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Working paper

CHICKPEA VALUE CHAIN FOOD LOSS ANALYSIS: CAUSES AND SOLUTIONS

Case studies in the small-scale agriculture and fisheries subsectors

State of Andhra Pradesh – India

Manuscript

Chickpea value chain
Food loss analysis: causes and solutions

Case studies in the small-scale
agriculture and fisheries subsectors
In the State of Andhra Pradesh, India

Manuscript

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Executive Summary

This study covers chickpea post-harvest value chain in the state of Andhra Pradesh and was conducted during the period April – August 2016. Chickpea value chain was selected because of its importance in the state's food security and economy. The methodology focuses on identifying the symptoms and causes of food loss and finding relevant solutions, using a phased "4S" approach consisting of Screening (secondary research from documents, reports, and expert consultations), Survey, Sampling, Synthesis (root cause analysis and solution finding). The methodology also takes into account environmental, social and food safety aspects that enable formulation of well-rounded solutions in addressing the losses. The strategy aims at using the results of the case studies to target opportunities for further detailed studies with a wider scope that can lead to concrete investment programmes and interventions. In the case of these findings indicating low levels of losses, the study helps in identifying the reason for such low losses and articulating the learning for implementation in other regions.

Food supply chain selected for the study was that of desi variety of Chickpea in the Prakasam and Kurnool districts of Andhra Pradesh. The supply chain studied included all four final products - whole chickpea, chickpea split dal, roasted chickpea dal, and chickpea flour. Both cold and dry storage warehouses were observed. Value chain actors such as farmers, commission agents, warehouses, processors, transporters, wholesalers and retailers were surveyed to understand activities such as harvesting, threshing, transportation, storage, dal milling, flour milling, and trading.

The study found Chickpea to be an environment friendly crop. Socially, men and women contribute to the value chain, though the activities and responsibilities are segregated, more due to cultural reasons rather than gender exploitation. Food safety wise, there were no unfavourable observations in the supply chain.

In this selected Food Supply Chain (FSC), no critical loss points were observed. At each stage/activity of the FSC, good practices were reported resulting in low loss points viz. mechanical threshers for threshing, professionally managed dry and cold storage houses, wide adoption of single variety owing to uniform size and better processing efficiencies, good transport practices and conditions, fast rotation of small quantities at wholesale and retail stages. The low loss observations were found to be in agreement with the low losses reported by CIPHET, ICAR 2015 study.

Root causes/reasons for the low loss points were identified through further deliberation with experts and key stakeholders and through analysis. These findings were further discussed and validated in the consultative workshop with stakeholders. Some of the key findings include:

- Research leadership & adoption of latest technologies: Close presence of research institutes like ICRISAT, RARS, ANGRAU, help in relevant research and quick dissemination.
- Adoption of good agricultural practices: Chickpea farmers in Andhra Pradesh show good fast adoption of best agricultural practices.
- Commercial rental farm services: Most of the chickpea farming activities are mechanized and available for hire increasing the adoptability by smallholder farmers.
- Aggregated farming by farmer groups: Availability of mechanized farm services and land on lease, facilitate aggregated farming by farmer groups resulting in knowledge sharing and market linkages
- Availability of storage facilities: Cold and dry storages that are professionally managed are widely available and used by chickpea farmers
- Transparent sales system: Most supply chain actors have easy access to market information, thus increasing competition and efficiency in the supply chain
- Better support infrastructure: The roads in the districts of Prakasam and Kurnool are well developed
- Simple processing technologies: Technology is simple, resulting in good processing efficiencies

Based on the above analysis, recommendations were suggested for possible future actions that could be applied to other geographies in the state and elsewhere. These included capacity building for farmers (who use their own storages) on scientific storage practices, promotion of cold and dry storages, listing of a crop in commodity exchange, promotion of aggregated farming by farmer groups, promotion of single variety in smaller areas. The expected cost-benefit scenario analysis for two of the above suggested recommendations was also done.

Glossary

Names	Description
A3P	Accelerated Pulses Production Programme
AGMARK	Agriculture Marketing
AICRP	All India Coordinated Research Projects
ANGRAU	Acharya N. G. Ranga Agricultural University
APMARKFED	Andhra Pradesh State Co-operative Marketing Federation Ltd
BRC	British Retail Consortium
CACP	Commission for Agricultural Costs & Prices
CER	Currency Exchange Rate
CIAE	Central Institute of Agricultural Engineering
CIPHET	Central Institute of Post-Harvest Engineering & Technology
CLP	Critical Loss Point
DAP	Di-ammonium phosphate
FAO	Food and Agriculture Organization
FMCG	Fast-moving consumer goods
FSC	Food Supply Chain
FSSAI	Food Safety and Standards Authority of India
GHG	Greenhouse gases
GHP	Good Hygiene Practices
GOI	Government of India
HACCP	Hazard analysis and critical control points
HDPE	High-density polyethylene
ICAR	Indian Council of Agricultural Research
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IIPR	Indian Institute of Pulses Research
JG11	Seed variety
KAK2	Seed variety
LLP	Low Loss Point
MoFPI	Ministry of Food Processing Industries
MSP	Minimum Support Price
NA	Not Applicable
NABARD	National Bank for Agriculture and Rural Development
NAFED	National Agricultural Cooperative Marketing Federation of India
NBEG47	Seed variety
NCDC	National Cooperative Development Council
NCDEX	National Commodity & Derivatives Exchange Limited
NDC	National Development Council
NSFM	National Food Security Mission
QLT	Qualitative
QNT	Quantitative
RARS	Regional Agricultural Research Station
SEBI	Securities and Exchange Board of India
UAE	United Arab Emirates
USD	United States Dollar
WDRA	Warehousing Development and Regulatory Authority

1. THE CHICKPEA SUBSECTOR - Introduction and Background

a. Status and importance of the subsector:

Chickpea (*Cicer arietinum*), also known as Bengal gram or Chana in India, is one of the major pulses cultivated and consumed in India. It is one of the oldest, important and ubiquitous source of protein for the people of India. After dry bean and peas, chickpea is the third most important pulse crop grown in the world accounting for around 20% of the world pulses production[1]. The year 2016 has been declared as the International year of pulses and there is a worldwide attention on this crop.

India is the world's largest producer as well as consumer of chickpea. The country produces around 8 million MT of chickpea annually which contributes to nearly 70% of the world's chickpea production. Two varieties of chickpeas are grown in the country namely:

- Desi: Dark brown in colour, relatively smaller in size, thicker seed coat and is consumed in four different forms (whole chickpeas, split gram, roasted gram and flour).
- Kabuli: Whitish cream in colour, relatively larger in size, thinner seed coat and is served as whole seed.

Kabuli chickpea **Desi chickpea**

Consumption forms and the various names by which they are known

Kabuli chickpea Kabuli chana	Whole chickpea Desi chickpea Desi chana Bengal Gram	Chickpea split dal Chana dal Gram dal	Roasted chickpea dal Roasted chana dal Roasted gram dal Phutana Chutney dal	Chickpea dal flour Chana dal flour Besan Gram flour

Months	J	F	M	A	M	J	J	A	S	O	N	D
Sowing												
Harvest												
Sales												

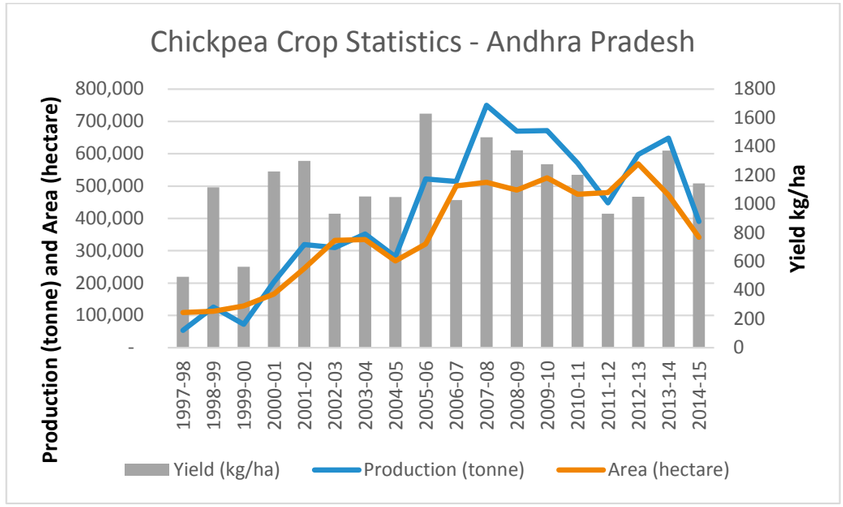
Chickpea is a three month rabi crop (winter crop season) sown between mid of October to mid of December and is harvested between mid of January to mid of March. In India, the crop is grown mainly in the states of Madhya Pradesh, Rajasthan, Maharashtra, Uttar Pradesh, Karnataka and Andhra Pradesh. Together these six states account for more than 90% of the area under chickpea production[2]. Over the past few decades, production of chickpea in the country has significantly moved from the cooler, long season environments in Northern India to warmer, short season environments in Central and Southern India. Development of short duration cultivars has played a key role in the expansion of area and productivity of chickpea in South and Central India.

The state of Andhra Pradesh lies in the southern part of India and contributes to around 9% of the country's chickpea production. The increase in area under cultivation, production and productivity of chickpea in this state has been phenomenal in the past decades. Between 1997-98 and 2013-14, the area under production of chickpea in Andhra Pradesh has grown over 5 times and the production grew by more than 12 times. The yield has more than doubled to around 1,300kg/ha which was mainly due to

1India's Pulses Scenario, National Council of Applied Economic Research, New Delhi

2Directorate of Economics and Statistics, Department of Agriculture, Cooperation and Farmers Welfare at http://eands.dacnet.nic.in/

the introduction of better varieties and their adoption by the farmers in Andhra Pradesh. However, there is a reduction in the acreage as well as production in the last two years which is due to the combined effect of unfavourable weather and low prices in 2013-14. The following graph shows the trends in the area under production, production and yield of chickpea in Andhra Pradesh.



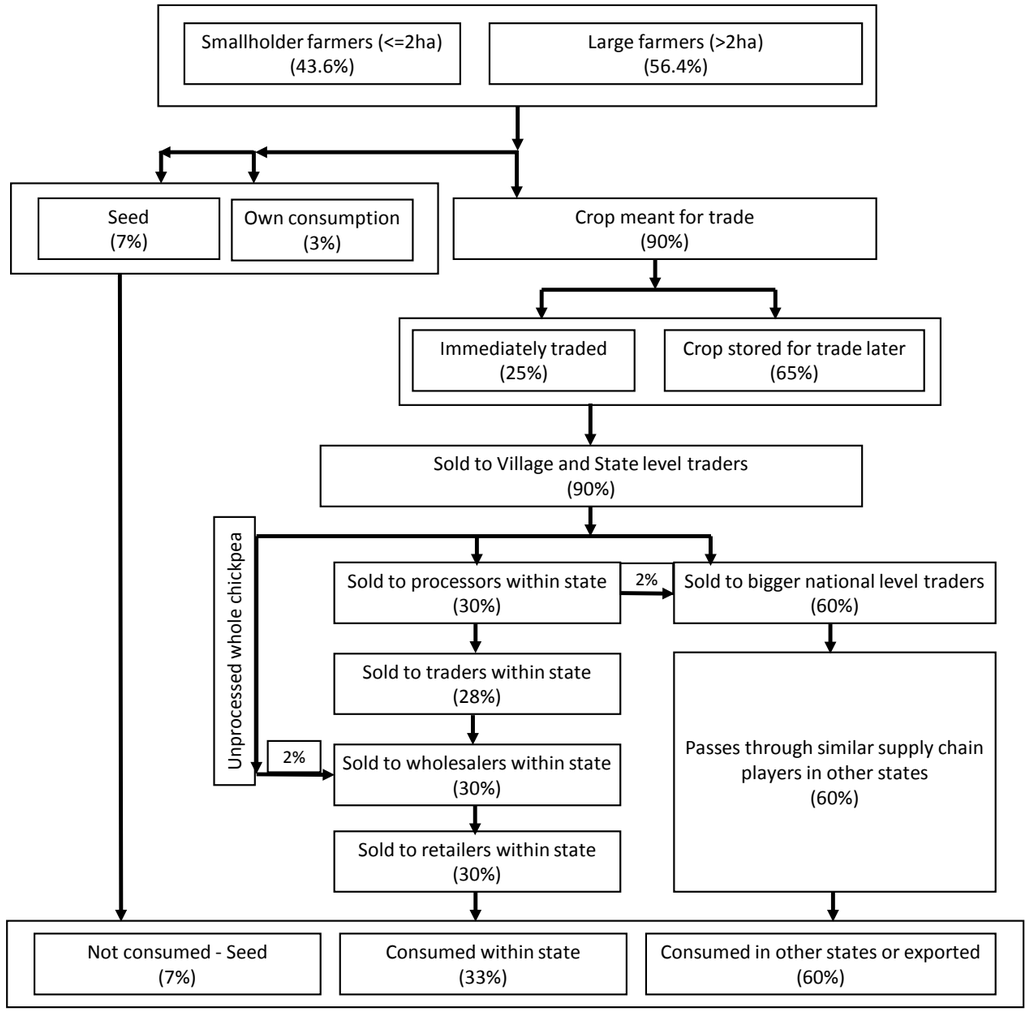
Source: Ministry of Agriculture and Farmers Welfare

Economic Importance of Chickpea[3]: Despite being the largest producer of chickpea in the world, India still imports significant quantities of chickpea from different countries as the domestic consumption is high. In 2014-15, India imported around 418,870 MT of chickpeas (about 5% of the total production of India) primarily the desi variety from countries like Australia, Russia, Tanzania and Myanmar. Despite a restriction on export of pulses[4] from India as they form a part of essential commodities, Kabuli chickpea and restricted quantities of Desi chickpea is allowed for export and it contributes the largest share in India's export basket of pulses. India exported around 190,230 MT of chickpeas (about 2.3% of total production) in 2014-15 to countries like Pakistan, Algeria, Turkey, Sri Lanka and UAE. With the increase in the consumption levels of pulses being observed over the past decade, the domestic production of chickpea is important to the nation to reduce its dependence on imports. Chickpea in Andhra Pradesh contributes to more than USD 330mn to the economy[5].

Nutritional importance of chickpea: Pulses are a low cost vegetarian source of protein and chickpea is one of them. Chickpea seed has 38-59% carbohydrate, 22-24% protein, 3% fibre, 4.8-5.5% oil, 3% ash, 0.2% calcium, and 0.3% phosphorus. Digestibility of protein varies from 76-78% and its carbohydrate from 57-60%[6]. The per capita consumption of chickpeas in India varies across the different regions of the country, and it is estimated to be around 6 kg per annum on average. As the income levels are on the rise in the country, the demand for protein is expected to increase and this is expected to drive the demand for chickpea in the near future. Since the majority of the chickpea farmers in India are small and marginal, this crop also contributes significantly to their incomes and thus plays a critical role in providing the livelihood for them.

[3] Commodity profile for pulses – July 2016 from Department of Agriculture, Cooperation and Farmers Welfare
[4] Notification No 78 (RE – 2013)/2009-2014 at http://dgft.gov.in/Exim/2000/NOT/NOT13/not7814.htm
[5] Sathguru research & analysis
[6] Hulse, J.H. (1991). Nature, composition and utilization of grain legumes (pp. 11-27)

Output I-1a: National Production Information of chickpea subsector - Actors and product flow



The above flow diagram shows in detail, the value chain path of chickpea moving from producers to the end consumers. Several actors participate in the value addition process and the role played by them is explained below.

Farmers/ Producers: Farmers who own a landholding less than 2 hectares in size are considered as small farmers and the remaining are broadly classified as medium or large farmers. In chickpea production, around 43.6% of the farmers are small[7]. Post-harvest, the farmers retain a small quantity (7%) of the produce as seed for next season and some for personal consumption (3%)[5]. The remaining produce is traded in an unorganized manner through traders/ commission agents. Depending upon the prevailing prices, farmers sell their produce to the traders immediately, or store the produce in warehouses/ cold storages for some period and sell them to the trader at an appropriate time. Generally, the small farmers cannot afford to keep their produce in storage spaces as they need to sell their produce to the traders for

[7] Agricultural census database at http://agcensus.dacnet.nic.in/

their sustainable income. Around 25%[5] of the produce is traded directly while the remaining produce enters storage spaces for trading at a later date.

Traders: Traders play an important role in the value chain by connecting the producers to the processors or to other traders in a different state and also by connecting processors to wholesalers or traders in different states. This way they ensure a continuous supply of the raw materials to the processors, continuous supply of processed products to the markets and also create a wider market for the produce. The traders charge ₹ 10 per quintal (USD 1.5 per tonne)[5] for their service.

Storage providers: Storage providers provide farmers/ traders, space on a rental basis to store their produce and ensure that the produce thus stored is well maintained. Thus they play an important role in controlling the losses in the value chain and in ensuring availability of quality produce for processing. They also play a key role in ensuring better returns to the farmers. The storage space can be a dry warehouse or a cold storage.

Processors: Processors procure raw material through traders and process them into value added products thus ensuring wider usage of the produce. A major fraction of the processors in the state are small with processing capacities of around 0.5 – 1 tonne per hour[5]. Only desi variety of chickpeas are processed and Kabuli variety are consumed as such. Split gram, roasted gram and flour are the major products from the processing activity. Around 30%[5] of the total produce is processed within the state while 60% of the produce is exported to other states as such.

Wholesalers and retailers: Wholesalers and retailers maintain a stock of whole chickpeas as well as processed products and distributes them to the end consumers thus playing a key role in reaching the end consumers. Apart from the chickpea, they deal with several other commodities. Retailers based on their method and scale of operation can be segmented into traditional mom & pop stores, supermarkets, hypermarkets and e-retailers.

OUTPUT I-1b: STATE PRODUCTION INFORMATION OF THE SUBSECTOR

The table below provides a synopsis of some key data points with respect to production and processing of chickpea in the state of Andhra Pradesh. Costs involved in land lease, land preparation, irrigation, purchase of inputs, harvesting and threshing are the broadheads covered under the calculation of the average cost of production. The average cost of production mentioned below is calculated for Andhra Pradesh state during rabi season 2015.

Year 2014-15; CER USD= 65 ₹	**Annual production (ton/year)**	**Cultivated area (ha)**	**Average yield (ton/ ha)**
Raw material (2014-15)	390,000	341,000	1.14
Average annual growth over the last 10 yr (%)	45%	21%	8.7%
Average cost of production (USD / tonne)	400[2]		
Percentage of production	on-farm consumption 10%	marketed 90%	
	Equivalent volume of raw material (ton/year)	**value (million USD/year)**	
Market product #1, Whole Chickpea (Kabuli) (10%)[8]	39,000	54	
Market product #2, Whole Chickpea (Desi) (5.5%)	19,500	21	
Market product #3, Split gram (39%)	152,100	152	
Market product #4, Roasted gram (Roasted/ fried gram) (13%)	50,700	52	
Market product #5, Gram Flour (33%)	128,700	131	

[8] Sathguru analysis. Prices as of May end 2016.

OUTPUT I-1c: FOOD SAFETY MANAGEMENT MECHANISMS.

Chickpea is a moderately hardy crop. The major food safety risks are adulteration during processing and rodents/ insecticides during storage. The table Output I-1c captures in detail the situation of the food safety mechanisms that are in place at different levels in the value chain of chickpea. While there are defined quality standards that are prescribed at different levels, the quality checks and audit procedures on the ground are very minimalistic and are based on the visual inspection. Basic hygiene standards are maintained at the processing level due to the regular government audits. However, they are unaware of the global standards of processing like HACCP, BRC and there are no incentives for them to maintain high quality standards.

Controller	**Control**	**Actual Situation in the FSC**		**Responsible agent**
Government regulation and requirements	National food safety/ quality standards	Exists and applies to the whole FSC		AGMARK, NAFED, NCDEX
		Exists but not rigorous	X	
		Doesn't exist		
	Frequency of checking (None, Low, Medium, High)	Harvest	N	
		Transport	N	
		Storage	M	Agricultural Produce Marketing Committee
		Process	M	Department of Commerce, FSSAI,
		Market	M	Agricultural Produce Marketing Committee
	Obligatory registration of the food processing/ preparation unit	Exists	X	Department of Commerce, FSSAI, Labour Department, Commercial Tax Office, Central Excise Office, Pollution Control Board
		Doesn't exist		
FSC actors - food safety management system	GHP/ GAP/ HACCP/ voluntary standards		N	
	Identification of potential hazards		M	

b. Inventory of activities and lessons learnt from past and on-going interventions in subsector losses

The state of Andhra Pradesh has witnessed a phenomenal progress with respect to the production of chickpea in the past 15 years. There is a substantial increase in the area under the crop, production as well as productivity of the crop. Though the crop is grown in several districts of the state, the districts of Kurnool and Prakasam are the forerunners for this change.

Introduction of high yielding varieties: One of the key reasons for this change is the introduction of high yielding variety seed- JG11 by International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and members of All India Coordinated Research Project (AICRP) on chickpea in 1999[9]. The variety was quickly and widely accepted by the farmers in the region with acceptance levels more than 90% as reported by experts during primary survey. Studies on another new variety of seed NBEG-47 which is a machine harvestable variety are currently being carried out. Post introduction of this variety it is expected that the labour requirement for harvesting will come down significantly.

[9] Directorate of Pulses Development, Department of Agriculture Co-operation and Farmers Welfare, India at http://dpd.dacnet.nic.in/

Mechanization of farms & collective pest management: Most of the farm operations in chickpea farming are mechanized. Farmers have access to machines for planting, spraying and threshing. The pest management process in the region is outsourced to private parties for a small fee (Rs.1000/acre ~ USD 38/hectare). These players regularly watch the fields for pest incidence like pod borers and spray pesticides post incidence. Threshers are widely available (Rs.2000/acre ~ USD 76/hectare) and no manual threshing was reported. These developments not only have reduced the drudgery but also helped in increasing the efficiency of farm operations.

Adoption of cold storages & warehouse receipt financing: Cold storages allows chickpeas to be stored for time periods of 3-4 years without any loss in quantity, quality or vitality of seed. The cold storage also eliminates the use of storage chemicals during the storage period. Post their introduction in Ongole region way back in 2002-03, the cold storages quickly gained popularity and their presence and coverage increased tremendously. Post entry of collateral management service providers and banks into warehouse receipt financing, the number of farmers storing their produce in warehouses/ cold storages further increased.

The development of well-connected road and transport infrastructure is of another indirect help to the supply chain as it reduces the need for maintenance of higher inventory in processing, wholesale and retail stages.

c. The process of policy making and current policy framework or national strategy on subsector losses (if any), and brief description/ assessment of the level and extent of current implementation.

Accelerated Pulse Production Programme (A3P) – National Food Security Mission (NFSM) – The National Development Council (NDC) launched a food security mission in October, 2007 comprising rice, wheat and pulses. The key objective of NFSM is to increase the production of rice by 10 million tonnes, wheat by 8 million tonnes and pulses by 2 million tonnes by 2011-12. A3P is sub-segment of NFSM targeted towards vigorous implementation of the pulses development program under the NFSM- Pulses. This program has brought India closer to self-sufficiency by directly facing the challenges of pulses production which are mainly: rain-fed and highly varying local conditions, uncertainty in prices, marginal soils, production losses, smallholder resource poor farmers, complex biotic constraints etc. The success of the program resulted in an increase of 15% in area harvested under pulses, 8% increase in yield per hectare and the overall production of pulses increased from 14.32 million tonnes in 2005-06 to 17.76 million tonnes in 2010-11.

Minimum Support Price Scheme (MSP)[10]*:* Minimum Support Price scheme is a scheme by Government of India (GOI) to safeguard the interests of the farming community in the country. Under this scheme, GOI declares minimum support prices of various agricultural commodities and thereby protecting the farmers from sharp falls in the market prices of the commodities. MSP is computed on the basis of the recommendations made by the Commission for Agricultural Costs and Prices (CACP). The government uses the MSP as a market intervention tool to incentivize the production of a specific food crop which is in short supply. In the last rabi season, so as to incentivize the production of chickpea, the GOI has increased MSP of chickpea from ₹ 3,175 to ₹ 3,425 a quintal (USD 488/ton to USD 526/ton).

Gramin Bhandaran Yojana / Rural Godowns Scheme[11]*:* Gramin Bhandaran Yojana / Rural Godowns Scheme is a capital investment subsidy scheme introduced by Government of India (GOI) for construction, renovation or expansion of warehouses in the rural areas of the country. Under this scheme, subsidies were provided to a number of entrepreneurs for the construction of warehouses and thus directly contributing to the strengthening of agricultural marketing infrastructure in the country. The warehouses thus established ensured that the harvested produce is stored scientifically and thus helped in bringing down the losses of agricultural commodities. Under this scheme, till March 2015, subsidies were provided to 1,225 projects contributing to 4.83 million tonnes of capacity in Andhra Pradesh.

[10] Commission of Agriculture Costs and Prices (CACP) at http://cacp.dacnet.nic.in/ViewContents.aspx?Input=1&PageId=36&KeyId=0

[11] Rural godowns scheme at http://www.archive.india.gov.in/outerwin.php?id=http://agmarknet.nic.in/amrscheme/ruralhead.htm

Some of the other relevant policies include:

Prohibition on exports of chickpeas[4]*:* Government of India, through an order, has introduced a prohibition on the export of pulses from the country from 2006. The prohibition remains valid till further orders. This ban was introduced taking into consideration the nutritional security of the country and the demand – supply mismatch in case of pulses. Kabuli variety chickpea and organic pulses and lentils to the tune of 10,000 MT per year are excluded from the prohibition list. A recent amendment to the policy also excludes export of roasted gram (whole/split) in consumer packs upto 1 Kg. Now as the country is slowly moving towards becoming self-sufficient in case of chickpea, this prohibition on exports may result in an increase in losses or a fall in the prices in the future.

Ban on new future contracts in chickpea[12]*:* Chickpea is the only commodity in the pulses basket that is traded on the commodities derivatives exchange. In June, 2016, Securities and Exchange Board of India (SEBI) which is the regulator of markets in India, imposed a ban on the introduction of any new futures contracts in chickpea. The direction came in after an analysis of the demand and supply scenario, the price trends and the expected supply constraints in the near term. This is mainly to curb the soaring prices of chickpeas. The ban on futures might affect the price discovery as the majority of the value chain players use the platform for information about prices.

d. Relevant institutions and their role in terms of policy, organizational structure, mandate and activities in the small and medium subsector industry sector.

The relevant institutions and their roles are summarized below in broad categories:

Department of Agriculture, Cooperation and Farmers Welfare is the apex body responsible for national policies and programs aimed at achieving agricultural growth. It is a part of the Ministry of Agriculture and Farmers Welfare. Directorate of Pulses Development which works under the department is established in 1971 and is responsible for the coordination and monitoring of all the pulses crop related centrally sponsored schemes and missions.

Department of Agriculture and Cooperation, Andhra Pradesh is commissioned to provide agricultural extension services; assess requirements of agriculture inputs well in advance and to regulate their production and monitor timely supply; perform the statutory functions under various acts and regulations, to ensure supply of quality inputs i.e., seeds, fertilizers and pesticides to farmers.

Directorate of Marketing and Inspection implements agricultural marketing policies and programs of the Government of India. It undertakes standardization, grading and quality control of agricultural produce, market development activities, training of personnel in agricultural marketing, marketing extension, consumer education etc. AGMARK is the certification mark employed on agricultural products by the directorate. The certification is employed through fully state-owned AGMARK laboratories located across the nation which act as testing and certifying agencies.

National Agricultural Cooperative Marketing Federation (NAFED) & Andhra Pradesh State Cooperative Marketing Federation (APMARKFED) are the nodal agencies for procuring of chickpeas at Minimum Support Price (MSP). NAFED is the national level agency and has been procuring grains through APMARKFED which is a state level agency. Apart from the procurement APMARKFED is also into sales of farm inputs like seeds, fertilizers and pesticides.

National Commodity and Derivatives Exchange Limited (NCDEX) is an online multi commodity exchange based out Mumbai in India. The exchange provides a platform for market participants to trade in derivatives of commodities. It also helps farmers of chickpea as well as other value chain players in price discovery. The role of NCDEX is limited till the ban on chana futures is lifted.

Research institutions – Indian Institute of Pulses Research (IIPR), International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Indian Council of Agricultural Research (ICAR), Central Institute of Agricultural Engineering (CIAE) - The research institutions focus on improving

[12] Securities and Exchange Board of India (SEBI) at http://www.sebi.gov.in/sebiweb/home/detail/34084/new/PR-Trading-in-Chana-futures-on-Commodity-Derivative-Exchanges

the complete spectrum of the crop sector activities. The main focus areas include seed varieties, production technologies, farm implements & machinery, climate change impact, product development and value addition, and marketing.

e. Overview of the most important FSCs in the subsector, selection of FSC

OUTPUT I-2a. FOOD SUPPLY CHAINS IN THE SUBSECTOR

The following table presents the various food supply chains (FSCs) that are present in chickpea subsector in the state of Andhra Pradesh. The FSCs are identified are based on the geographic location, final product and markets for the final product. The supply chain for different processed chickpea products (split gram, roasted gram and flour) is nearly the same and is a little different from the whole chickpea supply chain. Hence the products are clubbed into one category. The kabuli variety of chickpea is grown only in Prakasam region in the state.

FSC #	Geographical area of production	Final product	Volume of final product (tonne/year)	Number, age and sex of smallholder producers[7]	Market of final product, location, buyers
1	Prakasam	Whole chickpea (Kabuli and Desi)	95,867	Total farmers: 434,620; Smallholder (<=2ha): 306,432; Medium & Large: 128,188 Male: 77% Female: 23%	North and West India
2		Processed chickpea products			Andhra Pradesh, Tamil Nadu, North and West India
3	Kurnool	Whole chickpea (Desi)	190,205		
4		Processed chickpea products			
5	Kadapa	Whole chickpea (Desi)	43,083		
6		Processed chickpea products			
7	Other districts	Whole chickpea (Desi)	61,812		
8		Processed chickpea products			

OUTPUT I-2b. IMPORTANCE OF FOOD SUPPLY CHAINS (from I-2a) AT NATIONAL LEVEL

The following table shows the mapping of the importance of each of the identified FSC with respect to the economy, foreign exchange generation, nation's food and nutritional security and its impact on the environment. The consumption of Kabuli variety of chickpea within the state is limited and hence it gets exported out of the state mainly to northern states of India. Also, only the Kabuli variety of chickpea is allowed for export to foreign markets and hence they are the only pulses that generate foreign exchange for the country. The desi variety of chickpea is mainly consumed in its processed forms. So its contribution to nutrition is captured under processed products. However, most of the trade happens in the whole chickpea form (so as to preserve quality for a longer period), hence it is very important economically.

Among the processed products of chickpea, split gram is the most consumed product. Roasted gram is mainly used in the preparation of chutneys and is consumed mainly in the southern states of India. Chickpea flour is prepared by milling split gram in small quantities and is stored only for a limited period. Flour is used in the preparation of several sweet as well as savoury dishes and is widely consumed across the nation. In addition, by-products of processing (husk and broken) are used as cattle feed.

FSC #	Economic Importance	Generation of foreign exchange	Contribution to national food consumption	Contribution to national nutrition	Impacts on environment and climate change
1	2	2	2	2	1
2	3	1	3	3	1
3	1	1	1	1	1
4	3	1	3	3	1
5	1	1	1	1	1
6	2	1	3	3	1
7	1	1	1	1	1
8	3	1	3	3	1

Legend 1 (low), 2 (medium) or 3 (high)

OUTPUT I-2c. ECONOMIC IMPORTANCE OF FOOD SUPPLY CHAINS (from I-2a) FOR SMALLHOLDER ACTORS

FSC #	Sex[7]	Percentage of produce by[7]		Contribution to income generation (% share of total annual income)[5]				
		Smallholders	Other	Farmers	Middlemen	Processors	Wholesalers	Retailers
1,3,5,7 (Whole chickpea)	Female (22-25%) & Male (75 – 78%)	40%	60%	80%	50%	NA	5%	0.5%
2,4,6,8 (Processed chick pea products				80%	20%	50%	30%	2%

The above mentioned table depicts the importance of the identified FSCs for different smallholder actors in the value chain. The data on the number of people working in each of the identified FSC that is disaggregated by age and sex is not available. The contributions part of the above table is filled based on the observations made during the primary survey. The majority of the farmers in the surveyed area grow crop only in one season. For the remaining of the year, the land is left fallow. Hence chickpea is a very crucial crop for them. Some small farmers work as daily labour during the offseason and earn daily wages. Apart from this their household also rears some cattle and earns some income by selling the milk in the neighbourhood.

Middlemen involved in trading of whole chickpeas by connecting farmers to the processors or to other traders earn as much as 50% of their annual income from chickpeas. Apart from the chickpeas they also trade other commodities like pigeon pea, jowar, maize etc. Some middlemen are also involved in trading of split gram and roasted gram by connecting processors to wholesalers or traders. The volumes, in this case, are low.

The roasted gram mill can be used exclusively for the manufacturing of roasted gram, while the split gram mill with minor adjustments to roller spacing can be used for processing of pigeon pea. Hence the majority of the processors in the region are also involved in the processing of pigeon pea. In the case of flour mill, a wide variety of other agricultural produce like rice, chillies, jowar (pearl millet) are also processed using the same equipment.

It is observed that the wholesalers handling chickpea and its processed products handle only a few other products like rice, wheat flour, pigeon peas etc. The retailers, on the contrary, handle thousands of other products including FMCG products and thus the contribution of chickpeas and its processed products to their overall income is minimal.

OUTPUT 1-3b.PRELIMINARY SCREENING OF FOOD LOSSES IN THE SELECTED FSC

Chickpea is one of the important crops for the Indian economy. Hence a lot of importance is accorded to it and a number of studies were conducted in the past to understand the losses in the subsector.

A study of the literature indicates that chickpea losses in Andhra Pradesh is around 2.5%[13] and much lower compared to the national figure of 8.41%. The major losses that occur in chickpea are those during production due to high pest incidence such as pod borer. In the all India study, post-harvest losses occur relatively higher during harvesting/ threshing and other farm operations (>7%). Food loss during storage is relatively lower (less than 1.5%). Expert consultations from International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and Acharya N. G. Ranga Agricultural University (ANGRAU) also confirmed the progressive nature of Andhra Pradesh chickpea farmers and low losses in the state.

The following table was filled based on secondary research from the various past studies, internet sources and expert consultations.

FSC # 1-4 , 4 different final products – whole chickpea, chickpea split dal, roasted chickpea dal, chickpea flour			
Step in the FSC	**Expected Critical Loss Points**		**Comments Remarks**
	Quantitative	Qualitative	
Harvesting	0-2%		Late harvest, rainfall, spillage
Threshing	0-2%		Breakage, improper drying
Storage	0-2%	0-2%	Insects, mould. Literature study reveals losses due to insect attack during storage can cause up to 70% loss. However, in practice, the losses are low if monitored frequently
Dal milling	0-2%	0-2%	Processing inefficiency losses (excluding recovery)
Flour milling	0-1%		Processing inefficiency losses (excluding recovery)
Transport & other handling	0-1%		Other handling

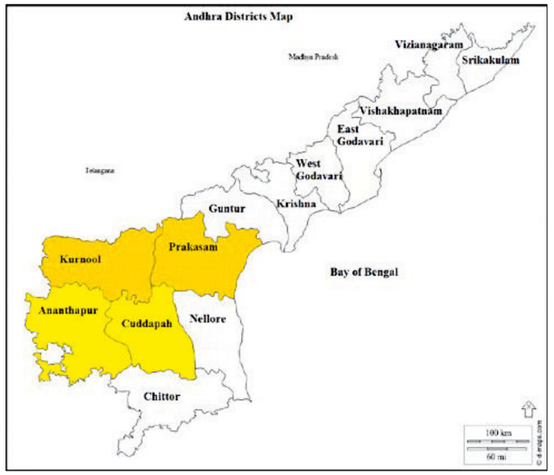
[13] ICAR-CIPHET, 2015, Report on assessment of quantitative harvest and post-harvest losses of major crops and commodities in India. http://www.ciphet.in/study-on-post-harves-losses.php

2. THE FOOD SUPPLY CHAIN - Situation analysis

a. Description of the selected subsector supply chain, its location, an estimate of the quantities of products, and when the case study took place

FSCs 1, 2, 3 and 4 that includes desi chana supply chain leading to four different final products – whole chickpea, chickpea split dal, roasted chickpea dal, and chickpea flour (in Prakasam & Kurnool districts) are considered for further analysis. The rationale for the same is mentioned below.

The rationale for selecting the FSC for case study:



Andhra Pradesh districts

Area cultivated: Chickpea is predominantly grown in 4 districts of Andhra Pradesh – Kurnool, Prakasam, Cuddapah and Ananthapur, accounting for approximately 49%, 25%, 11%, 10% of the production respectively; and totalling to more than 90% of total Andhra chickpea production[14]. Kurnool and Prakasam are identified for the survey as they adequately represent the selected food supply chain for the state. Combined these two districts contribute to more than 70% of total chickpea production in the state. The supply chains in these districts have all the actors and activities and have all four final products of desi chickpea produced, processed and consumed in large quantities.

Varieties grown: Farmers predominantly grow desi chickpea variety in the state accounting for more than 90% of the production[15]. Kabuli variety is grown only in Prakasam district and its share is reducing, further Kabuli variety is majorly exported out of state. So the selected FSC does not study Kabuli variety.

Chickpea in cold storage

Storage practices: Depending on the prevailing prices and farmers' capacity to carry stock, they either sells directly to commission agents/ traders or decide to send for storage. Farmers are well aware of cold storages, dry storages and warehouse receipt options. If the stock is sent to storage, the traders subsequently pick up directly from storage houses as and when a farmer decides to sell. The Farmer's Portal[16] give a more wider listing with about 599 cold storages in the whole of Andhra Pradesh and 1000+ dry warehouses with capacity in excess of 1.3mn tonnes.

Farmers in Kurnool generally store their produce in dry warehouses in a scientific manner at room temperatures. Unlike Kurnool, many farmers of Prakasam prefer to store chickpea in cold storage at a temperature of 10-15 ^{O}C due to the availability of the facility and also given the fact that the quality is maintained for even up to 3-4 years and the germination strengths continue without any reduction. As per the Farmers Portal, there are 47 cold storages (as against 31 in Kurnool) with a capacity of 275,512 tonnes. Dry chillies being the other major crop of the Prakasam region is also a contributor to the proliferation of cold storages in the district and the adoption of cold storage practices by the farmers (Chillies fetch high prices and is stored in cold storages). All these cold storages are connected to the grid and draw electricity from the grid. The grid, in turn, is

[14] State government production information
[15] Estimate from primary survey
[16] Farmer's Portal by Government of India http://farmer.gov.in/MCold_Storage_Total.aspx

Warehouse storage of chickpea

supplied through several energy sources which include renewable as well. Out of total installed utility power generation capacity of 21,000 MW in the state, only 3128 MW (~15%) is from renewable energy sources.

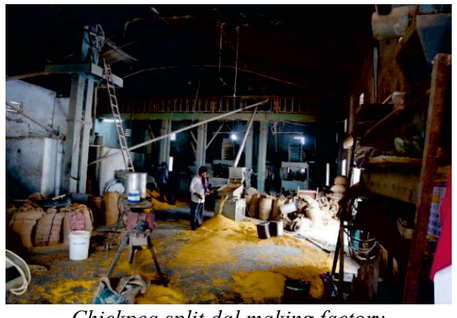
The selected food supply chain study areas have both dry warehouses (in Kurnool) and cold storages (in Prakasam).

Trading practices: Depending on prevailing prices and farmer's ability to carry the stock, the farmer decides to sell or store. The farming community is aware and has access to price information through TV, SMS and internet. However, it was observed that the practical situation still depends on a lot on word of mouth information exchange between farmers. More than 90% of chickpea trade takes place through commission agents/ brokers; the trade through government market centres is only about 7.2%[17]. The commission agents and brokers add value to the supply chain by reducing the counterparty risk for the parties on their either side (the parties could be farmers and bigger traders; traders and processors; processors and wholesalers; traders and wholesalers). They charge a fixed commission of ₹10/quintal (USD 1.53/ton) of the trade from both parties. The trading also involves short term credit practice of about two weeks by the seller to the buyer. A significant portion of the production in Andhra gets exported. Which can be estimated at about 60%.[18]

Processing practices: Chickpea dal has two stages of processing. In the first stage, there are two different processing practices resulting in two products – the normal split chickpea dal and the roasted chickpea dal. In the second stage, the normal split chickpea dal is further ground to produce chickpea flour (known locally as besan). The first stage processing normally takes place in processing factories with a capacity of ~5mt/ day. These factories are normally located in the district headquarters and township areas.

Flour mill to make chickpea flour (second stage processing)

The whole processing activity which involves converting chickpea grains either into split gram or roasted gram is called milling. Drying, de-husking, winnowing and roasting activities are sub-activities that form a part of milling activity and are carried out in the same machinery. Drying is done to reduce the moisture content of the grains and is achieved by heating the grains to a specific temperature using the dryer. De-husking involves removal of husk (top layer) from the grain. This is achieved through 2 steps. First, the husk is loosened by suddenly cooling the heated grain by sprinkling water on it. Later it is removed from the grain at the roller where the grains are split into two halves. Winnowing involves separating husk from grain and is achieved through a series of fans installed in the machinery which blows away the husk that is removed from the grain. Roasting achieved through a roaster which heats the grain to a temperature of 200 deg. C.



Chickpea split dal making factory

The second stage processing takes place at small scale flour mills in retail/ residential areas with a capacity of a tonne or less per day. The second stage processing is preferred to take place as late as possible because the flour with increased surface area loses freshness rapidly and is prone to insect damage. The selected FSC studies both stages of processing.

The below table gives the conversion factors in the FSC. The most important ones being the chickpea split dal outturn at 78% and roasted chickpea dal outturn at 74%.

OUTPUT II-3a (INTERMEDIARY) PRODUCTS AND CONVERSION FACTORS IN THE FSC.

Activity in the process	**Duration[19]**	**Product out**	**Weight from 100**	**Error (Cumulative in brackets) (± %)**	**Conversion Factor**
Harvesting		Chickpea plants	100+	-	1+
Drying	2-3 days	Chickpea plants	100+	-	1+
Threshing		Chickpea	100	-	1
Dal milling		a) Chickpea split dal b) Roasted chickpea dal c) by-products husk and broken	a) 78% b) 74% c) 21%	2% (2%)	1.28 / 1.35
Flour milling		Chickpea flour	98% of Chickpea split dal	1% (3%)	1.31

Transport practices: Transportation is another key activity in the chickpea supply chain and is carried out at different levels i.e. from farm to warehouse/ cold storage, from storage space to processing plant, from plant to distant markets etc. Different modes of transportation are used for transporting chickpeas from one place to another ranging from loading tricycle rickshaws to heavy trucks. The distance transported varies from 5 km to hundreds of kilometres. In all the cases, the losses reported are quite insignificant and the reason being that chickpeas are tough grains and do not get damaged due to rough handling. Also, proper care is taken to prevent any quality losses due to rains. In the majority of the cases, the grains are not transported during rainy days and in the case of long distance transport, the grains are properly covered on all sides using tarpaulin sheets thus ensuring lower losses.

Small scale transportation

[17] Agmarknet http://agmarknet.dac.gov.in/SearchCmmMkt.aspx 2015 mandi arrivals is 28k tons of total 390k tons

[18] Sathguru estimate from primary survey and other secondary data analysis

[19] Only applicable for processes that are determined by a length of time independent of the quantity of product and the amount of labour, such as drying, fermenting, ripening, storage, transportation.

OUTPUT II-3b: DETAILED DESCRIPTION OF THE FOOD SUPPLY CHAIN – BASICS

The below table is filled considering Prakasam district. It will be same for Kurnool also except for change in quantity.

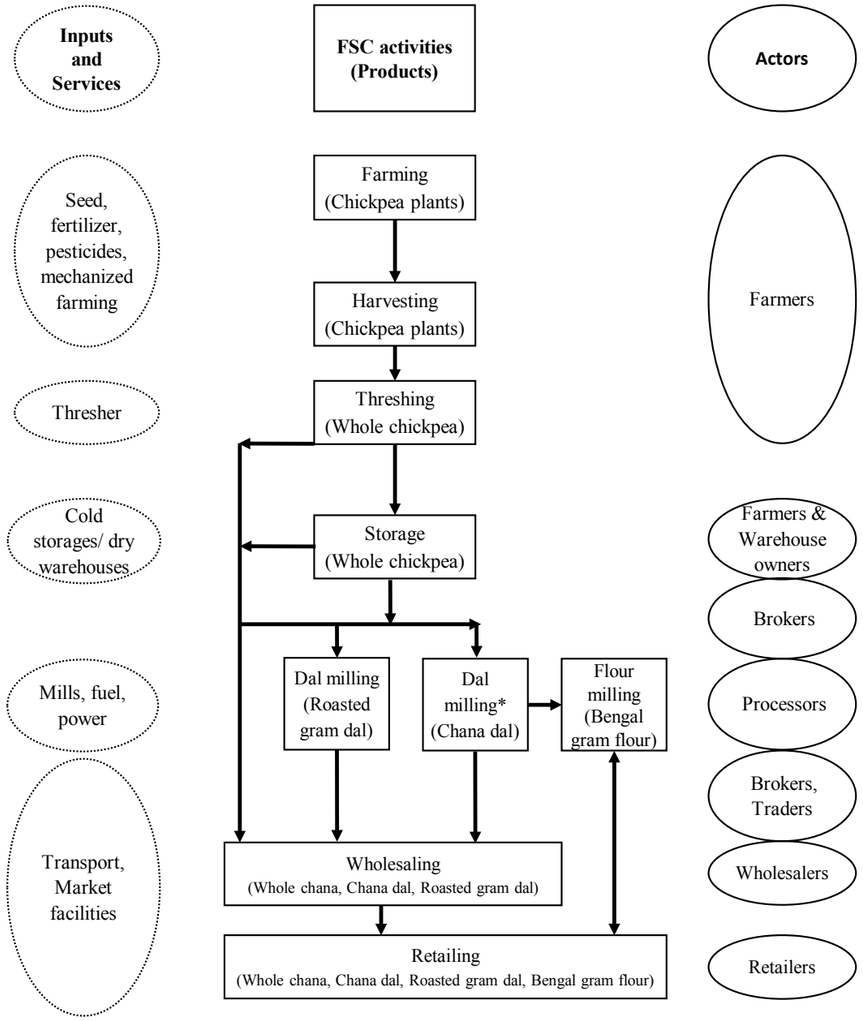
FSC stage[20]	Geographical[21] Location	Months of the year[22]		Main Products[23]	Quantity (tonne)	By-products	Quantity (tonne)	Duration/ Distance[24]	Services	Food safety and quality controls
		From	to							
Primary Production	Prakasam district (Villages Kandukur, Tangutur, Inkollu, Ongole)	Oct	Mar	Chickpea plants	15,000+		-	-	Seeding, spraying, weeding,	NA
Harvest	Same as above	Oct	Mar	Chickpea plants	15,000+		-	-	Manual harvesting	NA
Threshing	Same as above	Mar	Mar	Chickpea	15,000	Stalks, leaves		-	Mechanical Threshing	NA
Transportation	Same as above	Mar	Mar	Chickpea	15,000	-		20km	Loading, offloading, trucking	NA
Storage	Ongole (Prakasam district hq)	0 – 1 month after harvest	1 month to 1 year	Chickpea	15,000	None	-	-	Fumigation	NA
Cold Storage	Ongole (Prakasam district hq)	Mar	1 month to 3 years	Chickpea	15,000	None	-	-	Collateral management services	NA

[20] If one stage in the FSC has two different features, another row should be inserted. E.g. if in the same FSC both crib storage and warehouse storage exist.
[21] Village/town where the FSC stage is located.
[22]Timing of the stage of the FSC.
[23] "final" product produced by stage of the FSC.
[24] How long does the process in the FSC stage take / what is the distance (and duration) of transportation.

FSC stage[20]	Geographical[21] Location	Months of the year[22]		Main Products[23]	Quantity (tonne)	By-products	Quantity (tonne)	Duration/ Distance[24]	Services	Food safety and quality controls
		From	to							
Transportation	Ongole (Prakasam district headquarters)	Continuous	Continuous	Chickpea/ Chickpea split/ roasted dal	15,000			Big range, because it is intra city and exported to other state		
Dal Processing	Ongole (Prakasam district headquarters)	Continuous	Continuous	Chickpea split dal; Roasted Chickpea dal	78% chana dal; ~2700 74% roasted gram dal ~900	Husk Broken dal	Husk 18% Broken dal 3%		Processing	
Wholesale	Ongole (Prakasam district headquarters)	Continuous	Continuous	Whole chickpea; Chickpea split dal; Roasted chickpea dal	~1500					
Retail	Ongole (Prakasam district)	Continuous	Continuous	Whole chickpea; Chickpea split dal; Roasted chickpea dal	~1500					
Flour milling	Ongole (Prakasam district)	Continuous	Continuous	Chickpea flour	98% of chana dal ~600	dust lost in processing; moisture loss;	2%			

b. Description of the existing marketing systems of the selected subsector supply chain, for small-scale producers (formal and informal).

OUTPUT I-3a: FLOW DIAGRAM OF THE SELECTED FSC



*De-husking, winnowing, drying and roasting are all part of the milling activity. Please note, gram flour is made from split gram not from the roasted gram.

Description of the supply chain and the various actors. For each actor we provide the general observations with photos. This section should be read in conjunction with details provided under 2a (rationale for selection of FSC). This section also has a couple of case studies.

De-husking, winnowing, drying and roasting are all part of the milling activity. Gram flour is made from split gram not from the roasted gram.

Farmer: Chickpea is a rabi crop sown between the end of October to end of November depending on the weather conditions prevailing at the time. It is 90-110 days crop and is generally harvested in the month of February. Land preparations start from September and the seeds are planted either manually or using seed drills. Some subsidized seeds are supplied to the farmers by the government. Weeding is done manually employing female labourers. Around 2 bags of DAP and 1 bag of Urea per acre are applied as fertilizer to the soil and around 3-4 sprayings of pesticides or insecticides are done in a season to control the pest/insect damages to the crop. During harvest, the plants are manually cut by female labourers and are left on the field to dry for 3-4 days. Later the plants are collected, and threshing of chickpea is done through mechanical multi-crop threshers.

Farmers meeting in Rangapuram, Kurnool

Farmer explaining a thresher in Inkollu, Prakasam

These threshers can be used for multiple crops and are powered using an external source of power which can be a tractor (30-45 HP) or an electrical/ diesel motor. In the majority of the cases, tractor is used for powering the threshers. The threshing process in these threshers is mainly achieved by three parts, threshing cylinder, outer cylinder and a blower. The threshing cylinder contains rigid tines placed at regular spacing and rotates inside the outer cylinder at 600-800 RPM while the outer cylinder remains stationary. The dried chickpea plants which are fed into the thresher through a hopper gets caught between the tines of inner cylinder and due to the rotation of threshing cylinder the plants move across the length of the thresher from one side to the other. During this process, the plants strike the outer cylinder as well as experience shearing forces due to lateral movement. These forces help in breaking the pods releasing the grains. A strong blower blows away the chaff and broken pods which are lighter through a separate outlet while the grains comes out through a different outlet. Pods are left in the field along with the chaff and waste and are grazed by cattle. The seeds are then filled into gunny bags and sealed.

On an average farmers spend around ₹ 15,000/acre (USD 576/hectare) on the whole farming activities and depending upon the climate, soil and other factors, harvests around 4-10 quintals/acre (1-2.5 tons/hectare) of produce resulting in a profit of about ₹ 27,000/acre (~ USD 1000/hectare) which is equivalent to a profit of ~USD 510 per ton .

Storage: Depending upon the availability of storage spaces and capacity of the farmer to withhold the grain for some time to trade for better prices, farmers either store the produce in cold storages/ dry warehouses or sell them to the commission agents in the villages. Some small farmers might store the produce at their homes but that is only for a limited period (2-3 weeks). In Prakasam district, farmers use cold storages for storage of their produce owing to easy access and availability, however, in Kurnool district, the majority of the farmers use dry warehouses for storage. Dry warehouses are normal buildings with no temperature control or technology involved whereas cold storages are warehouses with temperatures controlled at 10-15ºC and most use ammonia as the refrigerant. Post harvesting and bagging the produce, farmers transport it to the nearby storage spaces either in trucks/ mini vans/ tractors. Upon receipt of goods,

random samples of chickpeas from different bags are collected and checked for the presence of pest and for moisture content.

Based on the checks, the bags are either sent into storage or for fumigation and in extreme cases, they are rejected. Post acceptance, the farmer is given a receipt using which he can also procure a loan from different banks through collateral management service providers who are present in the storage location itself. Regular quality checks and stock maintenance activities are conducted in the storages. The rentals for cold storage are around ₹ 120-150 per quintal/year (USD 21/t/year) while the same for the dry warehouses is around ₹70 per year/quintal (USD 10.5/t/year).

Warehouse in charge sampling stock periodically

Processors: Processors procure chickpeas from the farmers through traders. Processing happens throughout the year while procurement happens as and when required since stocks are also available throughout the year. As a result a small amount of stock is kept in the plant. Two types of processed products are produced from the chickpeas, which are split gram and roasted gram. Depending upon the quality, the chickpeas are processed into either of the two. Better quality chickpeas are sent for the preparation of roasted gram while the lower quality chickpeas are converted into split gram. The procedure, plants and machinery are different and the procedure is explained in the following sections.

Trader sampling while a labor is loading a truck

Preparation of roasted gram: Chickpeas selected for processing into roasted gram are initially put into sieves to separate the debris and other unwanted material. They are then dried using a drier around 50^{O}C to decrease the moisture content and then roasted at 110^{O}C and filled into bags and left to cool for a day. On next day, they are mixed with small amount of water and are once again fed to the roaster, this time at 270^{O}C and the grains are split using rollers. The husk is then separated and the grains are once again passed through sieves to separate full roasted gram, split roasted gram, broken gram. The husk is used as an animal feed and is sold at ₹ 10 per kg (USD 153/t). The broken gram is sold at ₹ 20 – 40 per kg (USD 300-600/t) per for flour production or cattle feed depending on quality. The split roasted gram and full roasted gram are sold at ₹ 80 per kg (USD 1,230/t). The realization of roasted gram from the process is around 74%.

Various products in roasted chickpea production

Preparation of split gram: Similar to the roasted gram processing, the chickpeas selected for processing into split gram are put into sieves to separate the sticks, mud and other unwanted material. The cleaned grain heated to a temperature of around 80^{O}C and then is passed through an elevator where water is sprayed onto the grain. This helps in loosening of the seed coat. The grain is then passed through a roller which split the grain into two. The grain is once again passed through sieves where the un-split grain is separated and is once again taken through the process. The husk is separated using fans into a separate chamber and the husk thus collected is used as an animal feed and is sold at ₹ 10 per kg (USD 153/t). Some processors mix food grade artificial colours to the split gram to enhance the colour. The realization of split gram from the process is around 78%.

Double layered packaging commonly used with inner plastic layer

We present below case studies of selected actors met by us in the case study field visits.

Case study of A Farmer: Mr. Koonam Sunder Rami Reddy is a farmer in the Kandukur mandal of Prakasam District. He owns 4 acres (1.6 ha) of land and in last season (Rabi of 2015) he chose to grow chickpea in his field. People in the region grow alternate crops like tobacco and cotton, but he preferred grow chickpea as it is a relatively easy to grow and maintain crop. He went for JG11 (desi) as well as KAK2 (Kabuli) varieties of chickpea this year as he was uncertain of the weather as well as prices for the varieties. He invested around ₹ 20,000 per acre (USD 769/ha) and the yield he observed was 8 quintals per acre (2 tonne/ha). Like other small famers in the village, he too sold his produce after harvesting to the middlemen. He received ₹ 7,600 per quintal (USD 1169/ton) for JG11 variety chickpea is and received ₹ 9,000 per quintal (USD 1384/ton) for the KAK2 variety chickpea. . He received information on price trends from other farmers in the village who already sold their produce and various other middlemen. According to him, the only loss that occurs in chickpea is when they are on the field and it rains during the harvesting period. Because of the rains, the seed coat of ripe yet unharvested chickpeas becomes dark in colour (qualitative loss) and such chickpeas are not preferred in the market and hence fetch lower prices.

Koonam Sunder Rami Reddy being interviewed with his inputs trader

Case study Commission Agent: Mr. Shiva Reddy works as a commission agent for chickpeas and operates through a small outlet in the Nandyal Region of Kurnool District. Apart from chickpea he also deals in red gram and sorghum. He procures chickpea through middlemen from different villages which are in the vicinity of 50-100 km radius from Nandyal region and connects the produce to either local processors or to traders engaged in cross state transport (Primarily to states of Tamil Nadu and Maharashtra). The majority of his business from chickpea is in the months of July and August. He regularly gets updates about the prices that are prevailing in the NCDEX futures market through SMS messages on his mobile phone and accordingly decides the maximum / minimum price for purchase/ sale of chickpea. According to him, there is only quality loss that is observed in the chickpeas that too either due to rains during harvest season or due to improper handling in the warehouses. He never observed a major quality loss due to pest attacks in

warehouses as all the warehouses in the region adopt best practices to keep pest under control. The produce of lower quality can fetch around ₹ 300/quintal (USD 46/ tonne) less than ongoing market prices.

Case study warehouse: Mr. Anand is currently working as a manager in Kisan Warehouse which is located in Nandyal of Kurnool District. He is a graduate in agricultural sciences and has been working for the warehouse from past 4 years. The capacity of the warehouse is 5,400t and it handles a variety of produce such as sorghum, paddy, maize, black gram, green gram and fox tail millets apart from chickpeas. At the time of our visit, around 300t of chickpeas were stored in the warehouse. As the warehouse is well reputed in the market, farmers from different villages which are in the vicinity of 50kms bring their produce for storage in the warehouse. He checks the goods upon receipt by taking random samples; if accepted he raises the documents for receipt and sends to goods for storage to allotted area in the warehouse. He also collaborates with collateral management service providers to provide documents that help farmers to secure loans with the stock as collateral. He does regular periodic quality checks and fumigation. According to Mr. Anand, there is no quantitative or qualitative loss that occurs in the warehouses as the produce stored is well maintained. Some minor changes in the weight of the produce are observed due to the moisture content present in the outside atmosphere.

Case study cold storage: Mr. Nageshwar Rao is the owner of Ongole Cold Storage which is in the Ongole town of Prakasam District and is also a pioneer for the cold storages in the region. The Ongole cold storage was the first one to be constructed in the region and has a capacity of 7,000t with 5 levels of storage space. The cold storage was mainly constructed for the storage of dry chillies, however in 2002-03 Mr. Nageshwar Rao carried out a pilot study by keeping 47 quintals (4.7t) of chickpeas in the cold storage which was mainly aimed at improving the capacity utilization of the storage. The chickpea thus stored did not deteriorate in quality and the same was advised to the other farmers in the region through a small press conference. The cold storages have become a popular method of storage for chickpeas in the district. The cold storage uses industrial refrigeration technology using Ammonia. Ammonia systems are a safe and sustainable choice. Due to energy efficiency and lower capital costs of ammonia based cold storages compared to that of freons, all the cold storages installed in the surveyed area are ammonia based ones. Ammonia is the most environmentally friendly refrigerant. It belongs to the group of so called “natural” refrigerants, and it has both GWP (Global Warming Potential) and ODP (Ozone Depletion Potential) equal to zero. However, Ammonia is a toxic refrigerant, and it is also flammable at certain concentrations. However, unlike most other refrigerants, it has a characteristic odour that can be detected by humans even at very low concentrations which help as a warning sign even in the case of minor ammonia leakages. For ammonia based storage systems several safety measures are recommended by the regulations which include

Inside Ongole cold storage

- Installation of ammonia chambers in the cold rooms and machine rooms
- Emergency ventilation systems for machine rooms
- Safety release of refrigerant to water pump
- Keeping ammonia masks, first aid kits and instruction manuals for handling emergency situations.

Detailed standards are also published by Chemical Hazards Sectional Committee on the handling of Ammonia.

The average storage period for the chickpeas is around 9 months while some stocks are stored even for 3-4 years without much deterioration in the quality. The peak arrivals season is between mid of February to mid of April. According to him, major losses occur in the chickpeas only in case of an attack of Sitophilus also known as grain weevil which bores holes into the grain and the only way to control the damage is by fumigation. No other treatment is required for stocks when stored in a cold storage.

Case Study for Processor: Mr. Hari Babu is the owner of A1 dal mills in Nandyal town of Kurnool district. The plant contains a roasted gram mill as well as a split gram mill. He employs around 10-12 people, including daily labour, who takes care of the operations of both the plants. These plants are operational throughout the year and the stocks for the processing plants are procured from the farmers who store their produce in the nearby warehouses. This procurement activity is carried out once in a week and the stocks thus procured are placed in the plant itself. The finished goods after processing are also kept in the same location. The machinery in the facility is assembled from different vendors and is more than 10 years old. The split gram and the roasted gram that is processed from his facility is sold to traders from Vijayawada region who in turn transports them to different states.

Roasted chickpea dal processing mill

Wholesale market complex - Prakasam

Case study wholesalers: Mr. Chebrolu Narayan Rao is a wholesaler of chickpea operating from a small outlet in the shopping complex area near Ongole bus stand. He handles both split gram as well as roasted gram. He procures processed chickpea from 3-4 local processors and sells to local retailers in packs of 50kg and 25kg. For quality he trusts the millers who assure him of quality while for price he regularly gets updates from NCDEX. While other wholesalers maintain different qualities of split gram and roasted gram, he maintains only the highest quality produce. He trades around 30-40 quintals (3-4t) of split and roasted gram every month and for containing the losses of the stock in his outlet, he maintains the outlet neat and clean and free from rodents. According to him, the transport losses are to the tune of 1-2 kg per truck which is mainly due to spillage while another 1-2 kg is lost due to rodents. According to him, the key to contain the losses is to order as per demand and maintain low stock levels in the outlet.

Retailer storing in metal containers

Case study of Retailer: Mr. Venkataramaiah is a retailer operating from a small store in the market area of Kurnool. Through his store, he sells a number of products like rice, wheat flour, red gram, split

gram, roasted gram and chick pea floor along with various FMCG products. He procures split gram and roasted gram from the local wholesalers while for flour he converts the procured split gram to flour from local flour mill. He stores these pulses in iron containers to protect them from rodent attacks and sells the pulses in loose form without any packaging while the supermarkets in the region pack and sell them. According to him, depending upon the capacity to sell, different shops maintain different levels of stock and this in ways contain the losses at retailer end.

c. FSC actors' involvement and their benefit, including job creation and income generation; economic data of the FSC; environment-related inputs and factors of the FSC

Chickpea is a male dominated FSC. Women are generally employed as farm labour and in some instances at processing level especially for activities such as winnowing and grading the chickpea in flour mills. Some of the farm lands where chickpea is cultivated are owned by women, however, the men of the household are responsible for the farm's overall management. Involvement of women was observed at the retail level where some of the traditional retail stores are family owned and there is an equal representation of the men and women of the family running the store. The cause for the lesser involvement of women across the chickpea FSC was observed to be more a cultural aspect. The table below gives further details step wise.

OUTPUT II-4: DETAILED DESCRIPTION OF THE FOOD SUPPLY CHAIN – SOCIAL STRUCTURES

FSC STEPS	Involvement of Women		Involvement of Men		Who is mainly involved:	Organization level of FSC actors[25]	Gender / social patterns Observations and remarks that explain the chosen qualifiers and/or give additional information
	Girls	Adult	Boys	Adult			
	Qualifier[26]						
Primary production		1		3	Men	Individual	Women labour for weeding while the rest of the activities are majorly done by men. There is a wage difference of 40% in the payments that are made to the female labour vs male labour. Females are paid @ 180-200 rupees/day, males are paid @ 350-380 /day. Men are involved in tasks such as loading, ploughing, threshing, etc, and women are involved in weeding, cleaning. Work involvement is more of cultural construct of masculinity and femininity.The qualifier in the case of men is 3 as the works that are being handled by men involves machinery.
Harvest		2			Women	Individual	Harvesting is done manually using sickles and other similar equipment. Only women labourers are employed for harvesting the crop as they have to be paid less compared to their male counterparts. The qualifier, in this case, is 2 due to the availability of satisfactory equipment.
Post-harvest, handling		1		3	Men and Women	Individual	Post-harvest handling activities involved includes threshing and filling the grains into bags. Women collect the harvested bundles from the field and bring those to thresher while men operate the thresher and fill the bags. A collection of bundles is done manually and no equipment is used while threshing is done using a thresher.
Storage				3	Men	Collectively in warehouses/ cold storages	According to the warehouse/ cold storage operators, it is considered as a difficult job for women as they have to deal with males at all the levels and the cultural barriers inhibit interactions. Hence none of the warehouses employed any females in their operation/ any other role. Also, it is the male head of the farming household that is involved in this activity. The qualifier is 3 due to the availability of good equipment and excellent sanitary conditions.

[25] f.i. Individual/Household level/Cooperative

[26] Qualify the equipment, conditions, access to services and training, 4: excellent, 3: good, 2: moderately good, 1: bad.

FSC STEPS	Involvement of Women		Involvement of Men		Who is mainly involved:	Organization level of FSC actors[25]	Gender / social patterns Observations and remarks that explain the chosen qualifiers and/or give additional information
	Girls	Adult	Boys	Adult			
	Qualifier[26]						
Transportation				2	Men	Individually	The produce is transported from the farm to the storage spaces using different means of transport like autos (3 wheelers), mini trucks and trucks depending upon the quantity. The qualifier is 2 as the loading into these vehicles is done manually, sometimes also using hooks.
Market sales				4	Men	Individually	The produce is sold to the traders/ commission agents who connect farmers with the processors. All the traders/ commission agents in the surveyed area are men. The qualifier is 4 as the parties on both sides of the sales activity have good access to the prices through their mobile phones.
Agro-processing		2		2	Men and women	Collectively	The processors buy the produce of different farmers for processing through traders/ commission agents. Activities like unloading the bags, filling the bags with processed produce, operation, maintenance and monitoring of the machinery are handled by men while other lower paid jobs like cleaning the plant and grading the produce are handled by women.
Storage				3	Men	Collective	The processor stores the processed produce in the plant itself. The storage period is less than a week and the sanitary conditions in the storage area are satisfactory.
Transportation				3	Men	Collective	Male dominated as women are not involved in transportation.
Wholesale				3	Men	Collective	This process involves negotiating on prices with traders as well as retailers, ensuring sufficient stocks are there in the inventory and the stocks are moving to the designated places at right times. At this stage as well, no women are involved, there are no female wholesalers in the study region.
Retail		2		2	Men and Women		We observed women helping their male family members in running the shops and distributing the goods. The females run the shop on par with males when male family members are occupied in other work. However the decision making on what commodities to keep, how much stock to maintain, what price to sell, where to procure from etc. are taken by the males. The interference of the females in these decision making subjects is limited which is may be due to the family culture.

OUTPUT II-5: DETAILED DESCRIPTION OF THE FOOD SUPPLY CHAIN – ECONOMICS

At the farming level, the cost of cultivation involves the general farming costs of land preparation, inputs, weeding, harvesting. When the land is not owned by the farmer, there is additional land lease cost. The farmer depending on his capacity stores the chickpea for a few months before selling it to agents/ traders. The agents/ traders play an aggregation role and counterparty risk reduction role. However, they tend to appropriate more value of the product by information arbitrage and price play. The processors incur costs of electricity, labour and packing material. The processors sell to wholesalers over a period of time through agents. The wholesalers and retailers rotate their business with small quantities. They adjust prices quite rapidly depending on the market. Using the various price points at different levels of the supply chain as of survey done in second half of May 2016, a detailed reconstruction of the various costs and margins at each actor level was done, the same is attached in Annexure 1. The analysis has left out tax implications and payments at the various stages – VAT and mandi tax – because it is not clear which all players actually pay the taxes and to what extent. Highlights of the detailed Annexure 1 is presented below:

- Farmer incurs various costs like land preparation, irrigation, inputs, harvesting and threshing; and land lease cost if applicable; and storage and broker commission costs. At a price of 846 USD/t he makes a profit of about 1000 USD/ha if the land is his own.
- The costs involved in the storage activity are already included in the farmer costing. The storage costs assumed are 23.077USD/t of whole chickpea for one year. Warehouses charge storage costs for one whole season (12 months).
- The supply chain has traders/ commission agents/ brokers in transactions between farmers and processors/ bigger traders or between processors and wholesalers. They usually do not incur direct costs as they are charged to the players on either side of the transaction. Their margin is 1.5 USD/t on both actors of the transaction
- The processors buy the whole chickpea in quantities that suit their working capital and processing capacity. They incur power, fuel for dryer and labour charges in the processing. They further sell to wholesalers after including their margin. Their economics calculation is affected by the outturns that they eventually get for the processed dal and the sales price of by-products like husk and broken
- The wholesalers and retailers incur charges mainly for transportation and labour as direct costs. Rest is the markup for their margin

FSC stage	Main Products	Cost of operation USD/kg	Cumulative Cost USD/kg	Value USD/kg final product	Value-added / Margins USD/kg
Farming, harvesting, threshing, storage by Farmers	Whole chickpea	0.619	0.619	0.846	NA
Traders/ Brokers	Whole chickpea	0.001	0.620	0.847	NA
Processor	Chana dal	0.224	0.844	1.11	0.263
Traders/ Brokers	Chana dal	0.001	0.845	1.111	NA
Wholesaler	Chana dal	0.007	0.852	1.202	0.091
Retailer	Chana dal	0.007	0.859	1.287	0.085

OUTPUT II-6a: DETAILED DESCRIPTION OF THE FOOD SUPPLY CHAIN – ENVIRONMENT

The chickpea supply chain's impact on the environment is very much in line with any farming activity and is quite environment friendly compared to other crops. The crop itself is nitrogen fixing and therefore adds to the nitrogen to the soil. The biomass from threshing is ploughed back in the field. The chemicals used in storage and fumigation are predominantly Aluminium Phosphide which is accepted worldwide for storage practices.

PRODUCTION		**Quantity**	**Unit**
Tools, Equipment, Facilities	Tractors/ power tillers (30-50 hp)	1	-
	Ploughs, cultivators (primary and secondary tillage)	1	-
	Knapsack sprayers, tractor mounted sprayers	1	-
	Diesel/ electric pumps for irrigation – (7.5 hp/ha)	1	Per ha
	Sickles and hoes	10-15	Per ha
	Threshers, gunny bag stitching machines	1	-
Materials, Chemicals	Urea, Phosphorous and Potassium fertilizers	100-150	kg/ha of DAP
	Pesticides	1-1.5 kg	Kg/ha
	Crop residues	-	-
	Gunny bags	1	No/60kg
Energy	Diesel (depending on using tractors)	40-50 L	Per ha
	Animal traction	-	-
	Electricity	250-280	Kwh/season
Water	Canal water	300	mm
STORAGE		**Quantity**	**Unit**
Tools, Equipment, Facilities	Warehouses, closed rooms	3.6	Tons/sq.m
	Cold storages, refrigeration systems	-	-
Materials, Chemicals	Storage pesticides and chemicals	3	gm/ bag
	Insecticides	2	L/ week
Energy	Electricity	0.12-0.25 mn	Kwh/year
TRANSPORTATION		**Quantity**	**Unit**
Tools, Equipment, Facil.	Auto (3 Wheelers), mini trucks, trucks	10`	Tonnes/truck
Energy	Diesel	3 l	Per ton
PROCESSING		**Quantity**	**Unit**
Tools, Equipment, Facili-	Plant/ shed	100	Sq. m
Materials, Chemicals	HDPE lined gunny bags	1	No/50 kg
Energy	Electricity	0.12-0.15 mn	kWh/year
	Fire wood (for 25 quintals of chickpea processing)	1	tonne
WHOLESALE, RETAIL		**Quantity**	**Unit**
Tools, Equipment, Facilities	Shops/outlets, storage containers	10-15	Sq. m
	Storage rooms	10-15	Sq. m
Energy	Electricity	150	kWh/year

OUTPUT II-6b: FACTORS FOR THE ENVIRONMENTAL ASSESSMENT.

Factors	**Description**
Production stage	Chemical sprays done on prevention basis. This can be controlled proactively. Experts suggested IPM and biological controls are not widely used even though results seen in demonstration forms. In addition to chemicals, fertilizer use also has an impact on the environment. Fertilizer runoff has significant impacts on the environment. The fertilizer run-off into streams, canals or ponds results in excessive growth of algae resulting in the choking or reduced capacity of such structures which is a major problem in India. In the case of chickpeas, since it is a nitrogen fixing crop, the overall usage of fertilizers is less compared to other crops. Also since the chickpeas are grown in the dry season of the year, due to limited rainfall, the fertilizer run off is limited.
Land preparation practices	Bio mass from the chickpea is left for cattle and mulched into soil. This helps in improving soil quality
Soil quality and land degradation	Single cropping system, so benefit of nitrogen fixation not efficiently used. The land is left fallow for the remainder of the year after chickpea harvest.
Water regime	A mix of rain fed and irrigation. Irrigation is from nearby water canals.
Ecosystem impacts	All by products from the mill are efficiently used. So there is no solid or liquid waste that causes damage to the environment. However, there are emissions of smoke from the dryer furnace.
Chemicals	Storage practices involve frequent monitoring and spraying on weekly/ monthly basis. This has an impact on the warehouse environment. And also downstream impacts on consumers and cattle. -There have been instances of food poisoning due to consumption of chickpeas without cleaning and pesticide affecting the consumers -The seed coat has pesticides that enter the food chain through cattle feed.
Sources of GHG emissions	All farm implements run on fuel and result in normal vehicular emissions. Processing mills use dryer which has furnace that runs on wood, husk and emits smoke. Fertilizers also significantly contribute to greenhouse gases as they emit N2O. However, this release of N20 is higher during rains. Since chickpeas are grown in dry season, the emissions are also limited. Cold storage facilities are run using electricity from the grid which in turn is majorly powered through non-renewable sources. Hence cold storages also significantly contribute to emission of GHGs. The same has been updated in the report.
Climatic factors	Due to climate change, more drought resistant, short duration, high temperature resistant crop varieties are being sought. Seed research organizations like ICRISAT, AICRP and IIPR are active.
Utilization of residues in the supply chain	All by-products from the mill are efficiently used. So there are no effluents. However, there are emissions of smoke from the dryer furnace. Brokens and husk are sold for cattle feed. The foreign matter and dust are what is discarded but that forms very small negligible percentage. The bigger brokens are even used for Bengal gram flour making.
Re-use of food losses	The losses if any, from harvest/ threshing stage, are ploughed back into the field as bio mass. The by-products from the processing stage are used for cattle feed.

3. THE FOOD LOSSES - Study findings and results.

a. Description of the FSC: risk factors

The risk factors that can cause food loss at various stages are observed as follows:

- Farming stage: the major risk factor reported by farmers is the probable occurrence of untimely rains during harvest
- Storage stage: the major risk reported by warehouse personnel are the pests especially bruchids in dry warehouses and sitophilus in cold storage. These are generally controlled by fumigation and frequent monitoring
- Processing stage: the major factors resulting in processing loss is the non-uniformity in size of grains and one of the main reasons attributed for the same is the different varieties. However, in Andhra, the JG11 is widely adopted by farmers and currently is not a major challenge.
- Good practices are being followed at the farming and processing stages. The lack of following the same by a few actors is likely to result in losses of quantity and quality, for e.g. improper storage at farmer's house without fumigation

OUTPUT II-7: FOOD LOSS RISK FACTORS.

The below table lists the various factors that we found to be important factors affecting the food supply chain losses.

Variable	**Unit**	**Parameter – relation to food losses**	**Value of variable (observed in the case study)**
Rains during Feb-Mar (harvest period)	mm	There should be nil rainfall during harvest.	NA
No. of varieties	Count	Ideally, there should be uniform single variety for uniform sizes	JG11 observed predominantly
Good agricultural and harvest practices	Y/N	Yes	Yes
Good storage practices	Y/N	Yes	Yes
Knowledge of FSC actors	Y/N	Yes	All actors inherently know to inspect quality and value. However, there is absence of quantitative measurements of quality parameters

b. Critical Loss Points: type and level of food losses in the selected subsector chains, including both quantitative and qualitative losses

In this sub-section, firstly quality standards used in the industry and in our load tracking exercise are reported in III-8a. Following that, in III-9, the load tracking exercise is presented. Then, III-8b shows the quality analysis of the samples taken. And finally, III-10 presents the summary of the losses found in the study with pertinent observations.

OUTPUT III-8a: QUALITY SCORING OF FOOD PRODUCTS

Quality standards for chickpea sector is governed by AGMARK.

AGMARK is the national body that sets the quality standards. The AGMARK standards for chickpea both whole and split are set as per Agricultural Produce (Grading and Marketing) Act, 1937 and Prevention of Food Adulteration Act, 1954. The detailed AGMARK quality standards schedule maybe referred from the link provided[27]. The important parameters of AGMARK standard grade whole desi chana are:

- Max. 12% moisture,
- Max. 0.1% foreign matter by weight;
- Max. 2% other edible grains by weight;
- Max. 2% damaged grains by weight;
- Max. 6% weevilled grains by count;

In addition to AGMARK, the other relevant standards are that of **NCDEX** since NCDEX is the body regulating Chana (Chickpea) futures. The NCDEX[28] contract quality specifications are as below:

Desi Chana Quality Specification for NCDEX contract	
The material should be free of Mathara and Kesari (types of pulses considered to be harmful for human consumption) and live infestation	
Foreign Matter (Other than Varietal admixture)	1% max. by weight
Green (Cotyledon colour), Immature, Shrunken, Shriveled Seeds	3% basis
Broken, Splits;	2% basis
Damaged	3% basis
Weeviled	1% max.
Moisture	10% basis
Varietal admixture	3% max.

For parameters with basis, there are further guidelines on discounting up to certain acceptable percentages.

The actors present in the chickpea value chain follow neither AGMARK nor NCDEX standards. Instead, they check the products for their quality based only on three main parameters as follows:

1. Kernel counts (count per 100gm). Count is used majorly for trading of Kabuli chana.
2. Moisture (measured by normal moisture meters)
3. Weevilled bean % (percentage by count)

For our load tracking exercise, we have followed NCDEX standards as they are comprehensive and more practical. Output III-8b, the quality analysis of sampled units, is presented after Output III-9.

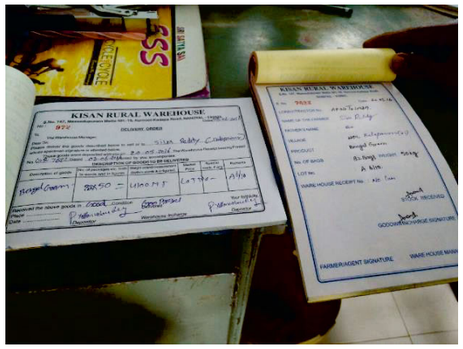
OUTPUT III-9: PRESENTATION OF LOAD TRACKING AND SAMPLING RESULTS.

Selection of load tracking stage in the supply chain: There are three main stages in which load tracking should be carried out – threshing, storage and processing. However, it was not possible to pursue load tracking at the threshing stage as threshing was already completed before beginning of field study for food loss. It was not possible to pursue load tracking at processing stage because the processors follow a continuous system of processing and the processors would have to clean the whole system to do a proper load tracking exercise. Load tracking exercise was conducted during storage stage and the results of the same are provided below.

Load tracking in storage stage: Load tracking was done at a dry warehouse storage (Kisan Rural Warehouse, Nandyal, Kurnool)in two ways – documentary load tracking by comparing input and output documents of same lot of stock; and physical load tracking by comparing the same lot of stock over a period of storage.

[27] AGMARK standards http://agmarknet.nic.in/bengal-gram-profile.pdf
[28] NCDEX standards http://www.ncdex.com/Downloads/ContractSpace/Chana10MT_CS_19012015.pdf

1. Documentary load tracking: The warehouse in charges reported that there is very rare occurrence of loss in quality or quantity between the input and output of stock in warehouses. We asked for documentary evidence of the same and were shown documents such as below. There was absolutely no variation shown in weight or quality. The



Warehouse documents

picture shows a receipt of 82 bags of 50kg Bengal gram from farmer Siva Reddy stored in Lot no. A6/10 on 20 May, 2016. And shows a delivery of the same quantity on 8 June, 2016 with no change in quality.

2. Physical load tracking: Samples were taken from the same lot in two visits separated by a time gap of 1 month. The quality of the samples was measured and no significant variation in quality was observed. Below tables present the load tracking results:

OUTPUT III-8b: QUALITY ANALYSIS OF SAMPLED UNITS.

Quality Parameter	**Observation of sample taken on 5 May, 2016**	**Observation of sample taken on 8 June, 2016**
Visual appearance	Good	Good
Foreign matter	0.1%	0%
Green immature shrunken shriv-elled	None	None
Broken/ splits	None	None
Damaged	None	None
Weeviled	None	None
Moisture	Manual (well dried)	Manual (well dried)
Varietal admixture	0%	0%

Observation from load tracking exercise in storage stage: From the load tracking exercise, it was observed that there is very minimal variation in quality during the storage stage.

A	Product	Desi chickpea			
B	Event	Storage			
C	Duration of the event	1 month			
D	Location	Nandyal, Kurnool			
	Before the event	Experimental Unit	Weight of unit	Nr of units	Total weight
E	Load	Bag	Bag weight is 50-60kg	50 bags	3000kg
F	1st-stage sample	Bag	50-60kg	5 bags	250-300kg
G	2nd-stage sample	Gm	100gm	1	100gm
		Value (score / %)	Observations / Causes		
H	Sample size 2nd-stage	100gm	Clean, good (detailed quality analysis presented in the following table)		
I	Average quality score (0 – 10)	Fit for trade – 100%	No discounts applicable		
J	%age unfit (< 2)	0			
K	%age low quality (2-6)	0			
	After the event	Experimental Unit	Weight of unit	Nr of units	Total weight
L	Load	bag	50-60kg	50 bags*	3000kg*
M	1st-stage sample	Bag	50-60kg	5 bags	250-300kg
N	2nd-stage sample	Gm	100gm	1	100gm
		Value (score / %)	Observations / Causes		
O	Sample size 2nd-stage	100gm	Clean, good (detailed quality analysis presented in following table)		
P	Average quality score (0 – 10)	Fit for trade – 100%	No discounts applicable		
Q	%age unfit (< 2)	0			
R	%age low quality (2-6)	0			
	Quantity loss	Value (%)	Observations / Causes		
S	%age lost (E-L)/E	0			
	Quality loss	Value (%)	Observations / Causes		
T	%age lost (Q-J)	0			

OUTPUT III-10: SUMMARY RESULT MATRIX OF FOOD LOSSES

The following table provides a summary of the different losses that were observed in the chickpea value chain along with comments on the loss points. The losses observed at different points were minimal and hence the respective points were identified as Low Loss Points (LLPs). No Critical Loss Points (CLPs) were observed in the chickpea value chain. The same was reported by different actors in the value chain and was also corroborated by several recent studies. The loss percentages are an estimation from our secondary and primary research and analysis. The reason for the low loss points and good practices that are leading to low food losses at different points of the value chain are analyzed in the subsequent section.

FSC stage/ process	**Type of loss Qn./Ql.**	**%age lost in this process Quant**	**%age of product that incurred quality loss in this step**	**%age of product that goes through this stage #**	**%age loss in the FSC #**	**Cause of loss/ Reason for low loss**	**Reduced market value**	**CLP / LLP**	**Destination of food loss**	**Impacts on the environment/climate change/natural resources**	**Impact/ FSC actors affected (men / women)**	**Loss perception of FSC actors (men / women)**
Harvesting & Threshing	QNT	0.1%	NA	100%	0.1%		NA	LLP	Discarded in field	Increase of biomass on field, stray cattle	Farmers	Not considered as high loss
Storage	QNT	0.1%	NA	>60%	0.1%		NA	LLP	Cattle feed	None	Farmers and warehouse owners	Heavy pest infestation is rare as the grain is fumigated regularly. Not considered as high loss
	QLT	NA	1.0%	>60%	1.0%		0.5% max. reduction on the quality basis	LLP	Traded with discount	Chemical sprays are used in the warehouses to control pests/ insects which affect the environment	Farmers and warehouse owners	The quality of the grain is checked by visual inspection only. So leeway is given for small variation.
Processing	QNT	0.25%	NA	>95%	0.25%		NA	LLP	Cattle feed	None	Processors	Not considered as high loss
	QLT	NA	0.25%	>95%	0.25%		90% reduction in value	LLP	Traded through lower channels	Negligible	Processors	Not considered as high loss

Total					**1.8%**							
Transport	QNT	0.1%	NA	100%	0.1%	Short distances of travel and adoption of good practices like covering the bags with tarpaulin sheets are followed. Losses are due to spillage of the grain while loading and unloading which is again collected.	NA	LLP	None	More diesel and carbon footprint for same quantity transported	Traders	Not considered as high loss

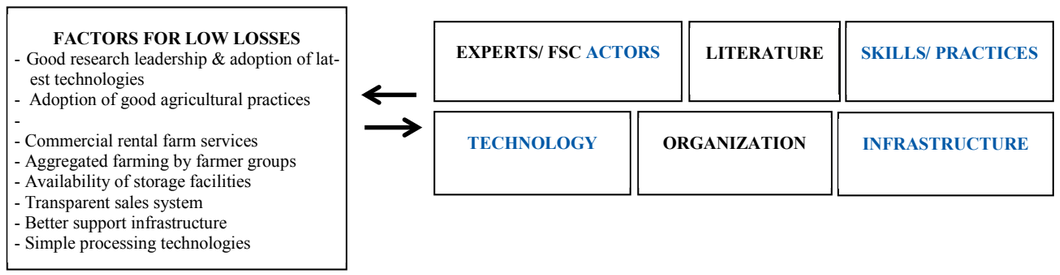
- The percentages will be slightly lower if we take into account losses in previous stages. This has been ignored because the impact is negligible.

4. THE FOOD LOSS REDUCTION STRATEGY - Conclusions and recommendations

As mentioned in the earlier sections, the losses observed at different points across the Chickpea Food Supply Chain were minimal and hence the respective points were identified as Low Loss Points (LLPs). No Critical Loss Points (CLPs) were observed in the chickpea value chain. Thus, in this section, we use the cause finding diagram for analysing the reasons for the low losses at various stages of the FSC that may be either due to good practices, adoption of latest technologies, availability of infrastructure, policy support, or other factors.

OUTPUT IV-1: CAUSE FINDING DIAGRAM FOR LOW LOSSES

1. The *factors* for the low losses are:



2. The underlying *reasons* for the causes

As illustrated in the above figure, there are many factors contributing to lower losses at each stage of chickpea value chain in Andhra Pradesh. Chickpea, by nature being a tough crop, encounters lower damage and less losses in its value chain than other crops. However some good practices that are being followed in Andhra Pradesh help in further bringing down the losses and can be a lesson for other regions as well as other commodity value chains.

The different factors for low losses in the chickpea value chain and their underlying reasons are further discussed in following paragraphs.

Farming, harvesting & threshing stages

1. Research leadership & adoption of latest technologies: Proximity to research institutions like ICRISAT, ANGRAU, RARS and SAU contributes to the research and development as well as quick dissemination of relevant technologies and seed varieties. The research community has been successful in continuously releasing newer and better varieties (e.g. harvestable NBEG47 is already in pipeline and successfully tested in 2016). The chickpea farming community in Andhra Pradesh is also one of the fastest to adopt latest technologies be it new varieties/ traits of seed or latest agricultural machinery and practices. Also, the adoption is probably high because chickpea is a relatively a new crop (since 1990s) to the state and farmers do not carry any legacy ideas of past traditional practices.

2. Adoption of good agricultural practices: Chickpea farmers in the state of Andhra Pradesh are progressive in nature. They understand and appreciate the benefits of adopting good agricultural practices like using quality seeds, regular weeding, timing of harvest etc. and follow them regularly. Also, in the case of chickpea, the deeper penetration of extension services and the support provided by agricultural officers in the dissemination of latest information about agricultural practices have also helped the chickpea farmers in rapid adoption.

3. Commercial rental farm services: Most of the farming activities for chickpea, like pest management and threshing etc. are being offered as a service to the farmers. This helps in increasing the affordability and adoptability of good practices for smallholder farmers. Dominance of chickpea as a winter crop in the region and availability of contiguous areas further help in offering such services.

4. Aggregated farming by farmer groups: Most chickpea farm activities are mechanized and available for commercial hire. Secondly, in chickpea, while the season is spread out for the whole state, within each particular locality, the window is small for carrying out the farm activities. This also encourages a faster pace of activities. Due to these characteristics, chickpea is especially suited for aggregated farming on large tracts of land. Such aggregated farming brings together farmers and leads to better knowledge sharing, good agricultural practices and market linkages.

Storage, transportation & processing stages

5. Availability of storage facilities: A large number of cold, as well as dry warehouses, are available in the districts of Andhra Pradesh for storage of different crops. Majority of the farmers use these facilities and trade on better prices. Availability of financial support from both the state as well as central governments helped in the establishment of the infrastructure. The transport distances from the site of produce to storage is shorter due to the availability of storage spaces at a closer proximity to the farmers. Particularly in Prakasam district, the cold storages are successful because it is used for multiple crops resulting in higher utilization, the farmers are financially able to carry chickpea for a longer period of time and the humid climate necessitates cold storage for better storage.

6. Transparent sales system: Since chickpea is listed on the commodity exchange, availability of price information from commodity markets has led to better price discovery at each level of the supply chain and the middlemen charging fair prices. This resulted in a number of traders taking up the profession and the marketing of the produce has become easy.

7. Better support infrastructure: The roads situation in Prakasam and Kurnool, the two predominant districts for chickpea production in the state, is well developed. Successive governments in Andhra Pradesh state have invested and developed quality rural roads because they realised the importance of support infrastructure for the development of agriculture as an economic activity. This not only reduces transportation losses but also brings down the transportation costs significantly. In addition to infrastructure, due to the inherent hardness of the grain, the losses are much lower in the case of chickpea.

8. Simple processing technologies: The processing technologies involved in the manufacturing of value added products from chickpea are simple. This makes the maintenance of the machinery cheap and easy which in turn leads to good efficiencies. Also, since the processors have low working capital, the stock rotations are high and storage periods are short, resulting in lower losses.

Recommendations for further improvements in the chickpea supply chain:

Storage is the point where the crop faces qualitative losses due to pest/insect attack. Ensuring the practice of good storage practices would further reduce the losses present at this stage. This can be achieved by

1. Capacity building of farmers on scientific storage practices: It is observed that a significant number of farmers (especially small farmers) who do not have access to warehouses/ cold storages in the vicinity, in order to trade on better prices, store their produce in special rooms in their house itself. However, due to limited understanding among farmers (in certain cases) about the scientific methods of storage, the produce in majority of the cases suffers qualitative losses due to pest/ insect attack. Imparting training to the farmers on the methods of storage can help in further bringing down the losses.

2. Cold and dry storage warehouses: The cold storages have been observed to be a positive intervention that can further reduce the food loss in chickpea. The large scale availability of cold storage facilities in Prakasam district is a clear indication of the advantages of storing chickpea in cold storages; especially in humid climates. Apart from Prakasam district, the presence of cold storages in other chickpea producing districts is limited probably because the dry storage warehouses work just as well in non-humid dry climates. Increasing the availability and accessibility of storage warehouses will help in further reducing the losses.

These strategies are explored further with a cost-benefit analysis in the subsequent section.

In addition to above two, other recommendations that came up during the expert/ stakeholder discussion are:

3. Listing of the commodity in exchange: This is believed to play a positive role in price discovery[29] and thus increase the transparency in price info for all supply chain actors. This needs to be explored further for implementation in other crops in other regions. The positive and negative impacts that speculators can bring about on other supply chain actors needs to carefully studied.

4. Promotion of aggregated farming by farmer groups: As mentioned earlier, chickpea is especially suited for aggregated farming on large tracts of land. Aggregated farming brings together farmers and leads to better knowledge sharing, good agricultural practices and market linkages. Thus, such aggregated farming by farmer groups may be actively promoted by government and other concerned stakeholders.

5. Promotion of single variety per locality: Single variety chickpea results in uniform grain size, which lead to better processing efficiencies. While it is generally accepted that diversified varieties are better than mono-variety, the cultivation of single varieties could be promoted in smaller geographical areas in an organized planned manner. This will result in uniform variety and grain size for a given processing mill from its catchment area of production.

Capacity building of farmers (who use their own storage) on scientific storage practices:

Based on our survey, it is observed that the losses in the produce that is stored at homes by some farmers is relatively significant due to limited understanding among the farmers about the scientific methods of storage. As a result, produce thus stored, suffer qualitative losses due to pest/ insect attack. Imparting training to such farmers who store produce in their own storages, on the methods of storage can help in further bringing down such losses. Capacity building exercise may be done at mandal level where two officers (one male and one female) may be trained as master trainers. These two officers can then go together to each and every village just before the harvest season to conduct farmer level trainings and farmer activity supervision. The training could cover in detail the different types of pest/ insect attacks that affect the quality of the chickpeas and how to identify and contain them, the methods of sampling and monitoring, maintenance of storage spaces etc. The cost-benefit analysis for such suggested capacity building efforts is shown in the table below.

	item	value	unit	calculation	Remarks
a	Product quantity	530,000	ton/year		Average state chickpea production on average 2010-2015
b	Product value	840	$/ton		@5500 Rs. per quintal and 65 Rs per USD exchange rate
c	Loss rate	1.1	%		Loss of 1.8% in whole supply chain. And 1.1% in the storage
d	Anticipated loss reduction	0.2	%		
e	Cost of intervention	0	$		
f	Depreciation	0	years		
g	Yearly costs of investment	0	$/year	e / f	
h	Yearly costs of operation	570,400	$/year		@400USD per training of trainer (one male and one female Agricultural officer in each mandal) and @100USD per seasonal training per village
i	Total yearly costs of solution	570,400	$/year	g + h	
j	Client costs per ton product	1.07	$/ton	i / a	
k	Food loss	5830	ton/year	c x a	
l	Economic loss	4,897,200	$/year	k x b	
m	Loss reduction	1060	ton/year	k x d	@0.2%
n	Loss reduction savings	890,400	$/year	m x b	
o	Total Client costs	570,400	$/year	a x j = i	
p	Profitability of solution	320,000	$/year	n - o	

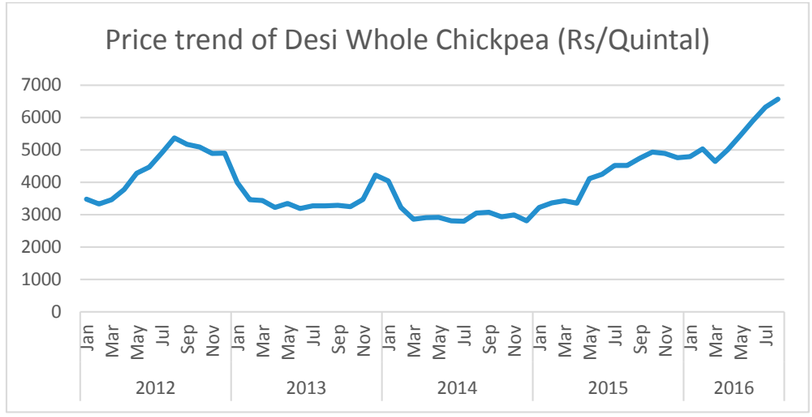
While the profitability from the capacity building is minuscule compared to the economy of chickpea sector in Andhra Pradesh, the capacity building helps bring other added benefits in the society. Capacity building exercises will promote interactions among farmers and trainers and creates a forum for problem discussion and solution within the community. Capacity building could also be designed to address other crops with similar storage requirements like other pulses. Further, since capacity building exercise is one which is long lasting and brings about a sustained change in the society, it is always good to invest in such exercises.

[29]Forward Markets Commission, Annual Report 2010-11 at http://www.sebi.gov.in/cms/sebi_data/commodities/AnnualReport/AR1011.pdf

Imparting the training to the farmers requires support of government machinery. Agricultural officers and farm extension officers need to be adequately trained before they impart trainings to the farmers. The risks in implementation include the uncertainty of farmer utilizing the knowledge gained during training.

Cold and dry storage warehouses:

The price cycle of chickpea as illustrated in below graph shows that the prices tend to improve after the harvest months of Jan-Mar, sometimes up to even 50% increases are seen. So it is in the best interest of farmers to be able to hold the crop and tap the best prices that they possibly can in their capacity.



So we illustrate below a few scenarios to understand the farmers' options of various storage practices.

Assumption: A farmer with 2 hectares of land produces 5tons of chickpea and has four scenarios of marketing his product. Let the harvest month prices be Rs. 5000/qtl (~2016 season prices). Let the prices increase by 10% in later months.

a. Scenario A: The farmer does not have access to storage. He is forced to sell at market prices during the harvest months. He faces no quality or quantity loss.
b. Scenario B: The farmer carries stock but without proper storage practices. He is expected to lose more than 10% due to quality discounts due to pest attack and 1% on quantity due to pest damages. He is able to get 10% better market prices than during harvest months.
c. Scenario C: The farmer stores in cold storage. He is expected to face nil quantity or quality loss. He pays Rs.140/qtl for cold storage facility per season (annual). He is able to get 10% better market prices than during harvest months.
d. Scenario D: The farmer stores in dry storage. He is expected to face negligible quantity loss (0.1%) and 1% quality loss if stored for long period. He pays Rs.70/qtl for dry storage per season (annual). He is able to get 10% better market prices than during harvest months.

As expected, the farmer gains by going for Scenario C or D where he accesses either the cold or dry storages and is able to tap a better price.

Parameter	Scenario A - no storage	Scenario B - storage at home with 1% quantitative losses and 10% quality losses	Scenario C - cold storage with nil losses in qty or qlty	Scenario D - normal dry storage with 0.1% quantitative losses and 1% qualitative losses
Qty loss	0%	1%	0%	0.10%
Qty (tons)	5.00	4.95	5.00	5.00
Qualitative impact on price		-10%	0%	-1%
Time impact on prices		+10%	+10%	+10%
Price (USD/ton)	769	762	846	838
Additional storage cost (USD)			108	54
Total farmer revenue (USD)	**3,846**	**3,770**	**4,123**	**4,130**

The dry storages work well in dry and non-humid climates of interior districts. However, for humid climates of coastal districts, the cold storages work better than dry storages due to controlled temperature and humidity environment.

To further bring down the qualitative losses in the chickpeas, adoption of cold storages is recommended. While the dry warehouses allow the farmers to store their produce without deterioration only for 9-12 months, chickpeas can be stored for 3-4 years in cold storages without much deterioration. Thus it can help farmers in trading on better prices. In addition, storing chickpeas under cold storage also reduces the requirement for chemical sprayings to contain insects and pests to almost zero.

Large multi-commodity cold storages with a capacity up to 5,000 MT can be established in the chickpea growing regions and the storage can be offered as a service to the farmers in the region. Government of India provides a subsidy to the tune of 40%[30] of the capital investment under its capital investment subsidy scheme for construction of such cold storages. The government subsidy scheme is a significant incentive for various entities like agribusiness companies, individual entrepreneurs, farmers and their co-operatives. The continuation of the incentive will be a boost for the implementation. Pro-active support from the state government for the clearances required in such a project will be a boost. In addition to the financial subsidies, methods like single window clearances will boost the implementation.

c. Follow-up action plan/ concept note

The study estimated a total loss of 1.8% across different stages in the chickpea supply chain of Andhra Pradesh. Though the losses are not significant, they can be further brought down through proposed recommendations. Going further, the proposed recommendations can be piloted on a small scale in identified villages in the state and the impact of the solutions can be analysed. Depending upon the success of the model, the same can be rolled out in other chickpea growing regions of the state as well as on a national level. For the model to succeed it is crucial for the government agencies and personnel, Agricultural Research Institutes and all the stakeholders in the chickpea value chain to work in tandem. The success will certainly help in employment generation, gender equity, improved economic profile of the FSC actors, especially smallholder farmers and qualitative and quantitative improvement in the final products.

[30] National Cooperative Development Council project profile for cold storage at http://www.ncdc.in/downloads/ProjectProfile_coldstrg.doc

Itinerary

Date	Place	Person
05-May-16	Kurnool	Agric officer
05-May-16	Kurnool	Star Agri warehouse
05-May-16	Kurnool	Government warehouse
05-May-16	Nandyal, Kurnool	Kisan Rural Warehouse Manager - Nandyala: Mr Anand
05-May-16	Nandyal, Kurnool	Cold storage
05-May-16	Nandyal, Kurnool	Processor @ Nandyal A1 mill
18-May-16	Prakasam	Farmer Desu Satyanarayana
18-May-16	Prakasam	Farmer Gommadi Brahmaiah
18-May-16	Prakasam	Farmer Koonam Sunder Ram Reddy
19-May-16	Prakasam	Central Warehouse Manager – Annu Srinivas Rao
19-May-16	Prakasam	Trader Prasad
19-May-16	Prakasam	Retailer Venkateshwar P
19-May-16	Prakasam	Wholesaler Chebrola Narayanarao
19-May-16	Prakasam	Sri Lakshmi Venkata Balaji Fried Gram Mill
19-May-16	Prakasam	Ongole Cold Storage - K Nageshwar Rao
20-May-16	Prakasam	Sri Lakshmi Dal Mill
20-May-16	Prakasam	Farmers from Inkollu
08-Jun-16	Nandyal, Kurnool	Dr. Jayalakshmi (principal breeder), S. Khayum Ahmed (plant pathologist - diseases), N. Kamakshi (entomologist – insects/pests), RARS, Nandyal
08-Jun-16	Nandyal, Kurnool	Farmers of Appalapuram
08-Jun-16	Nandyal, Kurnool	Kisan Rural Warehouse Manager - Nandyala: Mr Anand
09-Jun-16	Nandyal, Kurnool	Commission Agent Sudhir Reddy
09-Jun-16	Nandyal, Kurnool	Commission Agent Shiva Reddy
09-Jun-16	Nandyal, Kurnool	Retailer – Venkataramaiah
09-Jun-16	Nandyal, Kurnool	Retailer – Y Satyanarayana
09-Jun-16	Nandyal, Kurnool	Processor @ Nandyal A1 mill
09-Jun-16	Nandyal, Kurnool	Flour mill @ Nandyal
10-Jun-16	Kurnool	Market yard – Kurnool. Mr. Rajendra Prasad
02-Aug-16	Hyderabad	Dr.Ranjit and Dr.Surjijt, ICRISAT
Misc	By telephone/ Email	IIPR scientist
		Private sector professional who has worked with one of the three largest exporters
		Ex-ICRISAT scientist Dr. Parthasarathy P

Bibliography

Paper title	Authors	Institution	Year
Report on assessment of quantitative harvest and post-harvest losses of major crops and commodities in India	Jha SN, Vishvakarma RK, Ahmad T, Rai A and Dixit AK	ICAR - All India Coordinated Research Project on Post-Harvest Technology, ICAR-CIPHET, P.O.-PAU, Ludhiana-141004.	2015
Post-harvest management of pulses	Rajiv Ratan Lal & Prasoon Verma	Indian Institute of Pulses Research (IIPR)	2007
Inclusiveness of Chickpea Value Chain in Andhra Pradesh	Shreya Kakkar	International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)	2014
Chickpea production trends and marketing value chain analysis in Andhra Pradesh	Jeevan Kumar	International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)	2010
Nature, composition and utilization of grain legumes (pp. 11-27)	Hulse, J.H.	Siemens-Hulse International Development Association	1991
FAO Kenya food loss studies		Food and Agriculture Organization (FAO)	2014
India's Pulses Scenario		National Council of Applied Economic Research, New Delhi	2014

Experts name	Title/ position	Institution
Dr. Ranjit Kumar and Dr. Surjit Vikraman	Principal Scientist & Scientist	ICRISAT
Parthasarathy P	Retired Principal Scientist	ICRISAT
Dr. V. Jayalakshmi	Principal Scientist	AICRP on Chickpea Regional Agricultural Research Station Acharya N.G.Ranga Agriculrural University
Scientist from IIPR		IIPR

Website	Link verified as on 25th Aug 2016
Directorate of economics and statistics	http://eands.dacnet.nic.in/
Department of Agriculture, Cooperation & Farmers Welfare	http://www.agricoop.nic.in/
Government of India, Ministry of Commerce & Industry, Department of Commerce, Udyog Bhawan, Notification No 78 (RE – 2013)/2009-2014	http://dgft.gov.in/Exim/2000/NOT/NOT13/not7814.htm
Agricultural Census database	http://agcensus.dacnet.nic.in/
Directorate of Pulses Development	http://dpd.dacnet.nic.in/
Commission of Agriculture Costs and Prices	http://cacp.dacnet.nic.in/ViewContents.aspx?Input=1&PageId=36&KeyId=0
Rural godowns scheme	http://www.archive.india.gov.in/outerwin.php?id=http://agmarknet.nic.in/amrscheme/ruralhead.htm
Securities and Exchange Board of India (SEBI)	http://www.sebi.gov.in/sebiweb/home/detail/34084/new/PR-Trading-in-Chana-futures-on-Commodity-Derivative-Exchanges
Government crop production information by districts	http://aps.dac.gov.in/APY/Public_Report1.aspx
Farmers portal by Government of India	http://farmer.gov.in/MCold_Storage_Total.aspx
Agmarknet mandi arrivals	http://agmarknet.dac.gov.in/
Agmark grading specification	http://agmarknet.nic.in/bengal-gram-profile.pdf
NCDEX quality specification	http://www.ncdex.com/Downloads/ContractSpace/Chana10MT_CS_19012015.pdf
Agmarknet - Commodity wise distribution of cold storage	http://agmarknet.nic.in/commcold3112009.htm
Agmarknet - Sector wise distribution of cold storage	http://agmarknet.nic.in/sectorwisecold2009.htm
Agmarknet - List of cold storages in AP	http://agmarknet.nic.in/apnew.htm
Household survey	http://mospi.nic.in/mospi_new/upload/Report_no558_rou68_30june14.pdf
Andhra demography	http://www.ap.gov.in/wp-content/uploads/2016/01/2-AP-Demography.pdf
Warehousing Development and Regulatory Authority	http://wdra.nic.in/
Hindu article	http://www.thehindubusinessline.com/news/national/ap-to-come-out-with-new-agri-warehousing-policy/article4081850.ece
NABARD	https://www.nabard.org/pdf/Website_Warehouse_Infrastructure_Fund_WIF_2014_15.pdf
NCDC cold storage project profile	http://www.ncdc.in/downloads/ProjectProfile_coldstrg.doc
MoFPI	http://mofpi-pms.in/mainproject/MOFPI/AssistedProjects/cch_Report_format_3_Component_Status.aspx?ProjectCodeDB=CCH11076
Forward Markets Commission, Annual Report 2010-11	http://www.sebi.gov.in/cms/sebi_data/commodities/AnnualReport/AR1011.pdf

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