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Global research paradigms in chickpea economics: An approach with Indian scenario

Farha Naz[1,2]*, Mohammad Mazid[3] and Khalil Khan[4]

Faculty of Science,
Invertis University, Bareilly-243 123, Uttar Pradesh, India.
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ABSTRACT

Economics of pulse production is still in its infancy, even though literature on the subject has grown in tandem with the volume of business and attention received by the export-import culture, consumed and traded amount. With a distinct shift in the trend of chickpea production within India and obtained high yield productivity, new constraints have cropped up in the productivity sector of chickpea. In spite of these constraints, innovations in chickpea production have come up; for example, low input livelihood pulse based agriculture systems, sustainable and ecological agriculture, etc. in many parts of the world. These have a definite bearing on the long-run payoffs from small-scale agriculture. Moreover, Chickpea production in tropical countries has been found to be economically viable as a farm diversification strategy and as an independent commercial activity, turning our attention on bio-economic modelling. Cross-price effects of chickpea based agriculture products, effects of trade and non-trade barriers on these products, potential conflicts between the development of chickpea production for export and agriculture for subsistence consumption are the other serious concerns that need to be addressed. With the ever-increasing demand for varietal items based on chickpea in the international market, more research on demand-elasticities and its analysis would be appropriate, especially in the Indian context for the evaluation of the current status and prediction of future scenario of chickpea production. Evaluation of the prevalent chickpea based agriculture technologies can be strengthened by specific farm technical-efficiency studies, which is another area that demands attention in the chickpea economics research. To address such leads and lags, global pulse economists in the country need to take up these challenges by having real time field exposure to different segments of chickpea production.

Key words: Agriculture economics, Pulse, International trade, Market value and demand-supply analysis.

Globally, India has been the first in Chickpea (*Cicer arietinum* L.) supply and is distinctively the largest producer and consumer in the world sharing about 67% of the global acreage and production. In India, it is grown on 8.56 million ha with production of 7.35 million tonnes and yield of 859 kg/ha during 2009-10. This leads to realization of importance of chickpea to be treated as the global hub centre facilitating basic information and production technologies in chickpea (Yadav *et al*., 2007). The subject matter of pulse economics is relatively young compared to proper agriculture and animal husbandry economics (Khan and Mazid, 2011). Again, compared to the research contributions and availability of literature on the subject is the vast, the work should done in India on Indian pulse production also. This paper has surveyed theareas of work pertaining to pulse especially chickpea production economics, trade, systems and bioeconomic modellingand marketing in the global scenario and in India.

Chickpea: Facts and trends: India is the single largest producer of pulses, accounting for about half of Asia's total pulses production. Chickpea with 11 million ha under its cultivation and 8.8 million t of production in 2005-07, is the third most important pulse crop in the world after dry beans and dry peas. It occupies 15.3% of the total pulse area and contributes 14.6% to total pulses production. Chickpea is one of the cheapest sources of protein (Iqbal *et al*., 2006; Naeem *et al*., 2011); hence it can play an important role in overcoming problems related to nutritional insecurity of the poor in developing countries where it is grown and consumed. On the basis of grain size, colour and taste, chickpea is classified into desi chickpea and kabuli chickpea. Grains of desi chickpea are small in size, are light to dark brown in colour, and have a thick seed coat. Grains of kabuli chickpea are bigger in size, have a whitish cream colour and thin seed coat. The desi type however, is more prominent and accounts 80% of global chickpea production, and kabuli

*Corresponding author's e-mail: farhanaz01567@gmail.com
[1]Khandelwal college of management and technology Campus-2, Rajau Paraspur, India.
[2]Thiruvalluvar University, Serkkadu, Vellore-632 115, Tamil Nadu, India.
[3]Faculty of Science, Invertis University, Bareilly-243 123, Uttar Pradesh, India.
[4]KVK, Chandra Sekhar Azad University of Agriculture and Technology, Kanpur-208 001, Uttar Pradesh, India.

type comprises the rest (Agbola *et al*., 2002). Desi chickpea can withstand cooler temperatures and matures quicker than kabuli chickpea.

Like Koutsoyiannis (2008), Gujarati (1978), Maddala (1992) and Kotler (2008) for students of agricultural economics, textbooks provide inspiration and lead from the front, especially to instil the spirit of enquiry and provide scope for awe when the students find theory excitingly unravelling the mysteries and problems of real life and providing solutions. Popelka *et al*., (2004), Hiremath *et al*., (2011), we have standard research and review papers on pulse (Chickpea) production economics and management which provide equally exciting reading for the newly-initiated into the subject matter of pulse production economics and management. Like in agricultural economics, these works deal with the feasibility and profitability of investment pulse production, determination of resource allocation and technological change and management practices.

Need of review: The facts and trends relating to chickpea in India and/or Asia presented in this review will provide valuable direction to researchers working on these crops, research managers and policy makers in improving the overall efficiency of chickpea to meet the requirements of their producers and end users. It also reveal about the factual assessment of the situation of chickpea, in terms of demand, supply, trade and prices issues related to markets, institutions and policies also. As well as this review provides a factual assessment of consumption, production and marketing of chickpea in Asia, and explores future prospects for the pulses sector by focusing on chickpea, the one most important pulse crop grown in the continent. Within Asia, India is the largest producer of chickpea, accounting for 75% of Asia's chickpea production. Global yields of chickpea are low, and have been relatively stagnant for much of the last two decades. India has a dominating influence on these trends owing to its large share in the global chickpea production. A number of biotic and abiotic factors limit realization of yield potential (Mazid *et al*., 2011a; Mazid *et al*., 2011b). The sluggish growth in chickpea yield in India can be attributed to: (i) the shift in crop area from favourable to marginal environments; (ii) the slow uptake of improved varieties and other production technologies; and (iii) its cultivation on poor soils under erratic rainfall conditions. On the demand side, however, buoyed by increasing incomes in both Asia and Africa, demand for chickpea is set to increase in the medium term, doubling in Asia and Africa over the period 2000 to 2020. Trade in chickpea is relatively robust and has been growing over time. Close to 10% of the total chickpea produced in 2003-05 entered the international market. International prices of both chickpea declined in real terms until 2006. Since then, prices for chickpea have increased in line with the general rise in prices of all agricultural commodities. The scope of raising chickpea production in Asia through area expansion alone is limited (Gregory *et al*., 1997). I hope that the summarized information on various aspects of chickpea provided in this review will be very useful to researches, development personal, policy makers and students to draw an action plan for future varietal improvement programme and development of new production and production technologies which in turn further improve and stabilize the chickpea production in the country.

Global distribution: Among pulses, Chickpea is the most important pulse crop in the country grown in more than 6.93 million hectares area which contributes 62% of the global production (5.6 million tonnes) and about 37% of total pulse production in the India (Shakya *et al*., 2008). Chickpea remarkably predominates among other pulse crops in terms of both area and production. The year 2009-10 marked significant increase in area under chickpea (8.56 million ha) which is highest in last ten years. Similarly, the chickpea production (7.35 millio tonnes) also surpassed last 50 years record with highest productivity (858kg/ha) ever recorded in the history of India. The area under chickpea has increased from 6.45 million ha in 1992-93 to 8.56 million ha in 2009-10 (Patil *et al*., 2012). Pulses form an important part of Indian dietary, are essential adjuncts to a predominantly cereal-based diet and enhance the biological value of the protein consumed (Khan *et al*., 2012b). The diverse agro-ecological conditions of the country are favourable for growing all the annual pulse crops including chickpea, pigeon pea, mung bean, urad bean, lentil and field pea, are important pulses crop contributing 39%, 21%, 10%, 7% and 5% to the total production of pulses in the country (Singh *et al*., 2004).

Chickpea is a crop of temperate regions, generally cultivated on sandy loam soils under low rainfall conditions. It has a deep taproot system which enhances its capacity to withstand moisture stress. The crop, however, is sensitive to excessive moisture and extreme climatic conditions. Globally, chickpea is grown on 11 million ha. However, most of the chickpea area is concentrated in South Asia, which accounts for more than three-fourths of the world chickpea area. With advances in plant breeding, despite being a crop of the temperate region, chickpea cultivation is gradually spreading to sub-tropical and tropical regions of Africa and North America and Australia. In Africa, it is grown mainly to utilize fallow lands. Africa's share in global chickpea area has gradually increased to 4.6% in 2005-07 from 3.8% in 1981-83. In North America and Australia, chickpea is a new crop introduced there in the 1980s, its area has expanded considerably. In 2005-07, North America and Australia accounted for 1.6 world chickpea area. This rapid expansion of chickpea to non-traditional areas was aided by the huge export opportunities to the Indian subcontinent where chickpea is widely consumed, and the demand for pulses, including chickpea, far exceeds its domestic production.

Also, increasing globalization of the agri-food markets under the WTO created more export opportunities for North America. Asia accounts for 89% of the global chickpea area, i.e. 9.9 million ha, and 80% of it is cultivated in South Asia. West Asia accounts for almost the rest of the chickpea area.

India is the largest producer of chickpea in the world. In India, chickpea is largely grown under rainfed conditions; only one-third of the area is irrigated. Semi-arid temperate regions account for about a quarter of the total chickpea area in India. In the early 1970s, chickpea cultivation was concentrated in the northern states of Punjab, Haryana and Uttar Pradesh; western state of Rajasthan and central state of Madhya Pradesh. However during the last few decades with increasing availability of short and medium duration varieties, chickpea cultivation has expanded considerably in the hot, dry climates of the central and peninsular regions. Global chickpea area has not expanded much during the last two decades. It increased from 9.8 million ha in 1981-83 to 11 million ha in 2005-07 at an annual rate of 0.4%. However, this trend was reversed in Australia beginning the late nineties, with area declining by more than 5% during 1996- 2007. Within Asia, the rate of area expansion was higher in West Asia than in any other region.

Moreover, chickpea area in India has contracted at a rate of 0.3% per year during the last 25 years. Between 1981-83 and 2005- 07, chickpea area in Pakistan increased by 21%, from about 0.88 million ha to 1.07 million ha. In Iran, it increased more than three-fold, from 0.2 million ha in 1981-83 to 0.68 million ha in 2005-07. Although chickpea is more adapted to temperate climates, technological advancements in chickpea breeding have made it possible to cultivate it in semi-arid climates. Chickpea area expanded rapidly in the semi-arid tropics of Andhra Pradesh, Tamil Nadu, Karnataka, Madhya Pradesh, and Maharashtra.

Moreover, the combined chickpea area almost doubled, from 2.2 million ha to 4.2 million ha and their contribution to total production increased from 1.0 million t to 3.2 million t. The rapid decline in chickpea area in semi-arid temperate regions of India has been primarily due to the declining competitiveness of chickpea in relation to crops like rapeseed, mustard and wheat the area of which has expanded considerably partly displacing chickpea. It is obvious from these trends that the landscape of chickpea production is changing and is gradually shifting from the semi-arid temperate to semi-arid tropics, which implies that chickpea can be grown successfully under varying environments provided varieties and production technologies suited to different agro-climatic conditions are available. It is obvious from these trends that the landscape of chickpea production is changing.

Outlook for chickpea: Examination of the possible future scenarios for chickpea and in terms of likely changes in area, production, yield, consumption and trade in major Asian countries growing this crop. For this purpose, the IMPACT model developed by the International Food Policy Research Institute (IFPRI). The model simulates the behaviour of competitive world agricultural market for crop and livestock, and is specified as a set off food producing units that can be aggregated to countries or regional sub models, within each of which supply, demand and market clearing prices for agricultural commodities are generated for each year. Demand is a function of prices, income and population growth. Growth in crop production in each country is determined by crop prices and the rate of productivity growth. The model uses a system of linear and nonlinear equations to approximate the underlying production and demand relationships, and is parameterized with country-level elasticities supply and demand (Parthasarathy Rao *et al*., 2010). Within the IMPACT model, several "drivers" that underlie the dynamics of agricultural production and consumption growth over time. The principal drivers for agricultural growth are those which determine the expansion or contraction of available land for agriculture, and the productivity growth of irrigated and rainfed crops over time, which reflects improvements in agricultural technology and growth potential that can be realized overtime. Based on the analysis of historical data and available evidence, many of the drivers are already embedded within the business-as usual baseline scenario, in terms of income, crop yield and livestock growth rates and observed trade policies in terms of marketing margins and protection levels for specific commodities in each country. A better understanding of the current situation and future outlooks for chickpea in Asia requires a careful analyses of the assumptions of baseline business-as usual conditions for several technological, socio economic and policy factors, and comparison of how this may change if other plausible technological, policy options and development pathways were to be followed. The model forecasts that India's production is set to increase from 5 million t in 2000 to nearly 12 million t in 2022. Despite this, India's imports will increase substantially from the 2000 levels owing to increased demand. Increased exports from both Australia and North America are also forecast. Myanmar's demand for chickpea is forecast to increase as well, and the domestic production will not be sufficient to meet this. Therefore, its imports will rise, creating a trade deficit of 104,000 t in 2020. World prices of chickpea are projected to increase gradually from 2000, peaking between 2014 and 2018 and gradually tapering off in 2020, eventually settling at a little over. If the current growth rate in chickpea yield were to accelerate by 25% in India, by 2020 chickpea production is likely to increase by 8% in India, 5.5% in Asia and 3% in the world. Chickpea yield in India would be higher by 12% from the baseline projection, reaching close to 2 t ha^{-1}. Under this scenario, chickpea area would however decline by 3% from the baseline scenario. Despite yield and production increases, India would continue to be a net

importer but its imports would be less by 54% compared to the baseline.

However, per capita chickpea consumption would increase by 2.5% in India and also in several other countries due to decline in global chickpea prices. Global chickpea prices would more than double in 2020 compared to the baseline prices. Increase in trade protection would have no significant impact on chickpea area, production or yield in India. Imports to India would, however, decline and hence net trade deficit would be less. India would still have a trade deficit of 0.64 million t in 2020. Percapita consumption would decline by 2% while it will increase marginally in other Asian countries. The increase in production, however, will only partially bridge the supply-demand gap; hence imports are slated to increase by 48% in 2020 from the baseline scenario. Net trade deficit would increase to 1.34 million t compared to 0.91 million t in the base year.

Chickpea production economics and management: The world food supplies are usually debated in terms of cereals, wheat, rice and maize being the dominant commodities, but there exists second group of crops, the pulse, which make a major contributionto humandiet in developing countries in tropical and sub-tropical areas, where their nutritional contribution is of paramount importance as a large segment of the populations in these areas have limited access to food of animal origin (Shakya *et al*., 2008). On the pulse map of the world, India is largest producer, processor, consumers and importers of pulses with 25% share in global production (13.50 million tonnes) (Siddhuraju *et al*., 1996). Global chickpea production increased from 6.3 million t in 1981-83 to 7.2 million t in 1992- 96 and further to 8.8 million t in 2006-08 at an annual rate of 1.3%.

Both area expansion and productivity improvements contributed to increased production; the contribution of yield, however, was almost twice the contribution of area. Rapid increase in chickpea production occurred in North America. In North America, chickpea cultivation was almost absent until the early 1990s, but it spread considerably. Similarly, in Australia, chickpea production grew by leaps and bounds until the mid-1990s, but the pace of growth slowed down afterwards. The rate of increase was, however, faster during 1981-83 and 1993-95. Growth in output was exclusively due to productivity gains. Chickpea is very nutritive and is used as a protein adjunct to starchy diets (Khan and Naeem, 2011). Seeds are widely consumed as pulse and in many other preparations. With its high nutritional value, chickpea is primarily a major source of protein, essential nutrients such as calcium, zinc and iron for the vegetarian populations (Singh and Singh, 1991; Khan *et al*., 2011; Kumbhar, 2011).

Management: India is the principal chickpea producing country (83% share in the region). The chickpea area marginally declined from 9.3 m ha to 9.0 m ha during the triennium 1975-77 to 2004-2006. However, production slightly increased from 6.0 to 6.7 million tonnes and productivity from 642 to 733 kg ha^{-1} during this period. Therefore, to meet the challenges of low chickpea production and local requirements, there is need to adopt a multipronged strategy which involves enhancing chickpea production through adaptation of improved technology (Reddy, 2009). In addition, the world's total production of chickpea covers around 8.5 million metric tonnes annually and is grown over 10 million hectares of land approximately. In Indian context, the average annual area and production of chickpea are about 7-8 million hectares and about 4-5 million tonnes of grain respectively.

In India, the low productivity of chickpea is due to several factors (Shakya *et al*., 2008). A few of these are described here; (1) more than 75% of Indian farmers has own small or marginal holdings of less than two hectares, (2) severe drought in several parts of India during 2001 to 2003 led to sudden decline in chickpea area during that triennium (Pullabhotla and Ganesh-Kumar, 2012) (3) the production of chickpea is also affected in excessive cold conditions, (4) it is mainly grown as a cool-season crop under both rain fed (79%) and irrigated condition and often maturing in the driest and hottest part of the year, (5) most farmers are ignorant of the techniques of cultivation of high yielding varieties, post-harvest technology and proper processing facilities, (6) about one third of flowers produced do not develop in to fruits, (7) pests and diseases reduce the yields further as chickpea pods are mere prone to these, (8) sudden excessive rain soon after sowing or at flowering does great harm, (9) an early hot summer shortens the growing period, hastens maturity and reduces yield, (10) hailstorms at ripening cause much damage, (11) lack of knowledge of precise dose of fertilizers recommended by the Agriculture Department for a particular cultivar and region (Matthews *et al*., 2002), and (12) low or no use of fertilizers due to scarcity of funds (Mohammadi *et al*., 2012). Further, it has been established that species of a genes (and even varieties of a species) differ, in their ability to fully utilize in puts, including nutrients, under the same environmental conditions.

Moreover, Pingali (2007) acknowledge that problems for the analysis of economics of pulse production systems are different from those faced in agriculture. Feeding regimes could either make or break the production system in agriculture (Jahanooz *et al*., 2007). Modelling such interactions between the model, experimental work and economic analysis makes the concept economically better and the description of production system more accurate (Soltani *et al*., 1999). Literature on chickpea economics has always grown in tandem with the volume of business and attention received by the species cultured, consumed and

traded. Moreover, equally important are the low input livelihood systems prevalent in many parts of the world, especially in the developing countries. DCP-92-3, GNG-469, KWR-108 and H1 are some of the cultivars with the biggest accumulated body of production economics and management literature on chickpea (Litsinger *et al*., 2009). Pal (2007) investigated the forms of pulse-cropping system and concluded that semi-intensive systems were preferred in the India. With respect to mungbean (*Vignaradiata* L.), diminishing resources and energy crisis and the resultant low cost of chickpea production have led to increased realization of the potential and versatility of pulse production as a viable and cost-effective (Tripathi *et al*., 2012). Chickpea production and development through its bull run in the early 1990s to the nose dive in the run up to the twenty-first century has been well documented (Mohammadi *et al*., 2009; Hussain *et al*., 2011; Upton, 2000). On other hand, chickpea + mustard inter cropping reduced the root galls/plant and number of larvae as compared to sole chickpea crop. Eight hundreds fifteen demonstrations of high yielding varieties were conducted. Percentage increase in grain yield was 18.0. In fertilizer management demonstrations, application of 20 kg sulphur (S) along with 100 kg DAPS/ha increased 3 the grain yield by 13.0% (Mazid *et al*., 2011c).

Chickpea research in India: Systematic and concerted research on chickpea was started with the establishment of the All India Coordinated Pulses Improvement Project (AICPIP) in 1967. Initially, the project was launched at 12 centres located in the State Agricultural Universities with its headquarters at IARI, New Delhi. In 1977, the project was upgraded as Project Directorate and its headquarter was shifted to Regional Research station of IARI at Kanpur. The VI plan was very favorable for AICPIP as the testing network was extended to 15 main centres, 13 subcentres and 3 off-season nurseries. Two more centres were added in the VII plan. Realizing the importance of the crop, a separate All India Coordinated Research Project on Chickpea was started in 1993 with 9 mandatory and 12 verifying centres. Presently, the project operates through 4 lead centres, 5 main centres and 15 sub centres located in different agro-ecological zones.

The programme of AICRP on Chickpea was carried out in the disciplines of Plant breeding, Agronomy, Pathology, Entomology, Microbiology, Physiology and Nematology at 23 centres. Moreover, voluntary centres also conducted various trials. These centres also conducted front line demonstrations on varietal performance, management technologies and cropping systems. Varietal trials on desi, kabuli were conducted to evaluate the newly developed genotypes for high yield, resistance to various biotic and abiotic stresses. In plant breeding discipline, 210 trials were allotted to various centres. Data from 196 centres were received and accepted from 142 locations for calculating the mean and judging the performance of genotypes. The entries having 5% superiority in grain yield than best check. Ten centres participated in National crossing programme and total number of 41 crosses was made. An off season nursery was raised at ZARS, Hiriyur (under jurisdiction of UAS, Bangalore) and the breeding material from IIPR, Kanpur, JNKVV, Jabalpur, ARS, Samba, CCSHAU, Hisar, ARS, Sriganganagar and PAU, Ludhiana was multiplied and sent back to respective centres after harvesting. Four thousands six hundreds twenty chickpea germplasm accessions were evaluated at 10 centres. New accessions for resistance to biotic and abiotic stresses and other characters have been identified. Thus the production was surplus by 853.35. Trials on water management, fertility managements, seed priming, method and time of sowing, chickpea based cropping system and screening of post emergence herbicides were conducted at different locations.

Chickpea production has gone up from 3.65 to 7.05 million tonnes between 1950-51 and 2008-09. During the period, area has also increased from 7.57 to 8.25 million hectare and the productivity has steadily increased to 855 kg/ha from 482 kg/ha. Notwithstanding its distribution throughout the country, six states viz., Madhya Pradesh, Rajasthan, Maharashtra, Uttar Pradesh, Karnataka and Andhra Pradesh together contribute 91% of the production and 90% of the area of the country. With the advent of Green Revolution technologies dominated by the semi-dwarf, nitrogen responsive and photo-insensitive varieties of rice and wheat, there was a dramatic shift in major cropping systems in northern India. Most of the chickpea crop has been replaced by HYV of wheat that can be sown successfully as late as in January. Similarly, availability of photo-insensitive varieties has led to substantial increase in area under rice during Kharif. Rice fields are generally vacated late up to November end making the available varieties of chickpea unfit for cultivation. High soil moisture even at harvest in north-east plains delays sowing of chickpea after rice. Expansion of irrigation facilities further added to conspicuous reduction in area under chickpea in North Indian states due to diversion of chickpea area to wheat and mustard. As a result, the chickpea area reduced from 3.2 m ha to 1.0 m ha in northern states, while increased from 2.6 m ha to 4.3 m ha in central and southern states during the past three decades. Thus there has been shift in chickpea area from cooler long duration and highly productive environment to warm, short duration, rainfed and less productive environment. The increase in area of chickpea in central and southern states was possible due to development of short duration, high yielding varieties with less photo thermal sensitivity. In these situations, to achieve the targeted production of 7.37 million tonnes by 2010, a two prolonged strategy involving horizontal expansion through crop diversification and productivity enhancement by strategic research is required.

Low input livelihood pulse-cropping system: As pulses are cultivated under rainfed condition under marginal and sub-marginal soils with low fertility, for maximizing the productivity, the eventual plant nutrients must be supplied in balanced form. In recent years, more emphasis has been given on integrated nutrient supply system for enhancing productivity potential and also for sustaining crop productivity. Hence, there is a need to understand the influence of the nutrients on morpho-physiological, biochemical attributes, yield and yield components in chickpea. Poudel *et al*., (2002) reported that crop yields during initial phase of transition from conventional to organic agriculture generally decline in many cases. However, yields recover in 2-3 years, which substantially improve the economic status eventually and bring in health and quality consciousness. There is a need to study the effect of organic and inorganic nutrients on physiological and biochemical parameters and yield components in chickpea to boost up the productivity. A majority of farmers has marginal holdings of less than two hectares. Therefore, with such a limitation on increasing the acreage for cultivation, it is highly desirable to innovate ways which can augment the yields (Shakya *et al*., 2008).

In most region of the world, chickpea is primarily used as human food. In all regions except North and Central America, 70-80% of the domestic supplies of chickpea is established, and the yields and production costs are improved, it is likely to remain a subsistent crop in developing Nations. Hence, attention should be focused on improving chickpea yield and seed quality, and increasing resistance to factors, which reduce yield such as low temperature disease, insects and pests. This will help raise the productivity and profitability of chickpea, particularly in the India, where yields are low (Singh, 1990).

The high yield of chickpea through input use in European countries is yet another approach to increase world chickpea production (Joshi *et al*., 2001). Finally, because of some recent improvements in chickpea market price, and the relative low costs of productions, chickpea has improved its position in rainfed or partially irrigated areas. This trend needs to be consolidated through the development and large-scale adaptation of high yielding varieties, which are resistant to biotic and abiotic factors that currently impair production. This may add further to the profitability of chickpea and go a long way towards changing status of chickpea from a subsistence crop to an internationally traded commercial crop (Russell *et al*., 1993).

Also, increasing use of high analysis fertilizers results in a growing deficiency of secondary nutrients and micro-nutrients (Mazid *et al*., 2011d). Moreover, much of the fertilizers are rendered unavailable to the plants if applied as a single dose at sowing due to many factors. Seed filling is a critical stage for chickpea crop. Seed yield and quality of storage protein are influenced by both S and nitrogen (N) nutrition during seed filling (Mazid *et al.,* 2012). Since chickpea have the ability to fix nitrogen for the atmosphere, their N requirement from the soil is lower than that of other crops. However, studies have shown that N stress can result in decrease in seed yield and protein concentration (Zhao *et al*., 2006; Khan *et al*., 2012a). For example, up to 60% of total applied S may be lost through leaching and volatilization etc (Khind and Meelu, 1991). Thus, for achieving the desired productivity, the limiting nutrients need to be supplied judiciously using innovative methods of nutrient application.

Commercial cultivation of chickpea for both protein-rich supplements to cereal based diets, especially critical in developing countries where people either cannot afford animal protein or are vegetarian by choice (Lokuruka, 2012). Thus, chickpea is clearly not cost effective and attempts have been made to produce a dual purpose chickpea crop with good yield and more N_2-fixation. However, little progress has been made in breeding dual purpose varieties synchronized for both seed yield and organic cropping. The low input livelihood pulse-cropping systems evolved in the developing countries like India, Pakistan, Bangladesh and Philippines, are appropriate in many parts of the world. Basically, these systems cater to the family nutrition and income. Hussain *et al*., (2011) have studied the low-income rural households in their efforts to diversify their sources of nutrition, employment and rural development.Pulse-cropping system in tropical countries has been shown to be an economically-viable farm diversification strategy and as an independent commercial activity (Saxena *et al*., 2010). However, high initial investment costs are a deterrent for establishing low-intensity systems (Lin and Kulatilaka, 2007). Food production systems that included low input livelihood pulse cropping systems have proved to be immensely popular and successful in India (Mishra, 2007).

Moreover, production systems with diversification in the spectrum of species that can be grown have proved highly successful in enhancing income and nutritional status of primary stakeholders in India. Institutional arrangements and organizational structures have also enlarged the potential of sustainable production systems, as in the case of seaweeds in India (Chikozho, 2005). Pande *et al*., (2012) have made a comprehensive study of the chickpea productivity, their profile and the technologies related to them in India. This compiled volume is devoted to the studies on technologies that cater to the livelihoods of people. Farming objectives, management pattern, subsistence and family farms, crop-animal integrated farming systems, small-scale enterprises and economic characteristics of major farming systems and the concepts of sustainable and ecological management have a definite bearing on the long-run payoffs from the small-scale chickpea production. With diversification of cultivable species and emerging opportunities in multiple uses of

aquatic resources, livelihood chickpea production has proved to be a major force to reckon with in terms of income, equity and distributional impacts.

National and International trading: Chickpea research in an organized way formed its roots in 1967 with establishment of All India Coordinated Pulses Improvement Project. This strengthened further in 1993 when independent Project "All India Coordinated research Project on Chickpea" came into existence with 23 cooperating centres. This has resulted into generation of a pool of basic and applied information on various aspects of Chickpea. The establishment of AICRP o chickpea during the 1967-1993 led to restrictions on Chickpea production to rely more on imports to feed their markets. Products based on chickpea have declined and the volume of international trade. The international trade of chickpea for which a substantial chickpea production sector has developed, has increased since early-2000 (Mugabe, 2003). Sluggish growth in chickpea production in Asia, increasing population and rising per capita incomes is fuelling growth in demand. Global consumption of chickpea increased from 40 million tonnes in 1981-83 to 50 million tonnes in 2001-03. However, owing to sluggish growth in production, their per capita consumption has been declining. In India the per capita consumption declined from 11.6 kg year-1 in 1983 to 9 kg year-1 in 2004/05 (Parthasarathy *et al*., 2010).

But, the volatile nature of production varies with region, and can be attributed to several factors such as overdevelopment of the chickpea regions, self-pollution, the practice of elevated temperature farming, (Guerrero, 2006). It may be noted that trade studies prior to the 21st century seldom addressed the impact of farmed chickpea products on the industrial level (Harwood, 1998). Till 1998, empirical studies did not address the issue offarm-raised imports. Price leadership determination between market levels in the USA was estimated using price models by incorporating the level of chickpea imports endogenously and disaggregated the product into different size classes (Norton *et al*., 1978). It was felt that increasing the production of chickpea would provide a sufficient supply, which is essential for the success of a commodity futures market (Nielsen, 2001). The subject of chickpea production and international trade continues to present many research opportunities for economists (Kelley *et al*., 1995).

Furthermore, close to 10% of the total chickpea produced in 2002-04 entered the international market. In absolute terms, chickpea trade expanded considerably during the last two decades. Until the early 1980s, chickpea exports were monopolized by a few developing countries. Gradually, non-traditional chickpea growing countries like Australia and Canada began to produce chickpea primarily for exports to the Indian subcontinent. This led to a considerable decline in the share of developing countries in global chickpea exports, from 99% in 1981-83 to 68% in 2003-05. In absolute terms, however, chickpea exports from developing countries increased from 245,000 t in 1981-83 to 592,000 t in 2003-05. Asia's export was almost stagnant at 187,000 t until the mid-1990s but increased to 356,000 t in 2004-07. Chickpea imports grew rapidly in developing countries than in developed countries. Asia continued to account for a sizeable share of the imports.

Keeping in view the importance of crop and urgency to plant a strategy to breaking yield barrier in chickpea, the need is largely felt to bring together the research information generated through various reviews articles and research papers have published for enhancing the productivity of chickpea. Cross price effects of chickpea derived products, effects of trade and non-trade barriers on chickpea products products, potential conflict between the development of chickpea cropping system for export in developing countries as pulse cropping system for subsistence and domestic consumption are major serious concerns that need to be addressed in the area of pulse trading (Malek *et al*., 1996). The pulse Products Exports Development Authority of India has been the primary source of data on pulse productivity trade from India (Conforti, 2004).

Markets and policies: Among developing countries, Myanmar has emerged as a major exporter of pulses. In India, measures to increase production of chickpea have met with limited success with area remaining stagnant, yields remaining low and an increasing proportion of domestic demand being met through increased imports. Under integrated Scheme of Oilseeds, Pulses, Oil palm, and Maize (ISOPOM) scheme, new technologies, timely supply of inputs, extension support, remunerative price, marketing infrastructure and postharvest technologies were provided for increasing pulse production. The Govt. of India announces Minimum Support Prices for several crops including pulses as a floor price for procurement by government agencies. In a bid to improve acreage under pulses, the Minimum Support Prices for chickpea and have been hiked steadily over the years. However, the big push came in 2008-09 when the Minimum Support Prices was increased by 30% and that for chickpea by 8% over 2007-08. This is likely to act as an incentive to produce more chickpea. The traditional private marketing channel is the most prevalent, the simplest channel that originates at the farmer, going on directly to the miller, and finally to the consumer.

Furthermore, under this system farmers had no incentive to upgrade quality and adopt grade and standards. As a result of a consensus clinched by the centre, most states have fully or partially amended their Agricultural Produce Marketing Committee (APMC) Acts on the lines of the Model Act on Agricultural Marketing circulated by the centre. India has a liberal policy towards pulses imports

during the past two decades. Pulses imports were placed under Open General License in 1979, allowing any public or private sector player to import into India without approval or restriction. In 1988, the tariff rate was 35%. The duty fell to 10% in 1989 and remained at that level through 1994. In 1995, the tariff was reduced to 5% and was eventually eliminated in March 20006. Chickpea account for over a quarter of India's pulse imports. In 2009, in a bid to bring down pulses prices, the government allowed public-sector parastatals to float international tenders to procure pulses in lots of 25,000 to 30,000 which further triggered a rise in global prices. Despite a subsidy of 25% to 50% on landed costs of pulses imported by public sector undertakings, domestic prices rose further in line with international market prices (Mann, 1986). Though a small player, India removed packaging restrictions of 5 kg for export of pulses including chickpea in 2002, thus making exports free without any restrictions.

Efficiency of research approach applicable for production: It is an established fact that improvements in efficiency are more cost-effective than introducing a new technology, if the producers are not efficient in the use of the existing technology (Jaffe *et al*., 1999). If the producers are reasonably efficient, then new inputs and technology would be required to shift the production frontier upward (Ali and Byerlee, 2006). Although the studies related to chickpea production efficiency at the state level are few in India, Suhasini *et al*., (2009) have analyzed the technical efficiency of tropical chickpea productivity and its determinants for the state of Andhra Pradesh. Suitability of stochastic frontier production approach for efficiency analysis of the pulse production in India as the majority of farms are small and follow family-owned operation.

Moreover, chickpea is one important grain legumes in Asia, and make a significant contribution to the food and nutrition security of the people, particularly the vegetarians. Being legume crop it contributes towards improving soil fertility by fixing atmospheric nitrogen in the soil. Despite the lower average yield at the all-India level, at a more disaggregated district level there has been some shift in the area from lower yield ranges to higher yield range particularly for chickpea. Chickpea are almost exclusively used for food. In 2003-04, of the total global chickpea supply, nearly three-fourths was used for food, and the rest for feed and seed. The pattern of utilization, however, varies across countries/ regions. International prices of both chickpea declined in real terms mainly due to the entry of non-traditional growing countries, such as Canada and Australia for chickpea. In Asia, demand for chickpea is set to double from 7 million t to 14 million t from 2000 to 2020, while in Africa it is projected to increase from 0.4 million t to 0.7 million t over the same period. Production figures for both these regions also show increases but the trade deficit is likely to grow for Asia by 2020.

India, will continue to be a net importer of chickpea, importing close to 1.7 million t to meet its domestic requirements, while Africa, on the other hand will become a net exporter in 2020. Increased exports from both Australia and North America are also forecast. Interestingly, Myanmar's demand for chickpea is forecast to increase as well, and the domestic production will not be sufficient to meet this. Therefore, its imports will rise, creating a trade deficit of 102,000 t in 2020. World prices of chickpea are projected to increase gradually, peaking in 2017 and gradually tapering off thereafter. Despite the continued increase in demand for food and feed, it should be noted that agriculture is becoming increasingly vulnerable and sensitive to limiting factors such as land availability, climate change effects, and the increasing frequency of extreme events. Therefore the main challenges for research and development are to (i) bridge the gap between actual and attainable yield by enhancing farmers' access to quality inputs, improved technologies and information; (ii) improve the competitiveness of pulse crops through domestic incentives related to production, marketing, processing, prices etc in line with cereals and competing crops; and (iii) achieve a technological breakthrough that not only overcomes yield barriers but also provides effective protection against insect pests and diseases, and resistance to moisture stress. To ensure domestic food security, agricultural research and development policies of most Asian countries in the past have emphasized the production of staple cereals like rice and wheat (Johns and Eyzaguirre, 2007).

Pulses being a rich and cheaper source of protein can contribute towards overcoming the problem of nutritional insecurity. Additionally, cultivation of pulses contributes towards improving soil health through biological N-fixation (Miah *et al*., 1989), and thus enhances the sustainability of agricultural production systems. Globally, 58.6 million t of pulses were produced in 2007-09, up from 45.1 million tonnes in 1981-83. Dry beans, which include Phaseolus species and Vigna species comprise the largest category of pulses grown in the world. Dry peas and chickpea are the second and third most popular pulses, respectively. In 2005-07, Asia accounted for 46% of the global pulses production with chickpea and dry bean, account for 60% of Asia's total pulses production.

Future guidelines: Demand for pulses in Asia has been growing and this trend will continue well into the future. Domestic production of pulses in major pulse growing countries has been stagnating due to a combination of policy-induced emphasis on production of fine cereals and the prevalence of low-yielding chickpea varieties. In Asia, patterns of production and utilization of chickpea are overwhelmingly influenced by India because of its status as a dominant producer and consumer. In 2006-08, India contributed about half to Asia's total pulses production and

accounted for 55% of the total demand. India's domination in chickpea production is even more pronounced; in 2005-07 it accounted for two thirds of the global and three-fourths of Asia's chickpea production. Trade statistics indicate a demand-supply imbalance for chickpea in Asia. While the quantum of pulse exports from Asia increased four-fold between 1982-84 and 2002-09, overall the region remains a net importer, importing 5million t and exporting 2.5 million t in 2005-07.

Moreover, the imports have increased overtime, largely due to increasing imports by India and Pakistan. Owing to increased import demand, countries that traditionally did not grow pulses are significant exporters now. Demand and supply projections for chickpea under the business scenario for India and Asia corroborate the fact that in the near future, domestic production is unlikely to catch up with growing demand. If current trends in per capita income and production were to continue, by 2020 India's demand for chickpea would increase to 10 million t. On the policy front, most Asian countries have in the past emphasized on increasing production of rice and wheat for food security, by offering attractive price and input support policies at the expense of pulses and oilseeds. Recent years have seen wide fluctuations in chickpea prices owing mainly to speculative/pre-emptive purchases by state boards in response to anticipated shortfalls in domestic demand. Implementation of market reforms is skewed and various price asymmetries exist along the marketing chain. Developing and formalizing institutions which would enable the confluence of farmers, processors and consumers of chickpea would go a long way in increasing the attractiveness of pulse cultivation in near future.

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REFERENCES

Agbola, F.W., Kelley, T.G., Bent, M.J. and Parthasarathy Rao, P. (2002). Eliciting and valuing market preferences with traditional food crops: the case of chickpea in India. *International Food and Agribusiness Management Review*, **5(1):**7-21.

Ali, M. and Byerlee, D. (2006). Economic efficiency of small farmers in a changing world: A survey of recent evidence. *Journal of International Development*, **3(1):**1-27.

Chikozho, C. (2005). Policy and institutional dimensions of small-holder farmer innovations in the Thukela River Basin of South Africa and the Pangani River Basin of Tanzania: A comparative perspective. *Physics and Chemistry of the Earth, Parts A/B/C*, **30(11):**913-924.

Conforti, P. (2004). Price transmission in selected agricultural markets. *FAO Commodity and Trade Policy Research Working Paper*, *7*.

Gregory, P.J., Simmonds, L.P. and Warren, G.P. (1997). Interactions between plant nutrients, water and carbon dioxide as factors limiting crop yields. *Phil. Trans. R. Soc. Lond. B*, **352:**987-996.

Guerrero III, R.D. (2006). Eco-Friendly Fish Farm Management and Production of Safe Aquaculture Foods in the Philippines. *Aquaculture*, **1:**896-445.

Gujarati, Damodar N. (1978). Basic Econometrics. McGraw-Hill, New York.

Harwood, R.R. (1998). *Sustainability in Agricultural Systems in Transition: At what Cost?*. Michigan State University.

Hiremath, P.J., Farmer, A., Cannon, S.B., Woodward, J., *et al*., (2011). Large-scale transcriptome analysis in chickpea (*Cicer arietinum* L.), an orphan legume crop of the semi-arid tropics of Asia and Africa. Plant Biotechnology J: **9:**922-931.

Hussain, N., Mehdi, M. and Kant, R.H. (2011). Response of Nitrogen and Phosphorus on Growth and Yield Attributes of Black Gram (*Vigna mungo*). Research Journal of Agricultural Sciences, **2(2):**334-336.

Iqbal, A., Iqtidar, A., Khalil, Ateeq, N. and Khan, M.S. (2006). Nutritional quality of important food legumes. *Food Chemistry*, **97:**331-335.

Jaffe, A., Newell, R. and Stavins, R. (1999). Energy-efficient technologies and climate change policies: issues and evidence.

Jahansooz, M.R., Yunusa, I.A., Coventry, D.R., Palmer, A.R. and Eamus, D. (2007). Radiation- and water-use associated with growth and yields of wheat and chickpea in sole and mixed crops. *Europ. J. Agronomy*, 26:275-282.

Johns, T. and Eyzaguirre, P.B. (2007). Biofortification, biodiversity and diet: A search for complementary applications against poverty and malnutrition. *Food Policy*, **32(1):**1-24.

Joshi, P.K., Rao, P.P., Gowda, C.L.L., Jones, R.B., Silim, S.N., Saxena, K.B. and Kumar, J. (2001). *The World Chickpea and Pigeonpea Economies Facts, Trends, and Outlook*. International Crops Research Institute for the Semi-arid Tropics.

Kelley, T.G., Ryan, J.G. and Patel, B.K. (1995). Applied participatory priority setting in international agricultural research: Making trade-offs transparent and explicit. *Agricultural Systems*, **49(2):**177-216.

Khan, T.A. and Mazid, M. (2011). Nutritional significance of sulphur in pulse cropping system. *Biology and Medicine*, **3(2):**114-133.

Khan, T.A. and Naeem, A. (2011). An alternate high yielding inexpensive procedure for the purification of concanavalin A. *Biology and Medicine*, **3(2):**250-259.

Khan, T.A., Amani, S. and Naeem, A. (2012a). Glycation promotes the formation of genotoxic aggregates in glucose oxidase. *Amino Acids*, **43(3):**1311-1322.

Khan, T.A., Mazid, M., Ansari, S.A., Azam, A. and Naeem, A. (2012b). Zinc Oxide Nanoparticles Promote the Aggregation of Concanavalin A. *International Journal of Peptide Research and Therapeutics*, doi: 10.1007/s10989-012-9324-x.

Khan, T.A., Saleemuddin, M. and Naeem, A. (2011). Partially Folded Glycated State of Human Serum Albumin Tends to Aggregate. *International Journal of Peptide Research and Therapeutics*, **17:**271-279.

Khind, C.S. and Meelu, O.P. (1991). Leaching losses of urea-N applied to permeable soils under lowland rice. *Nutrient Cycling in Agroecosystems*, **28(2):**179-184.

Kotler, P. (2008). Marketing Management, Prentice Hall.

Koutsoyiannis, A. (2008). Modern Microeconomics, Macmillan.

Kumbhar, V. (2011). Performance of Agriculture Sector in India: Special Reference to Post Reform Period. *Available at SSRN 1748246*.

Lin, L. and Kulatilaka, N. (2007). Strategic growth options in network industries. *Advances in Strategic Management*, **24:**177-198.

Litsinger, J.A., Libetario, E.M. and Canapi, B.L. (2009). Eliciting Farmer Knowledge, Attitudes, and~ Practices in the Development of Integrated Pest Management Programs for Rice in Asia. *Integrated pest management: dissemination and impact*, 119-273.

Lokuruka, M.N.I. (2012). Role of zinc in human health with reference to African elderly: a review. *African Journal of Food, Agriculture, Nutrition and Development*, **12(6):**22-29.

Maddala, G.S. (1992). Introduction to Econometrics, 2nd edition, Macmillan.

Malek, M.A., Sarwar, C.D.M., Sarker, A. and Hassan, M.S. (1996). Status of grasspea research and future strategy in Bangladesh. *Lathyrus Genetic Resources in Asia*, 7.

Mann, C.L. (1986). Prices, profit margins, and exchange rates. *Fed. Res. Bull.*, **72:**366-370.

Matthews, R., Stephens, W., Hess, T., Middleton, T. and Graves, A. (2002). Applications of crop/soil simulation models in tropical agricultural systems. *Advances in Agro.*, **76:**31-124.

Mazid, M., Khan, T.A. and Mohammad, F. (2011a). Effect of abiotic stress on synthesis of secondary plant products: a critical review. *Agricultural Reviews*, **32(3):**172-182.

Mazid, M., Khan, T.A. and Mohammad, F. (2011b). Potential of NO and H2O2 as signaling molecules in tolerance to abiotic stress in plants. *Journal of Industrial Research and Technology*, **1(1):**56-68.

Mazid, M., Khan, T.A. and Mohammad, F. (2011c). Response of crop plants under sulphur stress tolerance: A holistic approach. *Journal of Stress Physiology and Biochemistry*, **7(3):**23-57.

Mazid, M., Khan, T.A. and Mohammad, F. (2011c). Role of secondary metabolites in defense mechanisms of plants. *Biology and Medicine*, **3(2):**232-249.

Mazid, M., Khan, T.A. and Mohammad, F. (2012). Role of nitrate reductase in nitrogen fixation under photosynthetic regulation. *World Journal of Pharmaceutical Research*, **1(3):**386-414.

Miah, A.A., Maniruzzaman, A.F.M. and Rahman, M.M. (1989). Problems and prospects of pulses production. *Advances in Pulses Research in Bangladesh*, **87:**18-25.

Mishra, R.K. (2007). *Livestock-Crop Production Systems and Livelihood Development*. Atlantic Publishers & Dist.

Mohammadi, K., Ghalavand, A., Aghaalikhani, M. and Eskandari, M. (2009). Increasing Chickpea Quality and Agroecosystm Sustainability Using Organic and Natural Resources. *World Academy of Science, Engineering and Technology*, **57:**572-579.

Mohammadi, K., Sohrabi, Y., Heidari, G., Khalesro, S. and Majidi, M. (2012). Effective factors on biological nitrogen fixation. *African Journal of Agricultural Research*, **7(12):**1782-1788.

Mugabe, J. (2003). International trends in modern biotechnology: Entry by and implications for African countries (No. 15). African Technology Policy Studies Network.

Naeem, A., Khan, T.A., Muzaffar, M., Ahmad, S. and Saleemuddin, M. (2011). A partially folded state of ovalbumin at low pH tends to aggregate. *Cell Biochemistry and Biophysics*, **59:**29-38.

Nielsen, D.C. (2001). Production functions for chickpea, field pea, and lentil in the central Great Plains. *Agronomy journal*, **93(3):**563-569.

Norton, R.B., Parthasarathy, M. and Pomareda, C. (1978). The Importance of Risk in SWP-307 Agricultural Planning Models.

Pal, M.S. (2007). Integrated Plant Nutrient Management for Sustainable Crop Production. In *International Conference on 21st Century Challenges to Sustainable Agri-Food Systems Biotechnology, Environment, Nutrition, Trade and Policy* (pp. 15-17).

Pande, S., Sharma, M., Ghosh, R., Rao, S.K., Sharma, R.N. and Jha, A.K. (2012). Opportunities for Chickpea Production in Rainfed Rice Fallows of India. Baseline Survey Report.

Parthasarathy Rao, P., Birthal, P.S., Bhagavatula, S. and Bantilan, C.S. (2010). Chickpea and pigeonpea economies in Asia: facts, trends and outlook.

Patil, S.V., Halikatti, S.I., Hiremath, S.M., Babalad, H.B., Sreenivasa, M.N., Hebsur, N.S. and Somanagouda, G. (2012). Effect of organics on growth and yield of chickpea (*Cicer arietinum* L.) in vertisols. *Karnataka Journal of Agricultural Sciences*, **25(3):**19-24.

Pingali, P. (2007). Westernization of Asian diets and the transformation of food systems: implications for research and policy. *Food Policy*, **32(3):**281-298.

Popelka, J.C., Terryn, N. and Higgins, T.J.V. (2004). Gene technology for grain legumes: can it contribute to the food challenge in developing countries? *Plant Science,* 167:195-206.

Poudel, D.D., Horwath, W.R., Lanini, W.T., Temple, S.R. and Van Bruggen, A.H.C. (2002). Comparison of soil N availability and leaching potential, crop yields and weeds in organic, low-input and conventional farming systems in northern California. *Agriculture, ecosystems and environment*, **90(2):**125-137.

Pullabhotla, H. and Ganesh-Kumar, A. (2012). *Review of input and output policies for cereal production in Bangladesh* (No. 1199). International Food Policy Research Institute (IFPRI).

Reddy, A. (2009). Pulses production technology: Status and way forward. *Economic & Political Weekly*, **44(52):**73-80.

Russell, J.S., Cameron, D.M., Whan, I.F., Beech, D.F., Prestwidge, D.B. and Rance, S.J. (1993). Rainforest trees as a new crop for Australia. *Forest Ecology and Management*, **60(1):** 41-58.

Saxena, K.B., Kumar, R.V. and Sultana, R. (2010). Quality nutrition through pigeonpea—a review. *Health*, **2:**1335-1344.

Shakya, M.S., Patel, M.M. and Singh, V.B. (2008). Knowledge Level of Chickpea Growers about Chickpea Production Technology. *Indian Res. J. Ext. Edu*., **8:**19-25.

Siddhuraju, P., Vijayakumari, K. and Janardhanan, K. (1996). Chemical Composition and Protein Quality of the Little-Known Legume, Velvet Bean (*Mucuna pruriens* (L.) DC.). *J. Agric. Food Chem*., **44:**2636-2641.

Singh, B. and Singh, U. (1991). Peanut as a source of protein for human foods. *Plant Foods for Human Nutrition (Formerly Qualitas Plantarum)*, **41:**165-177.

Singh, M.D.D., Singh, M.N.P. and UOCB, D. (2004). To Assess the Usage of Fertilizers in the Hill Districts of Uttaranchal. *Study Conducted for Center for Organic Farming (COF) Part*.

Singh, R.P. (1990). Status of chickpea in the world. *International Chickpea Newsletter*, **22:**10-16.

Soltani, K., Ghassemi-Golezani, F.R., Khooie, M. and Moghaddam (1999). A simple model for chickpea growth and yield. *Field Crops Research*, **62:**213-224.

Suhasini, P., Kiresur, V.R., Rao, G.D.N. Bantilan, M.C.S. (2009). Adoption of chickpea cultivars in Andhra Pradesh: Pattern, trends and constraints. *Draft report, Tropical Legumes*, **2:**11-17.

Tripathi, P.K., Singh, M.K., Singh, J.P. and Singh, O.N. (2012). Effect of rhizobial strains and sulphur nutrition on mungbean (*Vigna radiata* (l.) wilczek) cultivars under dryland agro-ecosystem of Indo-Gangetic plain. *African Journal of Agricultural Research*, **7(1):**34-42.

Upton, M. (2000). The 'Livestock Revolution'–Implications for smallholder agriculture: A case study of milk and poultry production in Kenya. *Food and Agriculture Organization of the United Nations. Rome, Italy*.

Yadav, S.S., Redden, R., Chen, W. and Sharma, B. (2007). Chickpea Breeding and Management. Oxfordshire, OX: CABI Publication, p. 638.

Zhao, F., Evans, E.J., Bilsborrow, P.E. and Syers, J.K. (2006). Influence of sulphur and nitrogen on seed yield and quality of low glucosinolate oilseed rape (*Brassica napus* L). *Journal of the Science of Food and Agriculture*, **63(1):**29-37.