Inefficiencies in agriculture supply chain in Punjab and opportunities for IT interventions

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About the report
“Improvement of agriculture is essential for growth of the country”: Prime Minister ManMohan Singh, 27th Dec 2012
Agriculture is a critical sector of the Indian economy. An average Indian still spends significant amount of his/her total expenditure on food, while close 60% of India’s work force is still engaged in agriculture for its livelihood. Though India is one of biggest producer of various commodities, it is still home to children who are malnourished. Through this report, we have studied the inefficiencies in agriculture supply chain of key commodities in the state of Punjab and we have given our recommendations for improvements through IT interventions

Acknowledgements
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FOREWARD

Indian economy has witnessed a respectable growth rate since the early nineties, breaking free from the shackles of ‘Hindu rate of growth.’ But in the agriculture sector – still main stay of a majority of Indian population – much needs to be done. With less than one – fifth contribution to national income, it employs more than fifty per cent of India’s work force. This imbalance needs to be corrected if we want our rural population to enjoy the fruits of increased growth rate. One of the way out, as suggested by economists and researchers, is to grow low volume, high value crops. And it is this area – of fruits, vegetables, flowers, dairy and mean products etc., which is plagued with wastages and inefficiencies in the supply chains. Producers are getting far less than paid by the consumers.

Munjal Global Manufacturing Institute at Indian School of Business (ISB), Mohali, has taken a discernible step in the direction of addressing the issue of inefficiencies in agriculture supply chains in Punjab through a targeted research study in collaboration with SAP. It has focused on existing business models, policies and practices and the scope for Information and Technology interventions. I congratulate the researchers associated with this project for their endeavour.

DIPINDER SINGH, IAS,
Secretary,
Punjab Mandi Board.
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1 EXECUTIVE SUMMARY

Agriculture and its allied services, though a very important sector in India, has not been a focus area from a supply chain perspective. In this study, we analyzed agriculture supply chain of Punjab. The study is divided into three primary commodities: milk, grains and vegetables; and for each commodity we focused on its flow of information, cash and the physical commodity. Despite the three commodities being significantly different from a supply chain perspective, we have kept a common methodology to study the three areas.

The first commodity under consideration is milk, which is pretty efficient from a physical good supply chain perspective, but the flow of cash and information can certainly be looked into for improvements. Two major areas of improvement which come out are: the first recommendation deals with recording and analyzing supply and demand in real time through an IT enabled system and then based upon this information, changing the supply, demand and prices for an optimum procurement at an optimum price. The second recommendation is for a analytics based system which can help decide the portfolio of products which can be made from the extra milk and further, this portfolio of products could be tuned for profit maximization.

The second commodity under consideration is grains, wherein we have analyzed rice and wheat as these are the main crops in Punjab. The supply chain of grains from all three perspectives i.e. flow of information, cash and commodity is not efficient and needs IT interventions. The information of supply and demand is broken as farmers take decisions based upon MSP (minimum support prices) rather than on demand of grains. The flow of cash is also inefficient in terms of the middle man being the recipient of money from government which gives them a lot of power, though the government is beginning direct transfers, however results can only be seen after its implementation. Then flow of grains is comparatively efficient till procurement but after procurement, storage is a key area to look into. Also, the impact of fertilizer subsidy on overall grain supply chain has been analyzed. The main recommendations in grains supply chain are in the areas of credit, information and the subsidies flow. In the credit area, a new credit rating based system is recommended, in the information flow a procurement focused information flow system is recommended and in the subsidies area, a system to monitor the fertilizer subsidy is recommended.

The third commodity under consideration is vegetables, which again have been studied for the three primary supply chains, the first supply chain is the farmers bringing in vegetables in the wholesale markets (mandis), the second supply chain is where farmers directly sell their produce in retail market and the third supply chain is where the farmers directly see the produce to the big retailers. The majority of the transactions happen at the wholesale markets (mandis) so we have analyzed this supply chain in detail. The key findings lead to a common problem area which is the flow of information. The seller does not know the demand and the buyer does not know the sellers and the quantity on sale. Our key recommendation is to make
a virtual market which takes care of the information flow and also helps in price discovery through demand and supply matching.

2 BACKGROUND

Agriculture and its allied sectors has been the back bone of most developing nations, employing majority of the country’s population. In India, this sector plays an important role in livelihood of majority of population; close to 60% of India’s population is engaged in this sector. As of 2011, India had a large and diverse agricultural sector, accounting for 10 percent of the total export earnings. Agriculture, because of its strategic and economic importance, has been a key focus area for policy makers. The government has started a number of initiatives for ensuring food and nutritional security and providing income security to people employed in agriculture and allied fields. But still the growth in this sector has not been comparable to the industrial and services sector growth, because of which the share of agriculture and allied sectors in GDP has been steadily reducing over the years.

Table 2.1: GDP of Agriculture and Allied Sectors

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<td>Per cent to total GDP</td>
<td>17.4</td>
<td>16.8</td>
<td>15.7</td>
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Source: Central Statistical Organization, Ministry of Statistics and Programme Implementation, Govt. of India

With only 2.3% of the total land in the world, India has to provide food security to 17.5% of world population. Factors like rising population, shrinking cultivable land and the enormous wastages in agriculture are additional constraints in this sector. Increasing agricultural production with shrinking natural resources has been a major challenge in pre-harvest cycle and reducing the wastages and ensuring an effective supply chain has been a major challenge in post-harvest cycle. With lot of work already being done on pre-harvest factors like – productivity improvement, research in crop varieties, etc the vast scope for improvement has been left in post-harvest segment.

India is ranked amongst the world’s five largest producers of 80% of the agricultural items including many cash crops such as coffee and cotton, in 2010. India is also one of the world's...
five largest producers of livestock and poultry meat, with one of the fastest growth rates in the segment, as of 2011. With such good numbers for crop production, Indian should be self sufficient in food availability also, but actual numbers depict an opposite trend. By analyzing ‘The Global Security Index’, which is based upon 3 categories of food: 'availability', 'affordability' and 'quality and safety', has ranked India 66th among 105 countries. India scores slightly higher in the category of 'availability' than in other two categories of 'affordability' and 'quality and safety'. This also points out that post-harvest areas like storage and supply chain needs much more attention. Different studies have also pointed out that each year India loses a huge amount of agricultural produce (30-35%) due to the absence of proper transportation and storage infrastructure. The aim of this report is to highlight the “Inefficiencies in agriculture supply chain in the Punjab and opportunity for IT in addressing these inefficiencies.” We identified top 3 commodities: milk, grains and vegetables and their stakeholder in each stage of Agro supply chain in Punjab. The supply chain includes flow of goods, information and cash.

India lacks cold storage, food packaging as well as safe and efficient rural transport system which are responsible for one of the world's highest food spoilage rates, particularly during Indian monsoons and other adverse weather conditions. Food travels to the Indian consumer through a slow and inefficient chain of traders. Indian consumers buy agricultural produce in suburban markets known as 'sabzi mandi' such as one shown or from roadside vendors.

On agricultural R&D, India spends just 1 per cent of agricultural GDP, thereby ranking amongst the bottom of the 26 lower middle-income countries in the index.

3 | SUPPLY CHAINS AND FINDINGS

Three identified primary supply chains: Milk, Vegetables and Grains have been studied and described in the later sections in detail. All three supply chains being quite different in nature have been studied by similar methodologies (primary and secondary sources) but the findings in all the three areas are quite different. The summary of overall findings and recommendations are mentioned in the figure 3.1 below.

1 http://en.wikipedia.org/wiki/Agriculture_in_India#cite_note-nytagriculture-4
3.1 MILK SUPPLY CHAIN

1.1 INTRODUCTION TO MILK SUPPLY CHAIN

In the context of diversification of agriculture in the state, dairying has come to occupy the centre stage. The rice-wheat system in the agricultural sector of Punjab has not only attained its potential but has also led to the depletion of soil and water resources of the State. Therefore, livestock is being considered as one of the feasible options for diversifying the agricultural sector of Punjab (Government of Punjab, 2002).

“The focus now has to be on doubling the production of milk and poultry products in the state as agriculture production is nearing its saturation point,” according to the Deputy Chief Minister of Punjab, Sukhbir Singh Badal.
Bearing a direct consonance to this view, it has been observed that the livestock is playing an important role in Punjab, thereby increasing its contribution to about 13 percent in the states income. According to Mr. Gulzar S. Ranike, Punjab’s Animal Husbandry Minister, daily milk production by Buffalos in Punjab, on an average stands at 8.585 kg and by cows, on an average stands at 10.947 kg; which is the highest in the country.²

Also the state of Punjab has witnessed in the recent times dominance of cooperative dairying in comparison to traditional milk market; in other words commercialisation of dairying.³ In fact, Punjab has been the first one amongst other states to opt for the establishment of commercial dairy farms and integrated farming systems thereby giving a new lease of life to dairying as an allied agricultural activity. This has further resulted in the economic upliftment of dairy farmers apart from increasing the milk production.

Dairy sector has emerged as an important contributor to the states domestic product owing to an increase in the per capita income of people due to high income elasticity of milk and milk products as compared to that of cereals.⁴ As reported by Dr Jaswinder Singh Bhatti, Technical Coordinator, Progressive Dairy Farmers Association, Punjab with its 6000 commercial dairy farms and successful progressive dairy farming programmes is emerging as a role model for other states.⁵ The growth of dairy sector has also been encouraged due to the expansion of milk collection facilities at the village level i.e. close to the farmer. Increasing demand for milk and milk products in recent years intensifies dairy farming as a profitable enterprise by the rural poor.

Punjab has acquired top position in the field of dairy farming with the production of 95.4 lakh metric tons of milk annually. The per capita availability of milk in the states of Punjab and Haryana was considerably higher than the country’s average. In the year 2012, it stood at 944 grams per persons across the country. Apart from being the highest milk producing states of the country it also maintains a huge surplus production of milk which makes dairy sector as one of the main sources of economic development in the state.

² The Times of India, 27 August 2012; “Punjab tops milk production in India”
³ Kumar et al., 2011; “Smallholder Dairy Farmers Access to modern milk marketing chain in India”
⁴ R.S. Sidhu and A.S. Bhullar; “Changing Structure of Farm Economy in Punjab: Impact of Livestock on Income and Employment”
⁵ Business Standard, 8 August 2012; “Punjab dairy farm model for other states”
Milk being a highly perishable commodity requires minimal time in procurement, processing and marketing so as to ensure minimal spoilage. In other words, a time efficient supply chain is imperative to ensure the success of dairy farming. Therefore, in the succeeding analysis we report the current scenario of dairy farming in Punjab.

In Punjab, Cooperative Federation in the name of MilkFed, incorporated in 1973 (under the Punjab Cooperative Societies Act 1961) with the main objective of providing a remunerative market to milk producers in Punjab. It came to its present form in 1983 when all milk plants of the erstwhile Punjab Dairy Development Corporation Limited (a unit of the State Government of Punjab) were handed over to the cooperative sector and the entire state was covered under the India’s Operation Flood programme. Operation Flood was one of the world’s largest rural development programmes focused on increasing milk production besides the upliftment of the rural poor.

Predominantly based upon the Anand pattern, cooperative milk market has emerged and coexisted alongside traditional informal milk market. An imminent demand supply gap can be identified in the dairy industry because of the dynamic demographic pattern, changing food consumption habits and rapid urbanization of rural India. Further, nearly 80% of the private dairies (in terms of number of units as well as capacity) are concentrated in the four states of Haryana, Punjab, UP, and Maharashtra making them as the highest milk producing states in the country.

In view of the potential dairy farming holds for the state, Financial Commissioner of Punjab, Gurinderjit Singh Sandhu reported; “We have already entered into collaboration with the Canadian government to exchange the knowledge base and expertise to bring about a white revolution in the state,” adding that “Canada is a leader in dairy farming. We are expecting that our collaboration on breed improvement, herd registration and nutritional aspects with the Canadian government would go a long way in making the rural economy predominantly based on livestock.”

1.2 METHODOLOGY

The basic approach used to undertake a detailed study of milk supply chain in Punjab has been a combination of primary and secondary information collection methods (refer to the figure 3.1.1 below).

Figure 3.1.1: Flowchart of Primary and secondary information collection methods
• **Primary information collection:** The primary information was collected through *focused interactions/interviews* in order to reach out to the important stakeholders for their insights and viewpoints.

Field visits were made to:

1. District Collection Society (DCS) located in Village Bajheri, District Ropar: Primary milk producers, village headmen, secretary of the DCS and workers at the DCS were interviewed. At this stage we gathered information regarding quantity of milk supplied by the primary producers, payment procedures, additional services provided to the primary milk producers, wastages involved in the system, quality control measures adopted and functioning of bulk milk coolers.

2. Verka Milk Processing Plant, Mohali: Structured interviews were carried out at the different divisions; procurement, processing and marketing. This enabled us to assimilate vital understanding of the procedure of milk processing and identifying wastages during the same. Information regarding procurement quantities and prices, and safety and quality control practices were also gathered.

3. Punjab State Cooperative Milk Federation Limited MilkFed, Chandigarh: Formal interactions with the officials of the federation were carried out in order to gain insights into the problems and wastages at their end.
Structured Discussions:
Apart from the primary field visits, structured discussions were carried out with subject experts like the SAP consultants, who by the virtue of their experience in the particular area provided useful suggestions on the technical front.

- **Secondary information collection:** The secondary inputs (information based on facts and statistics) were collected from a range of information sources both national and international, reports, articles, newspaper clippings and research papers of various organizations in India and other documents, reports, and statistics based on milk sector. Information collected includes diary sector’s profile data, overview of the production trends, supply chain management practices; inefficiencies and interface of information and technology.

### 1.3 MILK SUPPLY CHAIN

Based upon the primary field visits along with the review of academic literature and business reports, the identified liquid milk supply chain in Punjab is as follows (refer to figure 3.1.2):

**Figure 3.1.2:** Milk Supply Chain in Punjab

The organised sector basically pertains to the dairy cooperatives and private dairies which procure, process and market milk and milk products.

#### 1.1.1 TRADITIONAL MILK SUPPLY CHAIN

**Information Flow:**
There was no fixed demand stipulating the total quantity of milk to be supplied, in other words the primary milk producer could supply as much quantity of milk that he had as surplus to the private dairy. However, it was observed that the farmer supplied milk to these dairies only when they had surplus milk. When their production was just sufficient to meet their domestic consumption, they did not supply milk to these dairies unless tied under a loan obligation (further details pertaining to the loan obligation are explained in the cash flow section).

Information flows in the traditional sector start with the consumer, who fixes his demand for milk with the private dairy and further this information needs to be disseminated to the milk producer. Although directly no limit is exerted on the primary producer in terms of quantity of milk that he can supply, private dairies manipulate the procurement price to exercise control on the quantity of milk that can be procured so that by controlling milk supply, they can ensure profitability. For instance, if a private dairy wants to curtail supply in order to meet fixed demand, they reduce the procurement price. Accordingly, the primary producer corresponds to this reduction in procurement price and reduces his supply.

**Cash Flow:**

Milk producers are paid according to the fat content present in the milk. For instance, if the quantity of fat is 5.1 then a farmer is paid Rs. 23.97 per kilogram, similarly, if the quantity of fat is 10.0 (full fat milk) then a farmer is paid Rs. 47.00 per kilogram. *In case of full fat milk, these dairies pay one rupee more than the cooperative dairies.* However this has not been a deciding factor for the farmers in selecting as to whom they will supply their surplus milk.

To measure the fat content in milk, barometer testing is done. An important incentive for the farmers to supply milk to these dairies was the handsome amount of loan being provided by the dairy owners in comparison to meagre amount of loans by the cooperatives. This has resulted in farmers being tied to these traditional dairies as the recovery of loans is done by deducting the requisite amount from the quantity to be supplied by them in the future. Moreover, the farmers are not charged any interest on the load extended.
A written record in the name of every farmer is maintained, which provides a detailed account of quantity supplied and fat content in the milk, based upon which the farmers are paid. Payment of money by these dairies is being done after every 10 days. Apart from this, a bonus calculated upon the quantity supplied is also given.

It was also found out that supplying surplus milk to the private dairies is a profitable exercise for the farmer since they bear minimal costs in terms of animal’s feed and fodder. However, in case of events like animal sickness the entire cost of veterinary service is borne by the producer and the private dairy provides no support.

**Milk Flow:**
Milk is supplied by the producers to the private dairies (located in the village itself) twice a day. Within few hours of receiving the milk, it is transported to its final destination. Here convenience and proximity are important factors that govern the choice of farmers in choosing as to whom they will supply the milk. In the absence of any fixed demand-supply liability on the farmer by the private dairies, there are no written contracts signed between the two parties.

**1.1.2 MODERN MILK SUPPLY CHAIN:**
The milk supply chain in Punjab has become highly commercialised in its operations. The participation of multiple stakeholders has resulted in complex supply chain processes as shown in figure 3.1.3 below.
The cooperative dairy structure of Punjab is primarily based upon the Anand pattern initiated by Gujarat Co-operative Milk Marketing Federation (GCMMF). It is based on a three tier cooperative structure with village level primary milk producers’ at the grass-roots, eleven district level Milk Unions as second tier and Milk Federation as an apex body at the State level.
**Information Flow:**

Information flow in the cooperative sector is fragmented on account of no control on demand-supply of milk. Procurement prices cannot be manipulated in a cooperative structure largely owing to the fact that the cooperatives’ basic aim is to maximise the welfare of the primary producer. They cannot dictate the prices purely to realise inflated profits. Directly no limit can be exerted on the primary producer in terms of quantity of milk supplied by the producers to the District Collection Societies (DCS). DCS accepted raw milk only from those producers who had at least one milch animal. The cooperative dairy does not accept milk from private dairies or any other informal agents.

Since there is no limit exerted on quantity of raw milk procured from the producers, accordingly there is no limit on the supply of milk to the processing plant/union. Demand for processed milk by the distributor or the city supplier is by and large fixed i.e. marginal increase or decrease can be expected which is ascertained one day prior to the supply. However, consumers demand as per their need, in other words, there is no fixed demand by them.

Also, these dairies do not tamper with procurement prices and this can lead to excesses in milk supply with the demand being fixed by and large, ultimately leading to reduced profits.

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**Cash Flow:**

The milk producers are paid according to the fat content of the raw milk supplied by them, if the quantity of fat is 5.1 then a farmer is paid Rs. 24.30 per kilogram, similarly, if the quantity of fat is 10.0 (full fat milk) then a farmer is paid Rs. 45.50 per kilogram. The fat and SNF (Solid Not Fat) content of the milk is measured using Lacto’scan computerised testing at DCS’s milk collection centres itself.
Payment of money to the milk producer is being made after every 10 days (i.e. on every 5th, 15th and 25th of every month) plus a quantity based bonus during festive seasons like Diwali. Milk producers are also entitled to an additional payment of approximately 50 paisa per kilogram. A written record in the name of every farmer is maintained, which provides a detailed account of quantity supplied and fat content based upon which they are paid. The cooperative transfers’ money in the account of the secretary of the society who further makes payment to the producers based upon the quality and quantity of milk supplied. The DCS are entitled to some percentage of profits made by the cooperative’s processing plants (these plants, instead of paying taxes, prefer distribution of profits amongst the stakeholders at the village level).

The major costs accrued by the DCS in procuring and transporting milk to the plants are chilling costs (25 paisa per litre). DCS also make profits on daily basis based upon the quantity of milk supplied i.e. for every one quintal of milk that the DCS supplies to the plant they get extra money for 4-5 kilogram of milk. This is how the society makes its profits and accordingly, it utilizes these profits in meeting the maintenance costs incurred by them.

Supplying surplus milk to the cooperative dairies again is a profitable exercise for the farmer since they are bearing minimal costs in terms of the animal’s feed and fodder. It was seen that the cooperative provides seeds at subsidised rates annually. Also a farmer is entitled to veterinary consultation at a subsidised rate (approximately 40 percent) twice a month.

The procurement price paid by the Cooperative to the DCS at present, is Rs 455 per kilogram fat, out of this Rs 410 per kilogram fat is the basic price, Rs 15 per kilogram fat is the differential price (paid according to the fat content), Rs 25 per kilogram fat is the price difference (paid to the DCS by the cooperatives out of their profits), and Rs 5 per kilogram fat is the premium price (paid as a reward for the high microbial content in milk). Noteworthy is to mention that this procurement price is very high in comparison to the private players who pay on an average Rs 370-380 per kilogram fat.

Major costs involved in procurement of raw milk by the processing plant are transportation costs (Rs 38 paisa/litre) and chilling costs (Rs 30 paisa/litre).

On the retail side, the distributor agencies that are supplied milk as per their demand make payments on a cash and carry basis. This procedure involves making advance e-payments to the federation. The main source of funding for the cooperatives to run its operations is Banks (for MilkFed it is The Bank of Maharashtra).
Milk Flow:

Milk is supplied by the milk producers to these dairies located in the village itself twice a day. At the time of pouring milk in the DCS, if it is found to be adulterated, it is returned back to the farmer. The milk that passes the quality test is received by the DCS and stored in the Bulk Milk Coolers (BMC) at 4 degree Celsius after being checked for its fat content. Further, it is transported to the plant every morning at a fixed time in temperature controlled tankers (3-4 degree Celsius). On an average, based upon the distance, it takes 3-4 hours for transporting milk from BMC’s to the Cooperative’s plants. The supply tankers, in most of the cases, are owned by private transporters.

Raw milk transported to the Cooperatives Processing Plant using temperature controlled tankers is first brought to the reception dock in the production area. Here, huge pipes are attached to the tankers that first carry a small sample of raw milk to the reception dock. At the dock, raw milk is extensively tested in two stages; firstly there is a milko’scan testing i.e. computerized testing for checking fat content, milk content, SNF content, protein, lactose and total solids; and secondly raw milk is tested for adulteration (tests like salt test, urea test, rosalic test, sugar, ammonia compound, starch, formalin and hydrogen and glucose are performed).

Raw milk of good quality (that passes the above two tests) is received and collected in Silo’s (i.e. with a capacity of 60000/litre). Here milk is stored for about two days and acidity (0.13) is tested after every 13 hours. Chilling plants are attached to Silo’s where milk is pasteurized (filtered for impurity), then it is taken to the final taker (with attached pipes). If there is still any impurity in the milk it is re-pasteurized to avoid wastage. After processing the milk, packaging is done (polythene used in packets are also tested). The packaged milk is passed into the cold storage area. Again wastage is avoided by checking for leakage by pressing the packet.

On account of wastages, it was reported that on an average, the federation recovers 99.7 to 99.8 percent on account of production. Meagre wastages of maximum one percent can be seen.
and, that to *in case of processed products like ghee and not much in case of vet milk.* *Cooperatives also try to avoid these wastages by processing it into products with longer shelf lives (like ghee and dry milk powder).*

![Milk Supply Chain Diagram](image)

### 1.4 FINDINGS

1. **Fragmented Information Flow in real time leading to demand-supply mismatch:**
   Effective management of related information flows is critical to realize effective management of milk and cash flows, and ultimately an efficient supply chain. The liquid milk sector in Punjab is fairly unorganized, there is discontinuity in the information flow i.e. real time information flow is unavailable. Information flow from downstream chain members does not come back down the chain and does not reach the milk producer. There is a substantial information flow discontinuity particularly in electronic format (refer to figure 3.1.4 below).
2. Mismanagement of milk procured leading to wastages:
Milkfed procures milk from 3.5 lakh dairy farmers and sells around 8 lakh litres of milk per day in Chandigarh, Panchkula and Mohali with residents in each area consuming around three lakh litres daily. In context of Punjab’s cooperative sector at present, about 6,000 dairy farmers have threatened to stop milk supply to Milkfed if milk procurement price for farmers is not hiked on account of soaring input prices. For instance a 35 percent increase in cattle feed cost alone alongside an increase in interest rate on the loans taken by the farmers under the cooperative scheme is threatening the viability of dairy business for them.6

The federation on its part has been unable to give in to the demands of the farmers to hike the procurement price to Rs 485 per kg fat as against Rs 405 per kg fat which they are giving at present. Milkfed raised its procurement rate from Rs 395 per kg fat to Rs 405 in September last year and has been systematically increasing the price since 2007. There have been wastages on account of huge unsold stock of 1000 tonnes worth Rs 105 crore and outstanding stock of 80000 tonnes of powdered milk and ghee due to import of milk products by private players from other states like Rajasthan.

3.2 GRAIN SUPPLY CHAIN

2.1 INTRODUCTION TO WHEAT & RICE SUPPLY CHAIN

6 http://www.tribuneindia.com/2012/20121124/main3.htm
Punjab was on the forefront of the Green revolution in India during mid 1960s. However, in 1961-62 before green revolution, Punjab’s production of wheat was 1,765,000 tonnes. In 1971-72 production of wheat increased to 56 lakhs MT (metric tonnes) due to Green revolution. In 2009-10, Punjab contributed 42.2% share of wheat and 29.5% share of rice to the central pool as Punjab’s net sown area is 83% of its geographical area and 85% of the agriculture output comes from wheat and rice\(^7\). Wheat and rice played a major role in pushing up agriculture production. The production of wheat and rice increased to 150 lakhs tonne and 86.35 lakhs tonnes respectively in 2010-11(refer to Appendices 2a &2b). With an exponential increase in production of wheat and rice, there has been a shortage of storage capacity leading to colossal wastage of the staple food of India. Punjab alone lost 70,000 tonnes due to lack of storage facility. Such a wastage is an embarrassment for a country where millions go hungry every day, where food prices break the back of the common man, an estimated 231 million (23.1 crore) people in India go hungry every day, each minute, five Indians die of hunger and 2.5 million people every year.\(^8\)

As per the nation’s food security policy, the strategic and buffer stock of wheat and rice should be 31.8 million tonnes in 2012 which includes 26.9 million tonnes of buffer stock and 5.1 million tonnes as strategic reserve but the food grains stock is over 80 million tonnes in the country as on June 2012. Shortage of storage facility is the biggest problem identified by Food Corporation of India (FCI). Export of Wheat is not an attractive alternative for India as it is not competitive in the international market. The FOB (free on board) price of Indian wheat is $382 per tonne but the competitive price in export market is around $260 per tonne.

In June, 2012, Indian government decided to offer 3 million tonnes of wheat to local biscuit makers and flour millers at $205 a tonnes against the $225 it paid to farmers in 2012.\(^9\) The state of Punjab has always been on the forefront in adopting new agriculture technology which resulted in high capital intensive farming. Small and marginal farmers could not sustain capital intensive farming from their savings alone and thereby had to invest in farming technology by taking loans from the banks. The institutional source of credit could not meet the credit requirement of the farmers; therefore they choose expensive sources of finance such as commission agents and non-institutional money lenders.

The Indian fertilizer industry has been under government control for decades, given its strategic importance of self sufficiency of wheat and rice production in the country. Fertilizer subsidies

\(^7\) Singh &Kohli; the green revolution in Punjab, India: The economics of technological change


\(^9\) http://in.reuters.com/article/2012/07/02/india-wheat-food-malnutrition-crops-idINDEE86101620120702
cover 57.5% of the total subsidies in India.\textsuperscript{10} The total subsidies had increased from Rs. 12158 crore in 1990-91 to Rs. 129243 crore in 2008-09, increasing by 10.6 times. The fertilizer subsidy had increased from Rs. 4389 crore in 1990-91 to Rs. 75,849 crore in 2008-09 representing an increase of over 17 times.\textsuperscript{10}

This study found out that wastage of wheat and rice is one of the major inefficiencies in the supply chain. Procurement agencies need to motivate farmers to grow better variety of seeds and harvest their crops in time so as to avoid harvest of wet and immature wheat and paddy. On the other hand, indebtedness of farmers is a major concern for government of India. Farmers of Punjab were ranked highest in terms of indebtedness in the country and 66% of farmers’ suicides committed were due to the burden of debt. According to the annual budget of Punjab for 2009-10, rural debt is estimated to be Rs 35,000 crore. This comprises Rs 22,000 crore as institutional debts, and Rs 13,000 crore of debt towards money lenders and commission agents (Arhtiyas). It has been found that farmers are borrowing at 24% interest rate from commission agents (Arthiyas) which results into never ending loan terms.\textsuperscript{11}

After studying the supply chain thoroughly, this study proposes a model that would generate a win-win-win situation for banks, farmers and procurement agencies to overcome indebtedness of farmers, delay in payment process and delay in procurement process.

\section*{2.2 METHODOLOGY}

This study examines supply chain of wheat & rice and inefficiencies associated with them. India is the second largest producer of wheat and rice in the world therefore a little disruption in supply chain at any level can cause heavy losses. In order to examine inefficiencies in the supply chain, our team studied flow of information, cash flow and flow of commodities. The methodology adopted in preparing this study is based on primary data collected by interviewing farmers, commission agents and FCI food inspectors to acknowledge challenges and problems due to inefficiencies for each of them. We also investigate the physical movement of post-harvest produce through the supply chain to find the weak links in the supply chain and reasons for delay in procurement and payments to farmers.

The study comprehensively reviews the government actions and amendments of policy changes to overcome the inefficiencies and the current state of wheat and rice supply chain to find out the factors responsible for wastage. During primary research, field visits were made to \textit{anaaj mandis} (food grain market) and villages in Punjab. Our team visited mandis in Banur, district

\textsuperscript{10} IIM, Ahmedabad, Vijay Paul Sharma, Harima Thaker, July 2009, \textit{Fertilizer subsidy in India, who is the Beneficiaries?}
\textsuperscript{11} 2011; Sukhpal and Tejinderdhaliwal; The status of commission agent system in Punjab agriculture
Patiala and Chandigarh to conduct interviews with commission agents and food inspectors to collect information about current state of the supply chains and identify the problems in the process of procurement. Field visits to villages (Khanpur Khaddar; Tehsil Banur Haripur; District Ropar and Village Pithon; District Bathinda) helped us to address the problem of indebtedness faced by the farmers in Punjab and other information related to storage facility, reasons for delay in procurement and payments. The secondary research is based on collecting information on the wastage of wheat and rice to analyze economic impact due to losses.

This study intends to address inefficiencies in supply chain of wheat and rice in Punjab. The main objective of the study is to address the followings:

1) Flow of commodities: What are the reasons for commodities wastage in the supply chain?
2) Cash flow: How efficient is the system for cash flow through the supply chain.
3) Flow of information: What are the channels of information among stakeholders to overcome inefficiencies in the supply chain?
4) Is there any possibility of IT intervention to overcome inefficiencies in the supply chain of wheat and rice?

2.3 WHEAT AND RICE SUPPLY CHAIN

Wheat and rice markets are different from other agriculture commodities as government controls wheat and rice’ procurement for price stabilization and nation’s food security. Over time the cost of the price stabilization policies and institutions implementing the policies have risen and the benefits have declined.

Wheat and rice: commodities flow

Actors in wheat and rice supply chain are input suppliers of fertilizers, farmers, commission agents (Arhtiya), FCI (Food corporation of India), other government procurement corporations such as central warehousing corporations, Markfed (Punjab state Co-operative supply and marketing Federation), Pungrain (Punjab Grains procurement Corporation Ltd), Central Warehousing Corporation, large millers of wheat and rice, wholesalers and retailers of processed grains. As given below, Figure 3.2.1 will describe the physical movement of wheat and rice.

Figure 3.2.1: Wheat and Rice: Commodities Flow
**Input Supplier**

Input suppliers include major chemical companies, government distributors, small wholesaler/retailers, and even smaller retail shops that sell small quantities of seed, fertilizer and pesticide to farmers at the village level. The government sells subsidized DAP (diammonium phosphate) at Rs1200/50 kg bag, MOP (Muriate of Potash) at Rs 375/50kgs and Nitrogen at Rs 295/50kgs through government cooperative societies and the Indian Farmers Fertilizer Cooperative (IFFCO).

**Farmer/Producer**

Wheat is a major crop for most farmers, as it is a traditional crop and requires less water than rice. Most farmers have practiced a crop rotation pattern of rice and wheat on the same fields for years rather than alternating with other crops such as pulses, oil seeds, or vegetables. However, crops other than wheat and rice do not yield enough to meet household food and cash requirements for smallholder farmers. Large farm holders prefer to grow wheat and rice as it offers an assured return on production. Government announces minimum support price (MSP) every year for wheat and rice that guarantees an assured return on production for farmers. Wheat MSP is 1250/quintal for year 2011 and paddy MSP is 1280 per/quintal for A grade quality of paddy.

**Mandi Arhtiyas/Commission Agents**
Supply chain of wheat and rice in Punjab carries lesser stakeholders than other states. Even smallholder farmers sell their produce directly to commission agents and small millers (chakkivalas) in Punjab. Commission agents (arhtiyas) are licensed commission agents based in mandis charging 2.5% commission on the sale and purchase of wheat and rice. In 2010, FCI had tried to implement direct payment system which was stayed by the Centre after immense pressure from the Punjab government. State government has not amended APMC Act yet to eliminate commission agents.

Punjab Arhtiya Union leader, Vijay kalara said, commission agents are integral part of the procurement system of wheat and rice in Punjab. Elimination of commission agents would hit the MSP (minimum support price) in Punjab. In other states such as Uttar Pardesh and Andhra Pardesh where commission agent system is not in operation, farmers are forced to sell their produce for less than MSP.

Procurement at Mandi (FCI, Pungrain, Central Warehousing Corporation, Pungrain, Markfed)

FCI, Food Corporation of India is the largest national procurement and distribution agency of wheat and rice in India. FCI was set up for safeguarding the interest of farmer, maintaining the buffer stocks for national food security and distribution of food grains throughout the country. In order to maintain the food security for a nation, government announces minimum support price (MSP) every year for wheat and paddy to safeguard the interest of farmers and promote wheat and rice cultivation in India.

MILLERS

Miller in wheat and rice supply chain deals in one or both crops. Rice processing involves cleaning, polishing and packaging whereas wheat is milled into four products: bread flour (atta), cake flour (medha), semolina (suji), and bran. The by-products, wheat husk and de-oiled rice bran cake, are sold for use as animal feed. Rice husks are sold to solvent plants that extract oil and a base for soap.

FCI prefers to store wheat grains and distribute further in the form of wheat grains but in case of rice, FCI contracts out the milling process to the privately held rice mills to store rice instead of paddy. In another scenario Millers buy paddy from commission agents (Arhtiyas) and sell processed rice further to wholesalers, distributors and large retailers.

Processed grains’ Wholesale and distribution: Large companies such as ITC and Pantaloon food have established their buying centres to procure wheat directly from farmers. These companies also buy grains from FCI and other government procurement agencies. In case of rice’s supply chain, rice millers are buying from commission agents (Arhtiyas) and selling to regional wholesalers and distributors.
Retailers

Large retailers are procuring wheat and rice directly from the large manufacturers like ITC, Shakti Bhog and Pantaloon Food etc. Small retailers in villages buy Wheat products and rice from regional wholesalers and distributors. Small retailers were selling unbranded wheat flour (Atta) at Rs. 18/kg and unbranded medium variety of rice for Rs 20/kg (figures collected up till October 2012.)

Wheat and Rice Cash Flow

FCI and other state procurement agencies procure from commission agents in mandis. The final cost of wheat and rice to FCI is Rs 1910 and Rs 2484 respectively\(^{12}\) and Farmer sells at minimum support price for wheat and rice as announced in 2012 that is Rs 1250/quintal and Rs 1280/quintal respectively. FCI bought from commission agents at Rs 1281.5/quintal and Rs 1312/quintal in year 2011-12. As shown in Figure 2, commission agents charge 2.5% on the sale of grains and further transfer the funds to the farmers at minimum support price. CACP (Commission for agriculture cost and price) announces minimum support price every year for wheat and rice and other major agriculture products.

Figure 3.2.2: Wheat & Rice Cash flow chart

- **Procurement agencies**
  - • FCI, Markfed, Pungrian, Central warehousing corporation procure from commission agents at **MSP 2.5% commission i.e Rs 1281.25/quintal (Wheat)and Rs 1312/quintal (Rice)** for year 2011-12

- **Commission Agent/Arhtiya**
  - • As per the policy, commission agents is required to pay farmers within 72 hours at the **minimum support price: Rice (A grade) – Rs 1280, wheat - Rs 1250 for year 2011-12**

- **Farmers**
  - • Farmer buys highly subsidized fertilizers such as DAP(Diammonium phosphate)@ 1200/50kg, MOP (Muriate of Potash)@ 375/50kg, Nitrogen@ 295/50kg. 2011-12

- **Input supply**
  - • Fertilizer subsidies has taken the largest share and accounted for **58.7% share of the total subsidy** given by Indian government in 2008-09.

Wheat and Rice Information Flow

\(^{12}\)http://fciweb.nic.in/finances/view/9
It is evident that there is a lack of appropriate information channels among stakeholders in the supply chain of wheat and rice as shown in figure 3.2.3. Most of the commission agents complain that farmers bring wet and immature paddy and wheat to mandis, which cause delay and procurement and extra-labour costs to farmer for the drying process. Farmers are using hybrid seeds that take longer to harvest which results in early harvest of crops.

**Figure 3.2.3:**

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**2.4 FINDINGS**

Key findings from our research are given below:

**a) Colossal wastages: storage and procurement delays**

Federal and state governments are struggling to control post-harvest wastage of rice and wheat. The major reason for wastage is lack of storage facility and delay in procurement. Over 6.6 million tonnes of wheat worth over Rs 1,100 crore was lying open due to lack of storage facility as on June 2012.\(^\text{13}\) Being a major producer of wheat and rice, Punjab and Haryana leads in terms of food grains’ wastage.\(^\text{13}\)

\(^{13}\)http://articles.economictimes.indiatimes.com/2012-06-21/news/32352248_1_wheat-and-rice-storage-capacity-tonnes
According to Punjab’s chief minister, Parkash Singh Badal (2011) “Against the required capacity of 49 lakh tonnes for foodgrain storage, the total approved capacity is only 22 lakh tonnes “There is still a shortage of 27 lakh tonnes for storing foodgrains properly” he added.

Wastage of wheat and rice due to lack of storage is a major challenge for Indian government and Punjab. Punjab lead the race amongst other states in terms of grains’ wastage until September 2012. According to figures obtained through RTI (right to information of India), 19,290 tonnes of grains has rotten in Punjab since 2008. Such a colossal wastage of food grains is unbearable in a country where one-fifth of its population is malnourished.

Biraj Patnaik, Principal advisor to the commissioners of the Supreme Court on the right to food case; commented on the issue of food wastage “The reason we are facing this problem is our refusal to distribute the grain that we buy from farmers to the people who need it. The only place that this grain deserves to be is in the stomachs of the people who are hungry.”

Commission agents act as a link between farmers and buyers. They arrange payments to the farmers and other facilities like loading/unloading and cleaning of the produce in mandis. As discussed above, Commission agent charge 2.5% on the sale of wheat and rice produce from procurement agencies but this is not the only source of income for them.

According to one of our respondents, a large farm holder said, “Commission from sale-purchase of wheat and rice is a small portion of commission agents’ income. The major source of income of them is coming from money-lending to farmers at exorbitant rate of interests, which ultimately leads to farmer suicides. They charge more than 2% -3% per month interest rate from farmers, more than 24% interest per annum”. Balvinder Singh, farmer, Tehsil Banur, Punjab

FCI took an initiative to place system for direct payments to farmers in 2010 but due to the influential lobby of commission agents, the Punjab government stepped in to block the direct payment system and therefore FCI decided to withdraw direct payment system.

One of the farmers explained, “Small and marginal farmers are completely dependent on their commission agents for financial help. Some of the farmers never come out of debt. For example I pay off the debt and borrow again at the same time to produce next crop.” Baldev Singh, a farmer.

As per the FCI procurement norms, procurement agencies make payment to commission agents (arhtiyas) in 48 hours and thereafter commission agents pay to farmers in next 72 hours. Payments above Rs.10000 are made through cheque only. In some cases commission agents delay payments to indebted farmers and use the amount for their own purpose of money-lending.
b) Procurement: delay in procurement
High content moisture in paddy leads to large scale rejection by agencies and rice millers. Unseasonal rainfall and usage of uncertified hybrid seeds are the major reasons for wet paddy. Farmers are being misguided by private marketing seed companies to use hybrid seeds that take more time to grow and as a result, farmers cut their crops before they are ready for harvesting. FCI needs to motivate farmers to bring good quality produce to mandis.

According to a commission agent, “Farmers are using uncertified hybrid seeds for wheat and rice cultivation. Hybrid seeds take longer cycle of growth than other varieties. Farmers bring their immature produce and then it is a problem for everyone. No agency wants to buy it.” - Amit Jain, commission agent, Banur Mandi, Punjab

c) Subsides: excessive subsides on fertilizers
Today, India is one of the largest producers and consumers of fertilizers in the world. India's production in terms of nutrients reached 15.96 million tonnes in 2006-07 from 38.7 thousand tonnes in 1951-52. Prime Minister's Economic Advisory Council (PMEAC) in its latest Economic Outlook 2012/13 suggested that “subsidies are progressively losing their relevance and are becoming unbearable fiscal burden so a beginning can be made in dismantling fertilizer subsidy". Most of the agriculturists suggest that, fertilizers consumption in India is excessive as per the sown area. Small and marginal farmers use more fertilizers than large farmers as small and marginal farmers receive about 53 per cent of the subsidy, higher than their share in total cropped area (44.3%) which suggests imbalance and excessive usage of fertilizers.

d) Initiative: Government’s Initiative
There is a debate about whether the fertilizer subsidy benefits the farmers or the fertilizer industry. The government has initiated a plan to implement a new model of subsidy's distribution directly to farmers and the same will be implemented in three phases, redirect the fertilizer subsidy from companies to retailers and eventually to farmers.

Contrarily, Sharma and Thaker argued that one third of fertilizer subsidy going to fertilizer industry does not hold true, the policy of direct transfer of subsidy to farmers is neither desirable nor practically implementable. It would be difficult to ensure that direct transfer of subsidy to millions of farmers is actually used by farmers for only buying fertilizer and there are no leakages in transfer of subsidy.

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14 Fertilizer association of India, FAI, 2008
16 http://www.iimahd.ernet.in/assets/snippets/workingpaperpdf/14668129402012-09-01.pdf
According to one of the fertilizer retailers - it is true that subsidized fertilizers are being sold by trading companies for industrial purposes. People just establish fake trading companies and generate fake invoices to wholesalers to get the subsidy on fertilizers that never reach farm-gate. It is only possible with wholesalers' assistance to fake trading companies. Retailer, (Village Tappa, District Bathinda)

It is necessary for government to monitor the physical movement of fertilizers as it holds the major share (58.7%) of total subsidies in 2008-09. A new system, called the Mobile based Fertilizer Monitoring System (mFMS) will be implemented all over India by 2013 to extend the tracking beyond the 30,000 warehouses and to all the 230,000 licensed retailers and wholesalers.\(^\text{17}\)

The first phase of the project has been launched in some states of India with an objective to create information visibility of the movement of fertilizer along the supply chain from the manufacturer till the retailer. After phase 1 is implemented, it is envisaged that up-to-date information will be available, in the public domain, about the availability of fertilizers at the retailer level (last point of sale to the farmer). This would, in itself enhance the transparency of fertilizer flow across the supply chain and would facilitate better delivery of the fertilizers to the end user.

Fertilizer retailer commented that, this system would at least provide us the right information about the fertilizers allocation and stock availability which would bring transparency to the system but buying fertilizer at unsubsidized price and then wait for the payments from government is impossible practically. (Gurmeet Singh, Rampura, Distt, Bathinda)

mFMS (Mobile based fertilizer monitoring system)

The mFMS (shown in Figure 3.1.4) is designed to provide end-to-end information on the movement of fertilizers and subsidies, from the manufacturer to the retail level. Direct transfer of subsidy to the retailer and eventually the farmer will be implemented in subsequent phases. This will benefit 12 crore farmers, while reducing the leakages and expenditure on subsidies by curtailing the misuse of fertilizers. The system is described below in detail:

\(^{17}\) [http://agrariancrisis.in/2012/01/03/transfer-of-the-nodal-point-of-fertiliser-subsidy-has-companies-and-retailers-nervous/](http://agrariancrisis.in/2012/01/03/transfer-of-the-nodal-point-of-fertiliser-subsidy-has-companies-and-retailers-nervous/)
Figure 3.1.4: mFMS enabled Supply chain of fertilizers in India

Table - 3.2.1: Explanation of mFMS System

<table>
<thead>
<tr>
<th>Entity</th>
<th>Function of process</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>F1</strong> Manufacturer</td>
<td>Primary movement from plant to the rail head destinations on longer leads (called Rake points) - by rail</td>
</tr>
<tr>
<td><strong>F1-1</strong> Manufacturer</td>
<td>Manufacturer supplies to local (within 150-200Kms) wholesalers and retailers registered on mFMS only</td>
</tr>
<tr>
<td><strong>F1-2</strong> Manufacturer</td>
<td>Primary movement to the block (regional) warehouses from manufacturing unit - by road</td>
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<td></td>
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<tr>
<td>---</td>
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</tr>
<tr>
<td>F2</td>
<td>Rake points</td>
</tr>
<tr>
<td>F3</td>
<td>Warehouse</td>
</tr>
<tr>
<td>F4</td>
<td>Wholesalers outside the region</td>
</tr>
<tr>
<td>F4-1</td>
<td>Local Wholesaler</td>
</tr>
<tr>
<td>F4-2</td>
<td>Retailer</td>
</tr>
<tr>
<td>F5</td>
<td>Wholesaler to retailer</td>
</tr>
</tbody>
</table>

2.5 PUBLIC DISTRIBUTION SYSTEM: AN IMPORTANT LINK IN GRAINS SUPPLY CHAIN

Since the public distribution system (PDS) forms the key part of grains supply chain in India, PDS is analyzed in detail in the below section:

The Public Distribution System (PDS) in India is an important public intervention for enhancing food security and a huge supply chain effort goes into delivery of commodities to the eligible citizens. The PDS provides subsidised food grains (and other essential commodities) through a network of ‘fair price shops’. In this context, it may be worthwhile to look at the role played by the Public Distribution System which has been in existence for more than five decades and to analyze the implication of the policies perceived from time to time for ensuring food security in this country. The Public Distribution System is one of the important ingredients of the Food Management Policy of the Government of India. The food management policy essentially incorporates procurement system, storage and movement of foods, public distribution and maintenance of buffer stocks.

Basic flow of PDS
As depicted in the figure below, the procurement for FCI happens in the states and then FCI transfers the grains to the beneficiaries through Fair Price Shops.

**Evolution of Public Distribution System**

1. Public Distribution of essential commodities had been in existence in India during the inter-war period. PDS, with its focus on distribution of food grains in urban scarcity areas, had emanated from the critical food shortages of 1960. PDS had substantially contributed to the containment of rise in food grains prices and ensured access of food to urban consumers. As the national agricultural production had grown in the aftermath of Green Revolution, the outreach of PDS was extended to tribal blocks and areas of high incidence of poverty in the 1970s and 1980s.
2. PDS, till 1992, was a general entitlement scheme for all consumers without any specific target. Revamped Public Distribution System (RPDS) was launched in June 1992 in 1775 blocks throughout the country.

3. The Targeted Public Distribution System (TPDS) was introduced with effect from June, 1997.

**Inefficiencies in PDS**

The PDS currently suffers from a number of issues that make it difficult for it to meet its objective of ensuring that the allotted quota of specified food articles reaches the intended underprivileged/needy segments of society:

1) A large number of families living below the poverty line have not been enrolled and therefore do not have access to ration cards

2) A number of bogus ration cards which do not correspond to real families, exist in the BPL & AAY categories. Food drawn on the basis of these bogus cards is a significant leakage from the system, as it does not reach the intended beneficiaries. Additionally, these extra cards inflate the number of BPL and AAY cards in circulation and further reduce the amount of food available to rightful beneficiary families.

3) A number of instances where benefits are being availed in the names of rightfully entitled families without their knowledge. This shadow ownership is possible due to inefficiencies in ration card issuance and distribution

4) Errors in categorization of families that lead to BPL families getting APL cards and vice versa.

5) A significant portion of benefits provided to the APL category under the TPDS, are not availed by the intended beneficiaries and are instead diverted out of the system.

**Leakage and Diversion**

PDS is widely criticized for diversion and leakages in the delivery. PDS is ranked third in corruption among the 5 basic services (Schooling, Water Supply, PDS, Electricity and Hospitals) according the India Corruption study 2005 done by centre for media studies. It is estimated that 25% diversion takes place before the ration reaches to the beneficiaries. Some of the key areas where pilfering happens

1. Diversion in the procurement itself from commission agents and farmers

2. Diversion while transporting to FPS from FCI warehouses and other warehouses of state-procurement agencies.
3. Diversion at the Fair Price Shop level

Current status of IT usage in PDS:

Some states have implemented an IT monitoring system in India to counter subsidy leakages and commodities diversion into black market.

A summary of the best practices in TPDS implementation by some States is as follows:
1. Creation of central beneficiary database – Chhattisgarh, Gujarat, Tamil Nadu, etc.
2. Cleaning up of databases through use of biometrics – Andhra Pradesh, Madhya Pradesh etc.
3. Maintenance of Ration Card database using web based application software – Chhattisgarh, Gujarat, Tamil Nadu, etc
4. Issuance of TPDS commodities through:
   a. Bar coded Ration card – Chhattisgarh, Gujarat, etc.
   b. Smart Card based ration cards – Andhra Pradesh, Chandigarh, Haryana, Orissa, etc.
   c. Food Coupons– Bihar, Gujarat, Madhya Pradesh, Orissa, etc.
5. Online biometric verification before transaction – Gujarat.
6. Automated allocation every month using web-based application– Chhattisgarh, Tamil Nadu, Gujarat.
7. Generation of delivery order, truck challans, receipts and movement of commodities between Distribution Centers are being carried out through application software – Chhattisgarh.
10. Availability of PDS related information on website such as list of Ration Card holders, FPS list, allocation, month-wise lifting and sales by FPS etc. – Chhattisgarh, Tamil Nadu.
11. SMS alerts sent to registered beneficiaries / citizens, vigilance committees for a designated FPS whenever PDS commodities are dispatched from a godown – Chhattisgarh, etc.

Case Study of Andhra Pradesh computerized public distribution system.

The State has taken initiatives for computerization of the ration card household data. A household survey was carried out for a large number of parameters of which ration card details were a subset. For this Ration Card Designated Photography Location (DPL) centers were setup to collect/ verify the declaration forms and to enter beneficiary data in the computer. Iris scanning for each member of the family was also done. The Ration card household application
is a client-server based application. The data at present isn’t centralized and hence beneficiary verification across districts is not taking place. Bar-coded coupons were also introduced in the State. The coupons were given after manual verification of the beneficiary’s details. This was a difficult process and hence personalized bar-coded coupons were introduced as a pilot for kerosene and rice. These coupons were delivered at the doorstep of the card holder. However no mechanism has been set up for scanning of these coupons for verifying the actual distribution. Aadhaar enrolment is currently in progress in seven districts. The State Civil Supplies Department is implementing a smart-card based Point of Sales (PoS) solution in all FPSs covering the entire State in a phased manner. As part of a pilot in Maheswaram Mandal of Rangareddy district, smart cards have been issued to the beneficiaries covering all the 36 FPSs and these FPSs are also equipped with PoS terminals for the purpose of authenticating/verifying beneficiaries before commodity distribution. A grievance redressal module was developed and put in place to log calls from beneficiaries.

A pilot has been initiated in Krishna and Nellore districts for monitoring the transportation of essential commodities by using GPS from the MLS point to the FPS. After the pilot is completed, the same will be extended to other districts.

3.3 VEGETABLE SUPPLY CHAIN

3.1 INTRODUCTION TO VEGETABLES SUPPLY CHAIN

Growing demand for fruits and vegetables induced by rising incomes and changing consumption patterns, coupled with declining farm incomes due to rising costs and stagnating food grain productivity, has necessitated diversification towards high-value crops in recent times. There was a clear economic advantage in producing vegetables as compared to the traditional crops, but lack of marketing facilities has been the major impediment.

The current issues includes wastage during transportation (5-10% depending on the season and perish ability of the vegetable) and demand and supply mismatch (10-25% depending on vegetable), high cost of packing, high commission (agents), high transportation costs, costly cold storage facilities, delayed payments to the farmers and existence of malpractices in the marketing of vegetable crops. There are large variations in the share of vegetable producers in consumer’s rupee as well as marketing margins across different marketing channels. As a result, market intermediaries tend to apportion greater margins on the pretext of sharing larger proportion of producer’s risk.
Considering the above mentioned facts, we thought that there is a great scope of improvement in vegetable supply chain.

3.2 METHODOLOGY

To gain understanding about the working of the vegetable supply chains in India, both primary and secondary research methodologies were used. The scope of this project was restricted to the vegetables that gets harvested in Punjab and then consumed or sent outside the state.

**Primary sources:**
To gather the primary data, field visits were made to various stake holders in the supply chain. To gather information at each these primary data sources, more than 25 surveys and interviews with farmers, agents, vendors and transporters were conducted. Based on this information, the overall estimate of wastage in the entire supply chain lies in the range of 15% to 40%. However, no visits were made to farms to find harvesting losses. Visits were made to the following places:

1. Wholesale Mandis:
   Wholesale mandis were visited where the farmers sell to agent and then the agent sells to wholesale buyers like hotels, exporters, etc
2. Retail Mandi’s:
   Retail mandis were also visited where the farmers sell directly to consumers.
3. Government Departments
   Punjab government’s department: Mandi Board, which regulates the operation of the mandis in Punjab; was visited and perspectives of senior government official were taken. Few important findings were noted about the inefficiencies in the supply chain and they also provided valuable insights in misaligned incentives that distort the role of agents.
4. Research institutes
   Meetings with researchers from National Agro-Food Biotechnology Institute (NABI) were held to find out the importance and the current practices to extend the shelf life of the vegetables. Though the technology is available and has been applied to some expensive fruits, accurate estimates of price elasticity of vegetables remain a vital input to its commercialization.
5. Retailers
   Interactions with big retailers were also held to understand the evolution of the modern retail with respect to vegetable supply chain.

**Secondary sources:**
The secondary inputs were collected from a range of information sources; reports; articles; newspaper clippings and research papers. Information was collected on vegetables supply demand trends, the production trends, supply chain management, inefficiencies and use of technology in this area.

Based on the findings from primary and secondary sources we decided to narrow our focus to wholesale mandi. This was done as we found that removal of information asymmetry would not only empower the farmer, thereby increasing his power in the supply chain, but would also help him/her to get better value for the produce through access to better information.

### 3.3 Vegetables Supply Chain

We conducted field visits to the local mandis to find out the stakeholders in this supply chain and to study the flow of information, material and cash that runs this system.

![A rural market in India - farmers with limited marketing options sell their surplus produce](image)

Based upon the on the normal shelf life, vegetables could be classified into three categories

- **Low shelf life**: Around 1 to 2 days for green leafy vegetables such as spinach, cucumber, cauliflower
- **Medium shelf life:** 2 to 3 days- Many of the vegetables fall in this category. This category includes vegetables such as tomato, pumpkin, carrot & radish
- **High shelf life:** Expected life is more than 4 days. The vegetables in this category include Onion, garlic, potatoes etc.

**Stakeholders:** The stakeholders in the vegetable supply chain are:

- **Farmers:** They are responsible for bringing the vegetables to the mandi. The cost of transportation, packaging and any wastage till packaging is borne by the farmers.
- **Agents:** The farmer hands over the vegetables to the agent. The agent in turn sells it to the vendor. In this supply chain, agent acts as intermediary and facilitator of transaction between farmer and vendor.
  - He also bears the cost of credit, which he provides to the vendors and farmers.
  - In case of the farmer, he makes a lump sum payment upfront based on the price decided in the auction. Rest of the payment is made to the farmer on his subsequent visit.
  - The small vendors usually have 2-4 days of credit period.
- **Vendors:** They buy vegetables from the agents. The seller in this case holds the say on the price for small retailers. These vendors are not usually satisfied as they end up paying more for lesser quantity due to weighing issues.
- **Modern Retailers:** Modern retailers buy from the agents in bulk quantities and on regular basis. Retailers such as Reliance have their executives in different mandis. They coordinate amongst themselves to determine the trade price of the vegetables in different mandis. The communication usually happens over the phone. Based on the price information, they select which vegetable to buy from which mandi. If the prices are unusually low, they could also buy more than what they planned to. However, since the vegetable have low shelf life, the over buying is very limited.

**Material Flow:** Based on the information from the field visits to mandis in sectors 26 & sector 45, the material flow could be divided into 3 different supply chains.

**Supply chain 1:** In this case, the farmers bring their produce to the wholesale mandi where agents take a commission (from farmers) on sale of the produce and help the farmers sell their produce. Based on the auction, the price is determined. The farmers sell it to the retailers. The retailer then sells it to the consumer in the retail mandi. The vegetable that remains unsold in the retail mandi is often sold at discounted price in another mandi next morning. This helps retailers to minimize wastage.

**Figure 3.3.1:** Material Flow in supply 1
Information Flow:

There is no structured information flow in this supply chain. Farmer, based on his estimation, decides his production level. The decision of point of sales is based upon the information of prices available in various mandis. Farmers contact various mandis to find out best transit cost versus price trade off for selecting point of sales. Retailer gets the information of price and availability of the product only at the time of sale and the quality of product most of the time is revealed post sale mainly.

Figure 3.3.2: Information Flow in supply chain 1

Cash Flow:

Agent facilitates transaction between retailer and farmer. He deducts 7% from the amount paid by retailers, keeping 5% as agent’s margin and 2% as government’s tax. Farmer receives cash on D-day (Day of transaction) but retailer pays Agent two or three days post date of transaction. Agent bears risk of default from retailers so the credit to retailer is given based on trust only.

Figure 3.3.3: Cash Flow in supply chain 1
Supply Chain 2: In this case, farmers bring their produce directly in the retail mandi to sell to the consumers. The agent does not play any role. The transactions happen on the spot and no credit is involved.

Figure 3.3.4: Material Flow in supply chain 2

Information Flow:

There is no structured information flow in this supply chain as well. Farmer, based on his estimation, decides his production level. The decision of point of sales is based upon the information of prices available in various Mandis.

Figure 3.3.5: Information flow in supply chain 2

Cash Flow:

The cash transfer to farmers happens on the day of transaction. No Party bears credit risk.

Figure 3.3.6: Cash Flow in supply chain2
Supply Chain 3 (Modern Retail): In this supply chain, produce is sold to the retailers like Reliance. Since the representatives from Reliance were interviewed for this, therefore the details are mentioned in context of Reliance. However, the supply chain process followed by Reliance is very similar to that followed by other organized retailers and hence may be considered representative of other modern retailers.

The agents often provide cheaper prices to such retailers as they often buy in huge quantities. The produce is usually sold in units of bags. The retailer then sorts and grades the vegetables into different bins and transports these bins in temperature controlled trucks to the consolidation centers. The cost of wastage, i.e. the poor quality produce, is often borne by the retailer. However, if the wastage is more than 5%, then the agent accordingly adjusts for the price to compensate the retailer. In case the wastage is less than 5%, either the vegetable is sold on the spot or thrown away.

At consolidation centers, the vegetables are re-graded and sent to the stores in bins as per the demand. The consolidations centers are not temperature controlled and are not used for storage. However, the transportation vans are cooled to keep the vegetables fresh.

Initially, Reliance had contracted with farmers to buy the produce directly from them instead of from the mandis. However, this supply chain was very costly and hence they replaced contracting farming with current system to reduce their losses.

Figure 3.3.7: Material Flow in supply chain3

Information Flow:
Retail stores give their demand to central planning on D-1 day (Morning of day before the requirement). Purchase agents coordinate between themselves and look for best price-transit cost-delivery time combination in various mandis. They ensure the delivery from mandis to Central warehouse as per Central Planning order by D-1 evening. Central Planning delivers the items to retail store on morning or D-day.

**Figure 3.3.8: Information flow in supply chain**

Cash Flow:

Cash is credited to Mandi Agent on the evening of transaction through by Retailer. Agent deducts 7% from the amount paid by retailers, keeping 2% as his fee and 5% as government’s tax. However, farmer is paid as soon as the transaction is done.

**Figure 3.3.9: Cash Flow in supply chain 3**

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**3.4 FINDINGS**
Considering the fact that Supply chain 1 (as explained above) accounts for maximum sale in the vegetable supply chain, we have made our analysis based on this supply chain. Supply chain 2 and supply chain 3 are less significant.

The supply chain 1 was divided into flow of material, information and cash. For the above mentioned categories, data was collected on these flows. The key findings in wastage and in the overall supply chain are

**Wastage**

Wastage in vegetable supply chain happens at various levels. Significant losses occur at harvesting, handling & transportation, grading & packaging and marketing. The relative share of loss often depends on a specific vegetable. Overall, majority of wastage happens usually in handling & transportation and harvesting. Based on the primary and secondary research, the estimation of wastage exceeded 10% in all the cases.

**Sources of wastage:**

Wastage is this system could be defined in different ways.

1. **Vegetable that is rotten and could not be sold:** This happens mostly in monsoon season as the vegetables take more than two days to reach Punjab from Himachal Pradesh, a major producer of green vegetables in the Northern part of the country. So, by the time they reach the wholesale mandi, they are rotten and could not be sold at all.

2. **Vegetable that is inferior in quality due to size or color and hence could not be sold at the expected price:** The transactions often take place while the vegetables are in the bags. Therefore, retailers often buy vegetable mix of different qualities. Since they would not be able to charge high for lower quality produce, the earning is often less than expected and thus attributed as wastage.

3. **Vegetable that has degraded in quality due to limited shelf life:** Retailers and agents at times are not able to sell vegetables while they are fresh. This results in degradation of vegetables and hence to reduce the loss, they need to sell the vegetables at much lower price. This is another reason of wastage.

**Analysis and shortcomings in the overall supply chain system of vegetables**

After analyzing the vegetable supply chain, the following shortcomings were noted:-

1. A farmer enquires about demand and price from several agents at several mandis a day before (late evening) which is based on agents’ estimation and not the actual auction price.

2. There is a time lag between the time when a farmer calls an agent to enquire the price of his vegetable and the time at which he reaches a particular mandi. During this time
lag, the price fluctuates from the estimated price. This is called Information Inefficiency in the system.

3. Perishability of the vegetable enhances with travel (time lag 1-2 days) and farmer is forced to sell the stock the same day in order to avoid further loss on account of perishability of the vegetable.

4. There is a cost of travel to reach a particular mandi and if the farmer finds that the agent is not offering the right price for his vegetable, he is forced to stay in the same mandi in order to avoid further loss of travel costs.

5. Transaction is not instantaneous; farmers wait till the evening to sell the stock. Agents are just the middle man who earn commissions on transactions. So, till the stock is lying unsold in the mandi, farmer is responsible for his stock. There is no certainty with regards to the quantity and which of the produce to be sold (which may fall with demand and perishability) and time of deal (between farmer and retailer).

6. A farmer reaches a particular mandi based on inefficient information given by agents, it results in mismatch of supply and demand of the vegetable.

7. Base price is decided in a mandi based on actual supply and demand in the morning, it (base price) varies in different mandis. During the day, actual price of a particular vegetable fluctuates around the base price based on quality and demand/supply throughout the day.

8. By the end of the day in mandi, price falls due to reduction in shelf life of vegetable and farmers’ hurry to go back (accounted as wastage).

9. The Farmer gets the money in the transaction the same day or a day later based on the understanding with agents.

10. There is no physical wastage at mandi’s level; it is passed on to retailers who buy the excess stock at lower price but eventually not able to sell it.

4 RECOMMENDATIONS AND IT INTERVENTIONS

4.1 MILK SUPPLY CHAIN

Efficient price and quantity management can only be facilitated by exploiting IT opportunities to streamline the information flow to manage demand and supply effectively. Therefore, two important recommendations for price and quantity management emerge from the problems faced by Punjab’s cooperatives:

1. Real Time Information System: There exists responsiveness in procurement price and quantity supplied by the farmer which is not exploited due to lack of information symmetry. If substantiated by rich demand-supply database, then price manipulation
can be done to restore the imbalances in market demand and supply. Also, quantity procured must be brought to use in the most optimum manner i.e. quantity management backed by data driven intelligence i.e. processing and supplying milk according to its market demand so as to ensure minimal wastages as has been witnessed in Punjab at present as mentioned in the previous section. Therefore, analyzing supply and demand in real time through an IT enabled system and then based upon the information changing the demand, supply and prices for an optimum procurement.

2. **Analytics Based System**: There is a need for analytics based system (data driven intelligence) providing information pertaining to market demand which can help decide on the portfolio of products that can be made from the extra milk. At present, excess milk can be processed into a variety of products (ghee, powdered milk, cheese, curd, etc.) based upon the market demand to ensure minimal wastages. That kind of a portfolio could be tuned for profit maximization. *In order words, efficient quantity management can be ensured by an analytics based system.*

### SUCCESSFUL INFORMATION TECHNOLOGY INTERVENTIONS IN DAIRY INDUSTRY: EVIDENCES FROM INDIA AND ABROAD

In recent times, production systems are becoming demand driven with greater emphasis on technology adoption. To balance the twin objective of providing the maximum price for the raw milk to the farmer and making the best product available at the lowest price to the consumer, a tight integration i.e. a close coordination in the supply chain activities is required. Two-way information flow must be encouraged which essentially means engaging both the producers and processors. The information technology can help the cooperative system to gain control on procurement, processing and distribution activities.

The adoption of information technology can help in bringing about tremendous change to facilitate the uninterrupted flow of information. It has emerged as a key factor in improving the dairy industry globally. In India, Amul (Gujarat) poses to be a perfect example that proves the positive impact IT can have on rural India. The following initiatives that have already been taken up by Amul, need to be replicated or improvised for Punjab’s milk unions as well:

a. **Information Technology Interface for Organizational Efficiency**: In 2012, Amul has successfully completed SAP-ERP (Enterprise Resource Planning) application implementation across the enterprise enabling it to achieve better supply chain performance. The system helps in improving planning and monitoring across the enterprise. The federation has also developed animal productivity system in order to
help animal productivity improvement and its effective tracking. It has also enhanced its MPLS-based Virtual Private Network Connectively at all its sales offices, member unions, milk plants, milk chilling centers and warehouses on a common communication backbone to strengthen and automate the supply chain operations.

b. **Payment System:** AMCUS (Automatic Milk Collection Unit Systems) can be installed at the village level in the district collection societies, to record the quality and quantity of milk being collected. AMCUS involves automating the process of estimating the fat content in the milk and its volume, and thereby calculating the amount payable to each member, which helps in avoiding the errors in calculations from the manual setup. In the previous setup payment to the farmer is made every 10 days due to the time required by the DCS to calculate the amount due. Partially this system is adopted in Punjab’s cooperatives as well but the payment is made according to the traditional setup i.e. after every 10 days. The IT system enables prompt and immediate payments. Thus, an improvement in the cash availability to the producers reduces the need for taking loans.

c. **Information Sharing System:** Information sharing systems can be enabled through a system like Dairy Information and Services Kiosk (DISK) designed by IIM-A primarily to educate the rural milk producers. It includes the entire data history on milk production by the individual farmer. DISK has interconnectivity to a dairy portal at the district levels. It enhances the scope of services that would benefit the farmers as well as the dairy industry. On the education front, producers can get information on the best practices in breeding and rearing milch cattle, producing high quality milk, etc. Since a large amount of detailed history on milk production is available in the database, the system can be used to forecast milk collection/production and monitor the produce from individual sellers.

d. **Planning and Traceability System:** Amul is using GIS (Geographic Information System) for optimization of collection process which tracks the movements at milk collection centers. It uses GIS to capture business data at the collection level and captures member’s census data and the census data of the animals. With the help of this information, cooperatives can identify areas which have low productivity and suggest measures to change them. GIS can also be used to control the outbreak of diseases amongst cattle. When detailed milk records are kept for each farmer, patterns in production can be discerned. Seasonal variations in quantity and fat content can be predicted, which is useful for dairy, veterinary services and cattle feed.
The implementation of information technology can help the overall cooperative setup in building its competitive advantage. The growing relevance and importance of Information Technology in the dairy sector (and in the agriculture space generally) is realized by the initiatives taken by IT giants like SAP; with special reference to the Quantity management and Planning domain like decisions pertaining to product mix planning and excess milk management; SAP has come up with modules such as SAP-ERP (Enterprise Resource Planning), SAP-SCM (Supply Chain Management), SAP-APO (Advanced Planning Optimization)-Demand Management and SAP-APO-Supply Network Planning. Application of these modules in case of quantity differentials (excess or shortage) through inward and outward bound delivery system can ensure efficiency in the supply chain.

With the help of IT initiatives in the dairy development we can achieve what is popularly known as ‘just in time supply chain management’. A detailed analysis of IT intervention and it benefits adopted nationally as well as internationally has been provided in the table 4.1.1 below.

**Table 4.1.1: Opportunities created by Information Technology (IT) and its Impact(s)**

<table>
<thead>
<tr>
<th>Place of Adoption</th>
<th>Problem Area</th>
<th>IT Intervention</th>
<th>Impact(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nestle (USA)</td>
<td>Demand Planning</td>
<td>SAP-APO (Advanced Planning and Optimization) Module for demand planning (forecasting).</td>
<td>Ensured best possible estimate of true customer i.e. developed demand forecasts as an input to service planning, production planning, inventory and revenue planning.</td>
</tr>
<tr>
<td>Gujarat (Amul)</td>
<td>Connectivity within the Organization</td>
<td>SAP-ERP (Enterprise Resource Planning) Module and Virtual Planning Network (VPN).</td>
<td>Improved connectivity across the federation; thereby improving communication systems and infusing efficiency across the supply chain operations.</td>
</tr>
<tr>
<td>Gujarat (Amul)</td>
<td>Lack of flexibility in price adjustments</td>
<td>Enterprise-wise integrated</td>
<td>-Analytics backed by data: - It helps in forecasting milk production according to the region and suggests remedies, if any. For a</td>
</tr>
<tr>
<td>Region</td>
<td>System/Information Management</td>
<td>Benefits</td>
<td></td>
</tr>
<tr>
<td>--------</td>
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</tr>
<tr>
<td>Gujarat (Amul)</td>
<td>Application System (EIAS) and Geographic Information Systems (GIS)</td>
<td>Region that has surplus supply of raw milk can transfer the excess to the region that has lower milk production. Real Time Information Management &amp; electronic record keeping also provides better access to finance.</td>
<td></td>
</tr>
<tr>
<td>Australian Dairy Sector</td>
<td>Automation of processes through ERP systems</td>
<td>Planning and Lesser Wastages: - By streamlining the D-S on a continuous basis. -Reduction in costs. -Efficiency increased. -Improved communication across all mediums, particularly mobile phones and email has resulted in timely information flow.</td>
<td></td>
</tr>
<tr>
<td>Karnataka Cooperative Milk Producers Federation Limited</td>
<td>Integrated Dairy Information System (IDIS) i.e. an exclusive Enterprise Resource Module (ERP) for the Dairy Sector</td>
<td>-By integrating information flows in procuring, sales/distribution, material management and production control; it assured -Better visibility and control on the process and factors that impacted the profitability. -Increased transparency in the organization leading to timely and better decision making.</td>
<td></td>
</tr>
</tbody>
</table>
| Kenyan Dairy Farming & China Dairy Industry | Scanty and inaccurate information availability resulting in irrational decision making and inaccuracy (under measurement) in measuring the quantity of milk due to manual systems resulting in lesser return to the farmers. | E-Dairy i.e. Dairy Information Management System (including digital milk analyzers, e-dairy network modules and smart cards) | -Improved farmer’s earnings and reducing the number of days in receiving payments.  
- Digital milk analyzers help in tracking milk in real time.  
- Automation of procedures assuring efficiency, enhanced productivity and accuracy.  
- Also access to information aided rational decision making among the stakeholders.  
- Accounts containing quality and quantity of milk they have supplied ensure traceability for quality assessment. |
| United Kingdom and Ireland Dairy Sectors | Significantly huge transportation costs in milk collection resulting in lesser payments to the farmers.  
Time window constraints and problems in farmer’s access to large trucks  
Lack of transparency | Decision Support System (DSS) emerged in early 1990’s to provide logistic management in milk collection centre. | - Comprehensive database ranging from biological to financial data enabled rational decision making supporting profitability.  
- Infused efficiency and transparency in the system. |

If the milk federation has data pertaining to its members, their production and supply, it can help in minimizing the wastages. Availability of such information will bring effectiveness and tracking of losses at the stage where they are generated will help put better control mechanisms at each level. Therefore, there is a need to build a real time information flow system in the cooperative setup backed by analytics which would help in exercising price elasticity by synchronizing demand and supply through effective decision making besides coping with the seasonal fluctuations in milk production.
# 4.2 GRAINS SUPPLY CHAIN

## Table 4.2.1: Problem areas, Recommendations and IT interventions

<table>
<thead>
<tr>
<th>Problem areas</th>
<th>Recommendations</th>
<th>IT Intervention</th>
</tr>
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<tbody>
<tr>
<td><strong>Lack of storage capacity</strong></td>
<td>At present, small and medium size rice millers are milling paddy for government agencies only. They are not buying from commission agents because there is high taxation on selling further to distributors. To reduce the burden of procurement on FCI, government can reduce the sales tax for rice millers and motivate them to procure paddy privately from commission agents</td>
<td>Commission agents are exploiting farmers by charging high interest rate leading to a never ending debt for farmers. There is a need of win-win-win system that can provide credit to farmers at low interest rate based on the produce of quality; Low content moisture wheat and rice to FCI; Authentic system of credit information for banks. Figure 4.2.1 proposes a model to overcome these challenges.</td>
</tr>
<tr>
<td><strong>Late payment to farmers</strong></td>
<td>Elimination of commission agents is not feasible because farmers are financially dependent on them. Awareness about government credit schemes for farmers is necessary to implement direct payment system that is from FCI directly to the farmers.</td>
<td>1) There is a need for an information system to provide guidelines and information to farmers about the varieties of seeds and life cycles of such varieties so that farmers stop from harvesting immature crops. This system would save drying costs of paddy and wheat rot in mandis and counter delays in procurement 2) Farmers should be aware of the storage capacity problem through that system.</td>
</tr>
<tr>
<td><strong>Delay in Procurement</strong></td>
<td>There is a communication gap between farmers and government pertaining to seeds varieties and their life cycle.</td>
<td></td>
</tr>
</tbody>
</table>
### Subsidies on Fertilizers

Monitoring of fertilizer supply chain is necessary as it would counter misuse of fertilizer subsidies. **mFMS** has been recently launched to monitor physical movement of fertilizers. Some of the experts argued that it would not help to counter the problem of fertilizer’s black marketing. Explosives industry is the most scrutinized industry in terms of monitoring the physical movement of explosives. *(Shown in appendix 3).* Therefore, these two systems should be compared and analyzed to make mFMS more effective.

### Soil Testing

Some of the agriculture experts suggest that farmers are using excessive fertilizers irrespective of soil type. Use of excessive fertilizers depletes soil fertility and increases production cost – therefore soil testing should be compulsory for farmers.

There is a new handheld laser system, such as greenseeker, that has been developed and that would help farmers to know the accurate amount of fertilizers required for their fields. Government should provide subsidy on such technologies to offset one lakh crore worth of fertilizers subsidy. This would help in improving the yields and in turn help in planning of effective supply chain of the grains. Also the use of existing soil testing facilities should be encouraged.

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### Agro Supply Chain Credit in Detail

With the introduction of new farm technology consisting of biological and mechanical innovations, agriculture in Punjab has become capital intensive. Small and marginal farmers cannot afford capital intensive farming and therefore take loans from institutional banks and non-institutional resources such as commission agents (arhtiyas). In the last decade, Punjab has witnessed five times increase in the debt burden of the farmers. The debt burden on Punjab peasantry was Rs 784 crores in 1991-92 which increased to Rs 9886 crores in 2002-03 and further to Rs 35000 crores in 2008-09, out of which one third came from commission agents.\(^\text{18}\) Loans obtained from banks and other institutions are not sufficient for farmers, therefore they borrow from commission agents at very high interest rates.

This study proposes a tripartite value proposition for procurement agencies such as FCI, banking institutions and farmers as shown in the figure 4.2.1. Aim of Agro supply chain credit model is to propose a win-win-win situation for all the parties involved in the model.

\(^\text{18}\)*Indian Journal of Agricultural Economics; Oct-Dec 2011; 66, 4; pg. 662 The status of commission agent system in Punjab Agriculture*
Price stabilization policy for wheat and rice promoted the production of wheat and rice among farmers but it also decreased crop diversification in Punjab resulting in excessive supply and wastage of wheat and rice. Some commission agents and food inspector informed us that farmers are negligent about the quality of their produce due to price stabilization policy for wheat and rice. Agro supply chain credit would motivate farmers to bring right quality of wheat and rice and maintain their credit ratings to take loans at low interest rates.

Agro supply chain credit would enable FCI to make direct payments to farmers and procure the good quality of wheat and rice from farmers and provide confirmation of receivables in return. FCI also need to send quality, quantity and confirmation of receivables to bank through agro supply chain credit IT process to enable banks to make payment further to farmers. This system would help banks to collect information of creditworthiness of farmers which would result into low interest rate loans for farmers.

**Figure 4.2.1: Agro supply chain credit Process**

FCI and commission agents complain every year that some farmers bring wet and immature paddy and wheat to mandis. This necessitates a process wherein farmers are motivated to comply with the instructions for a good quality produce. According to a commission agent, “some farmers bring wet and immature paddy to the mandi, which is one of the reasons for
delay and procurement. Farmers pay Rs6/quintal a day to labour for drying paddy and wheat which add to their input cost of production”.

Agro supply chain credit process would motivate farmers to raise the quality of their produce which would help them in raising loans based upon quality and credit ratings.

2) **Benefits to Banks**: Most of the banks refuse loan sanctions to the smallholder farmers because of non-availability of credit information of farmers. This model enables banks to reach farmers and provide them loans at very low interest rates. Credit information of farmers and involvement of FCI, will enable banks to assess credit risk and expand their customer base.

3) **Benefits to Farmers**: It was found that 78.5% of farm households in Punjab were under debt. Small farmers’ indebtedness is rising in Punjab which is supported by rising number of suicides among farmers. 66% of the farmer’s suicides were committed due to burden of debt. Farmers borrow money from commission agents at exorbitant rate of interest. Most of the commission agents lend money at 2.5-3% per month rate of interest (30% per annum). Agro supply chain credit would allow farmers to maintain their credit ratings and have access to low interest rate loan schemes from banks.

4.3 **VEGETABLE SUPPLY CHAIN**

After identifying the shortcomings in the current system, we propose a new system of buying and selling vegetables in the market which is called **Virtual Market place**.

**Virtual Market Place**

In this system, all the registered buyers (big and small retailers and agents) would place their demand and price for the next day. The location of the registered buyers is also invisible on the system. Based on the demand and price, the registered farmers enter their supply for the next day and accept the demand of particular buyer based on the suitability of location, price and volume of vegetable available with him. The system is available on web and can be accessed from anywhere. The price bid by registered buyer is based on base price (based on demand and supply and previous base prices) To start with; we suggest a district information centre (DIC) where farmers can enter their supply. The DIC could cater to 2-3 village farmers. A similar setting (Mandi Information Centre) could be done at buyers’ level as well. Any incentive/penalty system could be adopted to maintain the compliance in the system. A rating system (both for buyers as well as suppliers) could be adopted to bring authenticity of buyers and suppliers.
Figure 4.3.1: Virtual market Place

Figure 4.3.2: Timeline: difference in current and proposed system
Salient features of Virtual market Model

1. Sellers would be registered farmers who would place the volume to sell for D day at D-1 day(morning) around 06:00 AM

2. Registered buyers would enter their available demand for D day at D-1 day(morning) around 06:00 AM

3. At 10:00 AM, the system would have demand and supply for the D day.

4. Between 10:00-12:00 Noon, the system would determine the base price (BP) based on system fed supply and demand and previous base prices.

5. At 12:00 Noon, registered buyers would place their actual bid price (BP+/−) and location of delivery

6. Registered suppliers would choose their buyers based on the suitable location, suitable deal by a buyer and rating of the buyer

7. Registered buyers would confirm the deal based on volume offered by sellers and rating of the sellers

8. Rating of a seller could be based on quality of vegetable delivered in previous deals and compliance of the deal. Rating of buyer could be based on compliance to the deal. There
will be some fluctuation in the offered prices by buyers throughout the day based on demand and supply.

**Advantages of Virtual market platform**

1. **Benefits to Farmers:**
   - **Material Flow:** There is certainty of the quantity to be sold, price (which may fall with demand and perishability) and time of deal (between farmer and retailer). The new system would reduce involvement/power of Agents in the system.
   - **Cash Flow:** Prices would not fluctuate between the time when a farmer cracks a deal with a buyer and the time to reach a particular mandi. Transaction is instantaneous; farmers would not wait till the evening to sell the stock. Base price is decided on the system based on actual supply and demand fed in the system in the morning, so, it (base price) does not vary in different mandis. Price would not fall due to reduction in shelf life of vegetable and farmers’ hurry to go back (accounted as wastage) because the delivery would be done early morning based on the deal.
   - **Information Flow:** A farmer gets the firm demand and price a day before (Morning) through the system. So, informational inefficiency would be removed. In the current system, both information and actual delivery happen at mandi, in the proposed system information would be shared at the system and actual delivery would happen at mandi. The system would de-couple and advance information flow from material flow. The system would benefit farmer in making an informed decision prior to deciding which mandi to sell.

2. **Benefits to Agents:**
   - **Material Flow:** Mismatch of supply and demand of the vegetable is minimized through this system because the buyer would order his maximum demand through this system and rest of his demand (10-20%) would be catered on spot in the mandi. A rating system (based on past performance) would help agents choose the right seller for better quality of produce.
   - **Cash Flow:** Base price is decided on the system based on actual supply and demand fed in the system in the morning, so, it (base price) does not vary in different mandis. Price would not fall due to reduction in shelf life of vegetable and farmers’ hurry to go back (accounted as wastage) because the delivery would be done early morning based on the deal.
• **Information Flow:** Since both supply and demand are available a day before, they can make more informed decision.

3. **Benefits to organized/unorganized Retailers:**
   - **Material Flow:** They can also get their demand served through system so the supply chain is narrowed down.
   - **Cash Flow:** Cash would be paid on delivery or on credit depending on the mutual understanding between the buyer and the seller. Price fluctuation throughout the day due to reduction in quality of produce would be reduced.
   - **Information Flow:** They would get the similar deal in all mandis available nearby so no hassle of roaming around in various mandis searching for a good deal.

**Role of IT**

As discussed above, everything (buying and selling) now would be fixed on web and then the actual deal would happen based on the fixed deal. So, the role of web platform catering the information exchange is very big. The software would have two faces.

**Buyer Face**

1. It would show the available supply, registered farmers and their ratings in the market.
2. The buyer could place the demand through this system
3. The buyer could place his suitable bid based on base price calculated by the system
4. He can crack the deal before the actual supply
5. The buyer could see the status of the deal.

**Supplier face**

1. The supplier could see the actual demand, available buyers and their ratings in the market
2. The supplier could place the available supply in the system
3. The buyer could crack a deal through the system based on delivery location, price offered by the buyer and demand

Back-end part of the platform would have the program which could calculate the base price based on demand, supply and previous day’s base price. Also, the platform would be equipped in dealing with inputs of demand and supply and producing the results.
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