organisation (FAO) has been propagating the importance of pulses in the global food diets, and accordingly have called 2016 as the international year of pulses. According to FAO, the importance of pulses stems from the fact that these typically contain about twice the amount of protein found in whole grain cereals such as wheat, which for most populations in developing countries they constitute a major source of protein. One of the lesser known facts about pulses is that when combined with

food high in vitamin C, pulses' high iron content makes them a potent food for replenishing iron stores, particularly for women at reproductive age, who are more at risk for iron deficiency anaemia, an issue which is common in developing countries. Apart from this, consumption of pulses has shown to have other health benefits such as reduction in the risk of coronary heart diseases and improvement in bone health.

FAO advocates for increased research in breeding strains of pulses that contain lower quantities of phytate (an acid found in plant tissues) so that iron and zinc can be better absorbed by the body. Pulses contain complex carbohydrates, micronutrients, protein and B-vitamins, all of which are vital parts of a healthy diet. Moreover, pulses are excellent for managing cholesterol as they are low in fat and rich in fibre, thereby helping regulate energy levels. Pulses are also considered to be rich in minerals such as folate, iron, calcium, magnesium, zinc and potassium.

In cognizance of these nutritional benefits, FAO considers pulses essential in contributing to food security. Protein obtained from pulses, globally is significantly less expensive compared to animal foods. In some countries, as is the case in India, pulse protein costs much less than the protein sourced from milk. Along with this, pulses having a long shelf life can be stored for long periods without losing their nutritional value. They are also considered to be drought-resistant and suitable for marginal environments. Due to these properties, pulse production has been mandated by FAO to be necessary in countries that suffer from severe levels of malnutrition.

Consumer preference towards pulses

As adequate availability and subsidized supply of cereals have failed to improve and achieve the goal of adequate nutrition, we need to look for alternatives which suit consumers' preference. Some experts feel that this deficiency will be filled by livestock products, as witnessed in the dietary transitions in other emerging economies like China. Empirical evidence shows that dietary diversification towards livestock products, particularly meat products, in India has been slow and this can be attributed to cultural factors. Presently, the predominant Indian population has preference towards vegetarian diet. Even for the population which is not strictly vegetarian, or the so called non-vegetarians, livestock dishes (curry) are not part of their regular and staple food diet. It is thus difficult to imagine livestock products substituting dishes such as *daal, vada, sambhar* and various snacks and sweets made from pulses.

Some studies indicate that income elasticity of demand for pulses is close to 1 and that for cereals is close to zero and even negative in some cases (Kumar et al. 2011). With the increase in per capita income, a consumer prefers to consume higher quantity of pulses. Research done on annual per capita consumption of various expenditure groups reveals that the average Indian diet continues to be a frugal one based essentially on grains and pulses, and, with the possible exception of milk, there does not seem to be a significant shift towards high-value protein foods (Swamy 2012).

Thus, pulses are part of the staple food diet and are highly preferred by Indian consumers. They are also relatively less costly source of energy and protein as compared to livestock products. Moreover, over the past few decades, the intake of pulses did not decline because of choice but because of shortage in supply. So there are strong reasons to believe that Indian consumers would raise consumption of pulses if they are available at reasonable prices. Pulses are therefore the best candidate for reducing hunger and improving nutrition of the Indian populace.

Conclusion

Presently, several constraints exist that have impacted the cultivation of pulses in the country. These include lack of availability of high yielding variety of seeds, poor knowledge about seeds, weed management and fertilizer application for pulses have further inhibited farmers from pulse cultivation. Apart from these issues, pulses are also susceptible to diseases and pest infestation; the knowledge for overcoming which is also limited for the farmers. Due to these reasons pulses tend to have lower yield than popular cereals. Lastly, low price of produce or lack of an assured price de-incentivizes farmers to invest in pulses. Recent initiatives of government like *Pradhan Mantri Fasal Bima Yojana*, procurement of pulses as a part of price intervention to check low prices received by the producers are expected to cover yield risk and price risk faced by pulse growers. There is also a change in price parity towards phosphatic fertilizers which are important for pulses. These initiatives will have strong positive effect on pulses production if these are matched by supply of quality seed and improved varieties of pulses.

If the pulses intake is restored to the levels of the years preceding green revolution (from the present 41.9 grams per capita per day to 69 grams per capita per day as of 1961), it will allow an increase of about 100 kcal in the per capita energy intake and 4.63 grams in the per capita protein intake (Chand and Sharan 2016). This increase will raise the nutrition levels close to what is considered the normative requirement of energy (2200 kcal per day) and protein (60 grams per day) for the Indian population.

Given the strong preference towards intake of pulses, there needs to be an increased emphasis of production of pulses in the country. The target now however is not only to increase the total produce to meet the exporting requirement, but also to increase the per capita availability keeping with the view to reduce import dependence. Such ambitious targets are necessary to eradicate the instances of malnourishment and undernourishment in the country.

Declaration

The authors declare no conflict of interest.

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