Sugarcane Transportation and Harvesting Cost

Yogesh Bhatt
Parmeet Kumar Vinit
Varnika Jain

Agricultural Economics Research Centre
University of Delhi
Delhi – 110007

February 2021

Research Study No. 2020/01

Research Team

Dr. Yogesh Bhatt, Assistant Professor, AERC Delhi

Mr. Parmeet Kumar Vinit, Research Investigator, AERC Delhi

Ms. Varnika Jain, Research Investigator, AERC Delhi

Mr. Utkarsh Yadav, Research Investigator, AERC Delhi

Mrs. Renu Sain, Research Investigator, AERC Delhi

Administrative, library and general support

Mr. Md. Asghar Ali

Mrs. Nandi Negi

Mr. Himanshu

Mr. Gyan Chand

Mr. Pramod Kumar

Acknowledgement*: The team is grateful to Prof. P. K. Joshi, Honrary Director, Agricultural Economics Research Centre (AERC), Delhi and Prof. C.S.C. Sekhar, Head, AER Unit, Institute of Economic Growth, Delhi for their guidance and valuable suggestions in preparing this report.*

Preface

The present study has been undertaken for the Ministry of Agriculture& Famers Welfare. The study attempts to estimate the transportation and harvesting cost of sugarcane in eight states of India. The study majorly utilized the primary survey data for analysis, collected by the participating Agricultural Economic Research Centres, to understand various costs factors associated, problems and constraints at the ground level related to transportation and harvesting operations of sugarcane. This analysis is supplemented by the secondary data, wherever required.

Our first and foremost thanks are to the Ministry of Agriculture & Farmers Welfare for supporting this study. Our sincere thanks also go to the Commission for Agricultural Costs and Prices (CACP) for their interest and valuable comments. We would like to thank all the participating Agricultural Economic Research Centres for conducting field survey and sharing primary data with us. We would also like to thank the district officials for their support during the field visits. Last but not the least, we would like to place on record our appreciation of our colleagues in the Agricultural Economics Research Centre, University of Delhi for their support.

Yogesh Bhatt

February, 2021

Table of Contents

List of tables

List of figures

Executive Summary

Sugarcane Transportation and Harvesting Cost

1. Introduction

India is the second largest producer of sugarcane after Brazil. Indian sugar industry impacts rural livelihoods of about 50 million sugarcane farmers, and around 5 lakh workers directly employed in sugar mills. The cane price announced by the Central Government is decided on the basis of the recommendations of the Commission for Agricultural Costs and Prices (CACP) after consulting the State Governments and associations of sugar industry. The commission publish a price policy report on sugarcane crop every marketing year.

Sugarcane is one of the important cash crops grown in India and its products serves as an important raw material and ingredients to various sectors of the economy, especially food processing, fast-moving consumer goods (FMCG) and ethanol companies. It provides a lump sum financial support to farmer's annual income if the overall operation from harvesting of the crop, transportation to the final outcome of product is managed well. Transportation of sugarcane is an important post-harvest activity for taking fresh harvested sugarcane to the mill gate.

In India, the manual mode of transportation is replaced with the mechanised modes in recent times. It helped farmers in terms of large quantity transfer to mills and highly reduced the time of transportation. But it increased the input cost to the farmers. Most of the marginal and small farmers in India still can't buy the own mechanised mode and hence they have to depend on the hired modes. This usually affects the process and hence loss to the farmers if the harvested produce is not being transferred to the mill timely due to unavailability of transport, higher hiring charges, losses due to long waiting times during peak season, etc. It is therefore evident that transportation of sugarcane to sugar mill plays an important role in connecting farmers with the sugar mill, and developing efficient and effective value chain.

Several important committees have reviewed the status of the sugar sector in the country and suggested the improvements needed. The important committees are – Jha committee in 1965, Sen committee in 1979, Hanumantha Rao committee in 1990, Y. K. Alagh committee 2005 and C. Rangarajan committee in 2012. These committees have suggested various policy measures at various times to improve the status of the sugar sector. The detailed data on various costs is collected by CACP under the scheme – 'Comprehensive Scheme for Studying the Cost of Cultivation of Principal Crops in India'. However, the data on transportation and harvesting costs is not collected under this scheme.

The transportation and harvesting costs are important components of the overall cost structure of any crop, including sugarcane. There is no reliable data on these costs for sugarcane

crop in the country. Inputs provided by the state governments, which are not based on a scientific survey, are the only source for the CACP. Thus, a reliable database and scientific methodology need to be developed to estimate the harvesting and transportation costs. The present study is an attempt in this direction.

Objectives

The present study intends to estimate the harvesting and transportation costs of sugarcane marketed by the farmers. The specific objectives of the study are as follows:

(i) To estimate the harvesting cost of sugarcane using different methods of harvesting.

(ii) To estimate the transportation cost of sugarcane from the farmers' field to the sugar mill and other selling points using different modes of transportation.

(iii) To identify various factors and input costs in the overall harvesting and transportation costs.

Methodology and database

Sampling approach

A multi-stage sampling technique was adopted to select the farmers. At the first stage, the states were selected based on the production of sugarcane. Eight sugarcane producing states were selected for the study. These were *Andhra Pradesh, Bihar, Haryana, Punjab, Tamil Nadu, Telangana, Uttar Pradesh and Uttarakhand*. Their share in total sugarcane production and area is approximately 68%.

At the second stage, districts were selected. Two districts were selected from each of the state following the CACP sampling frame. Special emphasis is given to the largest state – Uttar Pradesh, covering four districts (two districts from each, the western Uttar Pradesh and the eastern Uttar Pradesh regions). The following criteria has been adopted for selecting the districts: i) the districts should have large proportion of area under sugarcane to the total area under sugarcane in the state, ii) within the sugarcane growing districts, distinct geographic regions of the state are covered to the extent possible.

At the third stage of sampling, a cluster of sugarcane growing villages were randomly chosen such that a total of 100 farmers are surveyed from each district. A cluster of villages is preferred from each district, because the required sample size was not available from the villages which are smaller in size.Within the village clusters sample size is not uniform and the geographical representation is varying based on their location, hence a fixed sample of 100 farmers from each district is considered.Stratified random sampling was used to select the sample farmers from the list of farmers growing sugarcane in a particular village/village cluster to give representation to each size-group, i.e. marginal, small medium and large farmers.

Study coverage and data sources

Based on the study methodology, the aggregate sample size for each of the selected state is 200 farmers except Uttar Pradesh in which a total of 400 farmers are surveyed. Overall, the total sample size of the eight selected states is 1800 farmers. The selected eight states cover 18 districts and 115 villages. A total of 1800 sample includes nearly one-fourth of each farm class farmers namely – marginal (30%), small (25%), medium (24%) and large 21%). The detailed household questionnaire is used to survey the sugarcane farmers. The cost paid by the mills is also collected from the mills in the study region using the separate questionnaire.

The study utilized primary survey from the selected states. The survey work in selected eight states is covered by the respective Agricultural Economic Research Unit / Centre. The sampling frame is drawn from the 'list of selected states and crops' of the *State-Wise Crop Complex Selection* published by the CACP. The use of CACP sampling frame in the present study, to the extent possible if the village listed in the list is a sugarcane growing village, allows us to generate estimates of harvesting and transportation costs comparable with other costs published by the CACP. Also, the scientifically designed CACP cost estimation methodology can be directly adopted for the study. The survey pertains to the sugar season 2018-19, and it was conducted during December 2019except the eastern Uttar Pradesh region in which a re-survey is conducted during November-December 2020.The secondary data was used to understand the performance of sugarcane and sugar in different states of India. The database of Ministry of Agriculture, CACP, Cost of Cultivation and United States' Department of Agriculture is utilised for secondary data analysis.

2. Demographic details of the farmers

Land holding distribution

Among the sample states, nearly 30% farmers are marginal farmers. The largest proportion of marginal farmers is in Uttar Pradesh. Nearly 54% of surveyed farmers out of a sample of 400 farmers are marginal. In western Uttar Pradesh such farmers are nearly 60%. This is followed by Bihar and Uttarakhand covering 45% and 39% marginal farmers. Contrary to this, in the states like Haryana and Punjab, the representation of marginal farmers is just 4% to 8%. Most of the households are large farmer in these states as compared to other states; (nearly 46%-48% of farmers).

Household population, education and caste composition

The overall average family size is 5.22 persons per household. All the farm classes have an average family size of 5or more persons per household. At state level, eastern Uttar Pradesh has the overall average family size of nearly 7.7 persons per household (biggest among the sampled states). All the farm categories have family size of above 7 in this region. This makes farmers in

Uttar Pradesh having the largest family size of 6.19. Andhra Pradesh reported the minimum average family size of 4.4 persons per households.

Overall, for all the selected states, nearly 52.9% are male and 47.1% females, shows the basic sex ratio of 889 females per 1000 male population. At the state level, Tamil Nadu performs best for this social indicator, followed by Punjab, Uttarakhand and Andhra Pradesh. The marginal farm class in Haryana reported only 34% female population, lowest ratio among all the study states. Nearly half of the households (49.9%) belong to 'general' category. About 43% are 'OBC' and rest 7% are either 'SC' or 'ST' category farmers. Above 62% large households and 59% of medium households belong to general category. The education profile of selected states suggests about 83.4% of household heads are either "intermediate' pass or less. The proportion of 'graduate or above' education level is reported highest for large farmers (nearly 20.5%) and lowest for marginal and small farmers (14.1%). Only 4.9% of large farmers are illiterate, but 15.6% of small and 19.5% of marginal farmers never went to school.

Distance of household's farm from village centre

The numbers of farmers transporting sugarcane were enquired about the distance they cover to the village centre from the sugarcane fields. The distance is categorized broadly into three categories i) within the range of 2 km, ii) between 2 km to 4 km; and iii) above 4 km. Almost 71.6% of the household's farmsare within the range of 2 km. 19.8% farms are between 2 km to 4 km of distance. Only 8.6% farms have reported this distance of above 4 km. Exceptionally, in eastern Uttar Pradesh, nearly 51% farmers have their sugarcane fields at a distance of above 4 km from the village centre.

It is observed that the average distance of all the farms covered in this study is nearly 1.78 km from the village centre Overall, the range based average distance of the farms is closely 0.84 km. (for range 0-2 km.), 2.36 km (for 2-4 km.) and 8.25 km (for above 4 km.) far from the village centre.

3. Area, production and marketing of sugarcane

Land, irrigation and production

Of the total crop area cultivated by the sample farmers, about 59% of area is under sugarcane crop. Nearly 93% of the total land is irrigated. Overall, 96% of area under sugarcane crop is reported irrigated. Except the states – Bihar (79%), Andhra Pradesh (88%) and Telangana (98%), all the other states reported 100% irrigation under sugarcane.

The sampled households produced about 2296 thousand quintals of sugarcane from 7.18 thousand acres of area with a yield rate of 320 quintal/acre. The states like Punjab with sugarcane area share of about 23.8% among study states, reported almost same share in production (23.7%). Tamil Nadu with 12% area share recorded 19% share in total production. This is due to high productivity of sugarcane in Tamil Nadu (just below 500 quintal/acre), highest among the study

states. Compared to this, Bihar reported the sugarcane yield just 228 quintal/acre, less than half of the Tamil Nadu state, the lowest yield across all states.

Quantity of sugarcane sold

Almost the entire sugarcane production (97.9% of total production, Farmers keep a small part of the produce for seed and other purposes in some states, majorly in Uttar Pradesh, Uttarakhand and Haryana. Of the total sugarcane marketed, nearly 85.8% is sold at the sugar mill gate, 10.4% at the sugar mill purchase centres, 3.7% to the local gur manufacturer and just 0.1% to the khandsari units. However, in some states such as Andhra Pradesh, Punjab, Tamil Nadu and Telangana the entire sale is done at the sugar mill gates. In other states too, majority of the sale occurred at the sugar mill gates – ranging from 57% in Uttar Pradesh to 95% in Bihar. However, in Uttarakhand only 8% is sold at the sugar mill gates and 90% is sold to the purchase centres. In western Uttar Pradesh, a significant quantity (27%) is sold to the gur manufacturers. Nearly 16% of total sold produce in Haryana is carried to gur manufacturers. Farmers do not prefer to sell to the khandsari units in any of the states, except few farmers in Uttar Pradesh and Bihar.

The farmers in some states sell sugarcane to gur manufacturers and khandsari units, as they are in need of urgent money which they get in hand instantly although at reduced profit, whereas the payment from the mill usually gets delayed by up-to one year. If the mills are far, this increases the transportation costs. Also, the farmers don't want to delay the harvest of in-field sugarcane. The farmers have not paid any direct market fee for selling the sugarcane to the mill gates or at the purchase centre in the study states. The costs, which the farmer mainly bears, are transportation cost, harvesting cost and the loading cost. In all the study states (except Tamil Nadu), harvesting is performed completely by farmers (either by themselves or hired labour, contract or daily wage). In the surveyed districts of Tamil Nadu, all the sugarcane harvesting, transportation and loading-unloading related operations are performed by mills.

4. Harvesting and loading-unloading of sugarcane

Harvesting of sugarcane

In almost all the study states, harvesting is performed manually. Both of the ways of harvesting, i.e. contract system and daily wage system, are in practice in the study states. However, in three out of the eight study states, harvesting is completely on contract basis. These are Haryana, Tamil Nadu and Telangana. In states like Andhra Pradesh and Uttarakhand too, in one out of two study districts, the harvesting is completely on contract. In Uttarakhand, most of the households carry out harvesting on contract basis and very few households reported on harvesting on a daily wage basis. Uttar Pradesh, Bihar and Punjab are states in which harvesting is mainly on a daily wage basis. Overall, nearly 53% households are practicing harvesting on 'daily-wage' basis and about 47% prefer contract based harvesting

The estimated cost of 'contract' based harvesting is nearly Rs. 44.91 on combined basis. The contract rates vary from Rs. 38.4 per quintal (lowest in Uttarakhand) to Rs 63.7per quintal

(highest in Andhra Pradesh). In Haryana and Telangana, the contract rates are about Rs. 44 to Rs. 48 per quintal. This contract rate also includes the loading costs in it. Usually, the unloading is performed by mills in all the states; hence no cost is involved on that account, except very few cases in Uttar Pradesh. In Tamil Nadu, the average contract rate of Rs. 72 per quintal includes the harvesting cost, transportation cost and loading and unloading cost in it. Such costs are initial borne by the mills and finally the cost is deducted from the final payment made to the farmers.

A large proportion in the total labour employed (casual labours and family labours) for 'daily-wage' based harvesting is of casual labours, nearly 10.1 labours used per household. Of the total labours employed (11.4 labour per household) 3 are women. The highest number of labour employed in Bihar (15.6 labour per household) and Punjab (14.1 labour per household); and the least employed in Uttarakhand (4 labour per household). The average wage rates are nearly Rs. 388 per day for men labours and Rs. 189 per day for women labours, on all state level. The wages are nearly double for men labours as compared to women labours. In Punjab, only male labours are used for harvesting, receiving the highest wages (Rs. 452 per day) across all the study states. The lowest wages are paid in Bihar and west Uttar Pradesh (Rs. 268 per day) to male labours. The wages of women labours vary from Rs 158 to Rs 261, highest in Uttarakhand and lowest in east Uttar Pradesh. Of the total labours employed nearly three-fourth (74%) are male labours.

On an average, nearly 12 days of harvesting is practiced during a sugar season by the sugarcane farmers. Although, the average labour use during sugarcane season is reported highest in Bihar (nearly 15 to 16 labours) but the average days utilised are least in Bihar (about 2-3 days). Highest number of days in the field is reported in Uttarakhand (21.5 days) with about 4 labours during sugarcane season. Average 7.4 hours are spent on field per day in most of the states.

Given the differences in proportion of farm class across states the weighted average approach used may yield more accurate estimate. The cost of harvesting is worked out to nearly Rs. 37 per quintal when family labour is included in the costs. The cost of harvesting based on 'only casual labours', and 'only family labours', separately, are also calculated. The cost is about Rs. 35.7per quintal, when only casual labours are considered. The highest harvesting cost (nearly Rs. 48 per quintal) including the family labour, is paid by farmers in Punjab and Andhra Pradesh (Visakhapatnam district). The harvesting cost in Uttar Pradesh is Rs. 38.42. The farmers in eastern Uttar Pradesh paid higher charges as compared to the farmers in western Uttar Pradesh. The lowest cost of harvesting is estimated in Bihar (just Rs. 13.1 per quintal).

The reasons for such large differences in harvesting cost across state are mainly due to variation in wage rates, average number of labour employed and average days utilised across study states. The wage rates of men and women are observed least in Bihar and west Uttar Pradesh. The days utilised for harvesting are also lowest in Bihar. Whereas in Uttarakhand, the least man power is used for harvesting. In Andhra Pradesh and Punjab, the wage rates are high for the male labours employed and the labour and days employed are also high, reflecting on high cost of harvesting.

The farm class wise harvesting cost is also worked out across the study states. On overall basis, the highest cost for harvesting is paid by large farmers, nearly Rs. 40.5 per quintal. The

harvesting cost paid by small and medium farmers is close to Rs. 38 per quintal. Whereas, the marginal farmers paid nearly Rs. 36 as harvesting cost on per quintal basis. The marginal farmers in Andhra Pradesh and Punjab have paid nearly Rs. 50 or above per quintal for harvesting.

Loading and un-loading of sugarcane

Loading of sugarcane is performed manually in all the study states. The loading charges are included in the contract amount if harvesting is done on contractual basis. In most of the states, unloading system is mechanized and this is undertaken by sugar mills in all the states, except Uttar Pradesh, where in a few cases payment was made for unloading on a per quintal/ per trolley basis. The wage rates for loading are also similar to that of harvesting in most of the states. The rates are lower, in Punjab and Uttarakhand as loading is being done in these states by using the labour deployed for harvesting on a part time basis. The loading cost on per quintal basis is worked out in selected states at nearly Rs. 3.4 per quintal. In Uttar Pradesh, the cost is nearly Rs. 6.5 per quintal. Only male labourers are performing the loading operations. The hours of labour use per day are nearly half of that of harvesting and vary by state. On an average five to six labourers are employed for loading, nearly 3.4 hours per day were spent and nearly 9 to 10 days per season were spent in loading.

Harvesting related problems of farmers

There are various problems associated with the harvesting operations reported by the farmers. Shortage of labour is one such serious problem. It is very difficult to arrange labour, especially during peak season and labour demands high wages during shortage time and during summer seasons if harvesting gets delayed. Farmers do not prefer harvesting of sugarcane using machines because of sowing norms and also because the structure of fields in many parts of the country does not allow this. Another major problem reported by farmer is delay in payments, sometimes more than a year. This delay in payments impacts farmer's capacity to grow crop in next season. Being a perennial crop, the farmers don't have many options to switch the cropping pattern. This also delays the harvesting operations and hence delays the sowing of next season crop and dents farmer's profits.

5. Transportation of sugarcane

Quantity transported by mode

The manual carts, tractor trolleys and trucks are the main carriers used to transport sugarcane from farm to various destinations. The tractor trolley is the most common mode of transportation as nearly more than two-thirds of the sugarcane produce in the study states is transported by this source. Of the total quantity sold, 91% is transported using the mechanized mode. In about 5 states (Bihar, Haryana, Punjab, Uttar Pradesh and Uttarakhand) mechanized mode carried almost 100% of the sugarcane sold. The sugar mills perform the transportation operations in Tamil Nadu, majorly using the mechanized mode. In Andhra Pradesh, more than 52% of total quantity is transported through manual mode and remaining 47.5% through tractor

trolleys. In Telangana, nearly one-third of total quantity sold is transported through manual mode and the remaining two-third is transported through mechanized mode, using tractor trolley and truck, both. Of the total quantity transported to the sugar mill and purchase centre, respectively, nearly 90% and 95% is transported through mechanized mode. Whole of the quantity transported to the gur manufacturer and to the khandsari units is transported through mechanised mode.

Farmers transporting sugarcane

On the overall basis, of the total sampled farmers transporting sugarcane through various modes, nearly 62% are carrying to the mill gate and 24% are dropping at the purchasing centre. Nearly 13% of farmers are selling to the gur manufacturers and just 1% are selling to the khandsari units. At the state level, in Telangana all the surveyed farmers and in Punjab nearly 97% farmers are selling the sugarcane at the mill gate. In Andhra Pradesh and Bihar, nearly above three-fourth of farmers are selling at the mill gate. The highest percentage of farmers dropping sugarcane at the purchasing centre is reported in Uttarakhand (nearly 90%). This is followed by Uttar Pradesh (nearly 27%). In Uttar Pradesh (27.5%), Haryana (19%) and Bihar (11%) farmers are selling to the gur manufacturers. The proportion of farmers using manual and the mechanized mode to various destinations is broadly 10% (using manual mode) and 90% (using mechanized mode).

Average distance covered

The distance is a major component of transportation cost. Overall, on combined basis, to all the destinations altogether, the weighted average distance covered by the farmers is 13.5 km. The distance covered by manual modes is 4.7 km and the same covered by mechanized mode is 14.6 km. The least distance covered by farmers in Uttarakhand (3.15 km), followed by Andhra Pradesh (8.1 km) and Uttar Pradesh (8.3 km). The largest distance covered by farmers in Bihar (19.3 km), followed by farmers in Telangana (19 km). The weighted average distance covered by the sugar mills is nearly 27 km. The average distance varies from 18.4 km (lowest in Bihar) to 32.5 km (highest in Uttarakhand).

At the sugar mill, the average distance covered by the farmers is nearly 4.81 km through the manual mode and nearly 16.94 km through the mechanized mode. On the combined basis, this is about 15.39 km. At the purchase centre, the average distance covered on the overall basis is nearly 3.66 km. This is nearly same for the manual (3.62 km) and mechanized mode (3.67 km). The average distance of gur manufacturers is ranging nearly 3 km (least in Punjab) to 16 km (highest in Bihar). The khandsari units are located in range of 4.8 km (in Uttar Pradesh) to 7.4 km (in Bihar).

Transportation cost 'per quintal' borne by farmers

The costs involved in manually transporting sugarcane to various destinations include the feed and fodder cost to the livestock used in carts and the hiring charges, if the cart is hired. The feed and fodder cost of owned manual transport is comparatively low (as in Bihar and Uttarakhand, ranging from Rs. 150 – Rs. 225 per day) as compared to the hired manual transportation. The cost of hired manual transportation in Andhra Pradesh is higher compared to other states using manual

mode, sometimes even higher compared to the mechanised transportation modes. This is because the cart has to make multiple rounds around the mill gate on a particular day. The average manual transportation cost on combined basis, for all the states altogether, is nearly Rs 16.9 per quintal. The cost varies from Rs. 16 to Rs 18 per quintal in Andhra Pradesh and Telangana to the all destinations. This is nearly same whether the sugarcane is disposed at the mill or at the purchase centre. In Bihar and Uttarakhand, the overall average cost is comparatively lower, nearly Rs. 4.4 per quintal and Rs. 6.7 per quintal, respectively.

Mechanised mode of transportation is used in all the study states. If the farmers have their own transportation, they incur expenses on fuel charges, driver's wages and labour. On the other hand, the hiring charges include vehicle, fuel and driver/helper/labour charges etc. The cost on combined basis, for all the states altogether, is worked out at Rs. 15.2 per quintal. At the state level, this is ranging from nearly Rs. 8 per quintal (lowest in Punjab) to Rs. 30 per quintal (highest in Bihar). In Bihar, the mill and purchase centres are located far as compared to other states. Factors such as distance and hiring charges affect the transportation cost for various states. Moreover, a minimum basic hiring rate is observed in many states irrespective of the distance travelled to the mill and purchase centres. Higher mechanised cost is observed for Andhra Pradesh, Telangana and Uttar Pradesh – East. Overall, combining cases transporting the produce through manual and mechanised modes, the cost of transportation to the entire destination on combined sample basis is nearly Rs. 15.38 per quintal.

At the mill gate, the overall average transportation cost, combing manual and mechanised modes, and on combined basis for all the states is Rs. 16.45 per quintal. The cost is nearly same for both, manual and mechanised transportation. The overall cost of transportation, combing manual and mechanised cases, and for all the states, altogether is Rs. 11.05 per quintal at the purchase centre. The cost is nearly Rs. 9.4 (at the gur manufacturers) and Rs. 14.65 (at the khandsari units) on per quintal basis.

Transportation cost 'per quintal per km.' borne by farmers

The transportation cost to all the destination on combined sample basis is worked out at Rs. 1.14 per quintal per kilometre. The transportation cost on per quintal per kilometre is reported least for Punjab and Haryana (Rs. 0.55 and Rs. 0.71 per quintal per kilometre). The cost is Rs. 1.96 per quintal per kilometre in Uttar Pradesh, contributed by a high cost in eastern Uttar Pradesh which is nearly threefold of western Uttar Pradesh on per kilometre basis. This is mainly due to the threshold cost paid by farmers for hiring vehicles even for smaller distance covered. Andhra Pradesh and Uttarakhand also reported higher cost, mainly due to high wage rates (in Andhra Pradesh) and comparatively higher charges paid by farmers even for closely located purchase centres (in Uttarakhand).

There is variation in cost paid on per quintal per kilometre basis for two modes of transportation. This cost is about Rs. 1.04 per quintal per kilometre through mechanised mode and the same is nearly Rs. 3.57 per quintal per kilometre if manual mode is preferred. The average cost on per quintal per kilometre is high for manual transportation as this mode is mainly used for

shorter distances. This mode is preferred majorly in Andhra Pradesh and Telangana, paid higher hiring charges.

Transportation related problems of farmers

Problems involved in transportation are - long waiting time in queues at mill gates due to reasons such as slow processing at mill gate, traffic jams, factory break down etc., These delays cost them heavily in terms of time and money. Extra cost bearing by farmers for any minor and major incidence during transportation - such as trolley overturned, trolleys getting stuck in the sludge are also not uncommon. Farmers are required to pay a customary tip (beta) to the transportation driver from each field basis or trip basis, especially in southern states. Engagement of the skilled manpower, especially with the managerial skills such as operational research, queuing models and digital tracking of transportation operations at the sugar mill level will help farmers as well as mills to save transportation cost and time of sugarcane, reduce long waiting time and enhance recovery of sugar due to timely processing of harvested sugarcane.

6. Information on sugar mills

The sugar mills also establish the sugarcane purchase centres near the village/cluster of villages to procure the sugar to be further processed to the sugar mills. The mills manage the transfer of sugarcane stored at the purchase centres to the mill gates. The sugar mill usually bears the transportation cost of sugarcane from the purchase centre to the mill gate initially, and the partial or full share of this cost is deducted from the final settlement of the payments made to the farmers. The mills also take the help of transport companies if they do not have own logistic or transfer mechanism. The study includes 29 sugar mills spread across 20 districts in 8 study states. Out of these 29 mills, 6 mills are only sugar mills, 6 mills are sugar mills and having distillation facility, 7 mills having sugar production and cogeneration facilities, 10 having sugar production, distillation and cogeneration facilities.

Overall, these mills having the total installed capacity of about 178.95 ‘000 Tonnes with a capacity utilization rate of above 84 % in year 2018-19. During the operational period, of the total cane crushed by these sugar mills, a recovery rate of about 10.84% is achieved. On combined basis, of the total sugarcane received by the mills from the farmers, nearly 80% is received at the mill gate and rest 20 % is received at the purchase centres. Of the total number of farmers disposed sugarcane, nearly 58% brought sugarcane to mill at the rate of nearly 33.7tonnes of sugarcane per farmer. At mill gate, the sugarcane received per farmer is about 17tonnes per farmer by nearly 42% farmers in the covered states.

Transportation cost borne by Sugar Mills

The weighted average distance of the mill gate from the purchase centres is worked out at nearly 27 km. The weighted average cost of transportation borne by the sugar mills to transport sugarcane from these purchase centres to its mill gate is nearly Rs. 16.83 per quintal, on overall basis. At the state level, the cost is ranging from Rs. 15 per quintal (lowest in Andhra Pradesh,

based on only one sugar mill) to Rs. 19.55 per quintal (highest in Haryana). The weighted transportation cost on per quintal per kilometre is worked out and this is ranging from Rs. 0.50 per quintal per kilometre (lowest in Uttarakhand) to Rs. 0.89 per quintal per kilometre (highest in Bihar), contribute to Rs. 0.62 per quintal per kilometre as weighted transportation cost on overall basis by combining all mills in different covered states.

Problems related to sugar mills

The problems faced by sugar mills (mostly cooperative) include lack of government support to upgrade their outdated machinery. Many such mills are dealing with deteriorating infrastructure and hence causing dent on their margins due to reduced capacity. Some such units are on the verge of closure or staring at a financial crisis due to economic stringency of the sugar processing units. The mills face the extra burden of storage and transportation of sugarcane from far-off distances due to non-operational status of nearby mills. The sugar mills also need support in the form of facilitation with licenses to make other by-products from sugarcane to increase their revenue and improve their viability.

7. Policy Implications

- Measures are needed to improve technological adoption and up-gradation in procurement, transportation and processing of sugarcane by the mills. Emphasis should be on digital tracking of such operations, ensuring unbiased and timely distribution of dispatch slips without human interface to farmers by the mills for harvesting and transporting produce to mill/purchase centre in time bound manner. Ensure timely payment of dues online on farmer's account.
- Wherever possible, include sugarcane harvesting and transportation operations under the mill's jurisdiction for efficient and unbiased processing.
- Facilitate the sugar mills with licenses to make by-products from sugarcane to increase their efficiency and revenue to manage maintenance cost. Sugar mills need to be helped to upgrade deteriorating infrastructure.

*****

Chapter 1: Introduction

1.1 Background

India is the second largest producer of sugarcane after Brazil. Indian sugar industry impacts rural livelihoods of about 50 million sugarcane farmers, and around 5 lakh workers directly employed in sugar mills. The annual output of the sugar sector is worth about Rs. 80 thousand crores (*Department of Food and Public Distribution, Government of India*). There are 735 installed sugar factories till January 2018, produces nearly 340 lakh MT of sugar. Policies in sugar sector change very frequently. For example, the Statutory Minimum Price (SMP) of sugarcane was replaced with Fair and Remunerative Price (FRP) after 2009 by amending sugarcane control order 1966. FRP ensures that farmers do not wait for season end for payments and also assures the margins on account of profit and risk to them. Further, the FRP is linked to a basic recovery rate of sugar, with a premium payable to farmers for higher recoveries of sugar from sugarcane. States are free to top up the FRP and the price announced by the state governments is called the State Advised Price (SAP). The cane price announced by the Central Government is decided on the basis of the recommendations of the Commission for Agricultural Costs and Prices (CACP) after consulting the State Governments and associations of sugar industry. The Commission (CACP) is one such institution that works under the umbrella of Ministry of Agriculture, Government of India.

The CACP regularly publishes data on input costs such as land rent, irrigation, fertilizer, labour, seeds, machines, etc., for sugarcane production along with other crops. The commission separately publish a price policy report on sugarcane crop every marketing year. The CACP report of 2020-21 highlighted that the substantial increase in sugar production during last two seasons and almost stagnant consumption resulted in depressed market prices and adversely affected liquidity of sugar mills and their ability to pay cane dues to farmers on time. During the sugar season 2018-19 the cane price arrears were reduced significantly to Rs. 9444 crore in September 2019 (from Rs. 28390 crore on 31st March 2019) due to various interventions by the Government

of India. However, these support measures have been challenged by Australia in the WTO with a list of other countries and regions as third parties. To clear the cane price arrears of farmers, Central Government has taken several initiatives. These are - creation and maintenance of buffer stock of 4 million tonnes of sugar by the sugar mills for one year with effect from 1st August, 2019. The financial assistance to sugar mills for enhancing and augmenting ethanol production capacity was also provided. Extended assistance of Rs. 5.50 per quintal to be directly paid into the accounts of the farmers on behalf of the sugar mills for sugar season 2017-18 and Rs. 13.88 per quintal for sugar season 2018-19 to offset the cost of cane (*CACP report, 2020-21*). Import duty on sugar was increased from 50 percent to 100 percent in February, 2018 to restrict imports. Stock holding limits were imposed on producers of sugar for the months of February and March 2018 to stabilize domestic sugar prices. Customs duty on export of sugar was withdrawn. Assistance of Rs 5.50 per quintal of cane crushed to offset the cost of cane amounting to Rs 1540 crores. Creation of buffer stock of 3 million tonnes, with the assurance to reimburse carrying cost of Rs 1175 crores towards its maintenance. Soft loans of Rs 4,440 crore through banks for setting up new distilleries. Installation of incineration boilers to augment ethanol production capacity for which government will bear interest subvention cost of Rs 1,332 crore. The government also fixed minimum selling price of white/refined sugar at Rs 29 per kg for sale at mill gate in domestic market. These policy guidelines are yet to show the impact on this sector (*CACP report, 2019-20*).

Sugarcane is one of the important cash crops grown in India and its products serves as an important raw material and ingredients to various sectors of the economy, especially food processing, fast-moving consumer goods (FMCG) and ethanol companies. It provides a lump sum financial support to farmer's annual income if the overall operation from harvesting of the crop, transportation to the final outcome of product is managed well. The transportation operations play a major role in overall sugar economics. The transportation of sugarcane crop is highly linked to the other post-harvest operations of sugarcane process. Transportation of sugarcane is an important post-harvest activity for taking fresh harvested sugarcane to the mill gate. Timely transport of produce costs less in terms of fuel cost saving and time saving of the farmers. The timely transportation also enhances the sugar extraction rate and helps in more revenue to the sugar mills.

In India, the manual mode of transportation is replaced with the mechanised modes in recent times. In most the sugarcane producing states, the mechanised modes such as tractor trolleys and trucks have replaced the carts for transpiration operations. It helped farmers in terms of large

quantity transfer to mills and highly reduced the time of transportation. But it increased the input cost to the farmers. Most of the marginal and small farmers in India still can't buy the own mechanised mode and hence they have to depend on the hired modes. This usually affects the process and hence loss to the farmers if the harvested produce is not being transferred to the mill timely due to unavailability of transport, higher hiring charges, losses due to long waiting times during peak season, etc. It is therefore evident that transportation of sugarcane to sugar mill plays an important role in connecting farmers with the sugar mill, and developing efficient and effective value chain.

Several important committees have reviewed the status of the sugar sector in the country and suggested the improvements needed. The important committees are – Jha committee in 1965, Sen committee in 1979, Hanumantha Rao committee in 1990, Y. K. Alagh committee 2005 and C. Rangarajan committee in 2012. These committees have suggested various policy measures at various times to improve the status of the sugar sector. The suggestions provided by latest three committees are abstracted in the Appendix 3.

The detailed data on various costs is collected by CACP under the scheme – 'Comprehensive Scheme for Studying the Cost of Cultivation of Principal Crops in India'. However, the data on transportation and harvesting costs is not collected under this scheme. The transportation and harvesting costs are important components of the overall cost structure of any crop, including sugarcane. There is no reliable data on these costs for sugarcane crop in the country. Inputs provided by the state governments, which are not based on a scientific survey, are the only source for the CACP. Thus, a reliable database and scientific methodology need to be developed to estimate the harvesting and transportation costs. The present study is an attempt in this direction.

1.2 Objectives

The present study intends to estimate the harvesting and transportation costs of sugarcane marketed by the farmers. The specific objectives of the study are as follows:

(iv) To estimate the harvesting cost of sugarcane using different methods of harvesting.

(v) To estimate the transportation cost of sugarcane from the farmers' field to the sugar mill and other selling points using different modes of transportation.

(vi) To identify various factors and input costs in the overall harvesting and transportation costs.

1.3 Methodology and database

Sampling approach

A multi-stage sampling technique was adopted to select the farmers. At the first stage, the states were selected based on the production of sugarcane. Eight sugarcane producing states were selected for the study. These were *Andhra Pradesh, Bihar, Haryana, Punjab, Tamil Nadu, Telangana, Uttar Pradesh and Uttarakhand*. Their share in total sugarcane production and area is approximately 68%.

At the second stage, districts were selected. Two districts were selected from each of the state following the CACP sampling frame. Special emphasis is given to the largest state – Uttar Pradesh, covering four districts (two districts from each, the western Uttar Pradesh and the eastern Uttar Pradesh regions). The following criteria has been adopted for selecting the districts: i) the districts should have large proportion of area under sugarcane to the total area under sugarcane in the state, ii) within the sugarcane growing districts, distinct geographic regions of the state are covered to the extent possible.

At the third stage of sampling, a cluster of sugarcane growing villages were randomly chosen such that a total of 100 farmers are surveyed from each district. A cluster of villages is preferred from each district, because the required sample size was not available from the villages which are smaller in size.Within the village clusters sample size is not uniform and the geographical representation is varying based on their location, hence a fixed sample of 100 farmers from each district is considered. Stratified random sampling was used to select the sample farmers from the list of farmers growing sugarcane in a particular village/village cluster to give representation to each size-group, i.e. marginal, small medium and large farmers.

Study coverage and data sources

Based on the study methodology, the aggregate sample size for each of the selected state is 200 farmers except Uttar Pradesh in which a total of 400 farmers are surveyed. Overall, the total sample size of the eight selected states is 1800 farmers. The selected eight states cover 18 districts and 115 villages (Table 1.1, Figure 1.1, Appendix I – Table A1.11). A total of 1800 sample includes nearly one-fourth of each farm class farmers namely – marginal (30%), small (25%), medium (24%) and large 21%).The detailed household questionnaire is enclosed in Appendix 2 (A). There are some instances of mills paying partly / wholly the cost of harvesting / transportation to farmers. Such information on costs paid by the mills is also collected from each of the mills in the study region using the questionnaire in Appendix 2 (B).

The CACP reports the cost of cultivation data information of sugarcane in ten states – Andhra Pradesh, Bihar, Gujarat, Haryana, Karnataka, Maharashtra, Punjab, Tamil Nadu, Uttar Pradesh and Uttarakhand. This covers most of the major sugarcane growing states in India. These states contribute above 95% area and production share of sugarcane in the country. Sugar mills arrange for harvesting and transportation operations in some of the states like Maharashtra, Karnataka and Gujarat. The sugar mills deduct the amount from the payment to be made to farmers. These three states have been excluded from the study and the newly formed state of Telangana was added to the states to be covered. Finally, eight states were selected as mentioned above.

The study utilized primary survey from the selected states. The survey work in selected eight states is covered by the respective Agricultural Economic Research Unit / Centre. The sampling frame is drawn from the 'list of selected states and crops' of the *State-Wise Crop Complex Selection* published by the CACP. The use of CACP sampling frame in the present study, to the extent possible if the village listed in the list is a sugarcane growing village, allows us to generate estimates of harvesting and transportation costs comparable with other costs published by the CACP. Also, the scientifically designed CACP cost estimation methodology can be directly adopted for the study. The survey pertains to the sugar season 2018-19, and it was conducted during December 2019 except the eastern Uttar Pradesh region in which a re-survey is conducted during November-December 2020.

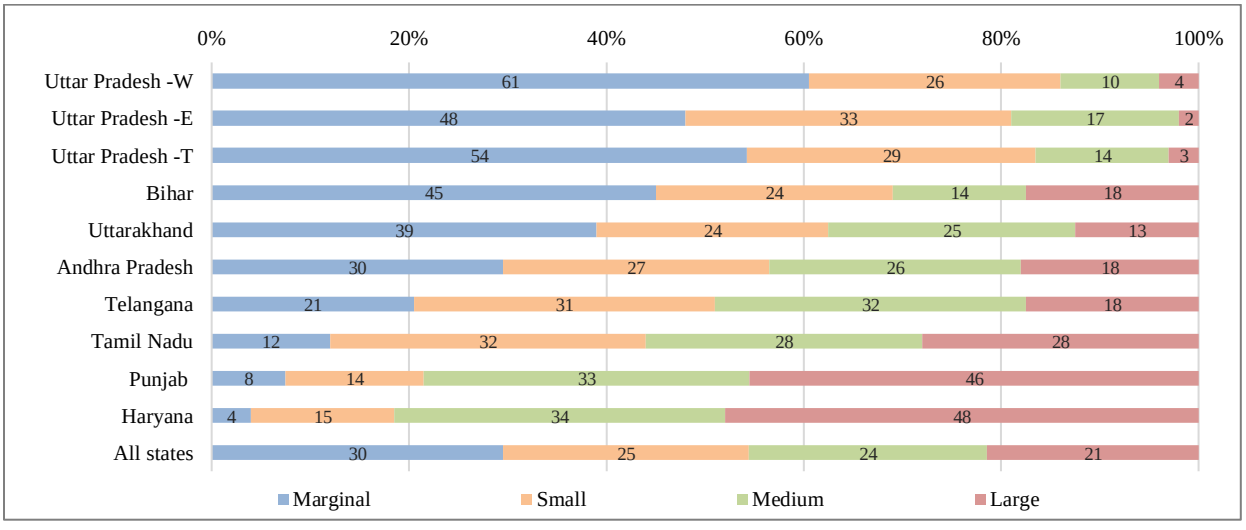
The secondary data was used to understand the performance of sugarcane and sugar in different states of India. The statistics used for the analysis cover Area, production and yield of

sugarcane, consumption and trade of sugar, and variables related to sugar industry. The database of Ministry of Agriculture, CACP, Cost of Cultivation and United States' Department of Agriculture is utilised for secondary data analysis.

Table 1. 1: Coverage of study - based on 2018-19 sugarcane season

State	District	Marginal	Small	Medium	Large	Overall
Andhra Pradesh	Krishna	29	24	26	21	100
	Visakhapatnam	30	30	25	15	100
Bihar	E. Chamaparan	45	23	12	20	100
	W. Champaran	45	25	15	15	100
Haryana	Kurukshetra	8	23	34	35	100
	Yamunanagar	0	6	33	61	100
Punjab	Gurdaspur	10	15	34	41	100
	Hoshiarpur	5	13	32	50	100
Tamil Nadu	Erode	8	20	33	39	100
	Villuppuram	16	44	23	17	100
Telangana	Kamareddy	22	29	35	14	100
	Sangareddy	19	32	28	21	100
Uttarakhand	Haridwar	55	23	14	8	100
	Udham Singh Nagar	23	24	36	17	100
Uttar Pradesh (East & West)	Bijnor	66	22	10	2	100
	Lakhimpur Khiri	55	29	10	6	100
	Faizabad	39	36	22	3	100
	Kusinagar	57	30	12	1	100
8 States	18 Districts	532	448	434	386	1800

Figure 1. 1: Farm class distribution of sampled farmers



1.4Review of past studies

In the past, limited numbers of studies were carried-out on harvesting and transportation cost of sugarcane. Some such studies are reported below:

Upreti and Singh (2017) utilized the cost of cultivation data to study relationship between productivity of sugarcane and various inputs including farm size using linear and Cobb-Douglas production function. Among all of the major components of operational cost only fertilizers, machine labour and irrigation cost witnessed significant increment over the period in Uttar Pradesh and Maharashtra. Although productivity of sugarcane was found higher in Maharashtra, but profitability of sugarcane was higher in Uttar Pradesh because of relatively higher cost of cultivation in Maharashtra. *Singh et. al. (2016)* discussed about the future need of mechanizing sugarcane cultivation in India. The small size of fields, cane purchase system, initial cost, field losses, etc., found to be factors limiting the introduction of large sugarcane harvesters especially in northern India. The efficient machinery would help in timely farm operation, input use efficiency and increase productivity by about 30%. *Shukla et. al. (2018)* also worked on highlighting low cost technologies in sugarcane cultivation. The study underlines the importance of mechanisation in sugarcane operations that reduces cost and increases profitability.

A similar study by Commission for Agricultural Costs and Prices (*CACP, 2019-20*) suggests incentives for farmers to adopt new technologies to promote efficiency and competitiveness of the Indian sugar sector. The report projected cost of production of sugarcane inclusive of cost of transportation for 2019-20 sugar season at Rs 182 per quintal. Some progress has been made in mechanization for planting and harvesting operations in few states but due to high cost of cane harvesters as well as non-availability of appropriate harvesting machines, these could not be widely adopted. A similar study by *Rao (2014)* analysed the input use and cost of cultivation of sugarcane in Telangana using primary and secondary data. The study reveals that the input use and cost of cultivation are more for large farmers compared to marginal and small farmers. Own family labour in self transportation and concentration of labour force are the responsible factors for the low level of expenditure. *Raut et. al. (2017)* examined the efficiency of various input factors employed in the production of sugarcane using Cobb-Douglas production function in Odisha. The authors found that bullock labour and fertilizers contributed significantly to the returns of crop. The negative and significant co-efficient of human labour on marginal and

small farms, but when all farm size groups pooled together, human labour, fertilizers and irrigation were found to have positive and significant relationship with returns from sugarcane.

There are few more studies on the sugar sector in India which suggest the measures to adopt to improve the status of sugar mills and of farmers growing sugarcane. The study report on vision 2030 by Indian Institute of Sugarcane Research (*IISR -2011*) suggests that the reduction in radius in cane reserve area will reduce transportation cost of cane, will improve in fresh cane supply to the mill and thereby will improve the sugar recovery. Entry of private players in sugar production help to provided needed impetus to increase the capacity of existing sugar mills and also to commission new sugarcane mills. *Saravanamoorthi and Navaneethakumar (2012)* discussed the idea of minimum transportation cost of sugarcane in Tamil Nadu using Linear Programming and the mode of transportation between the field and the factory. The possibility of loss due to accident is also discussed in order to get ready for the sudden loss of the product. The study computed the number of units of sugarcane to be transported to get the minimum transportation cost as well as with the minimum loss in sugarcane in different zones using LPP. The authors also calculated the rate of change in the juice content of the Sugarcane with respect to the weight of the cane loaded in the vehicle, speed of the vehicle and the road conditions which will help to calculate the loss occurred during transportation. Authors has also identified some of the significant connections between the quality of the road, possibilities of the accidents happened and their corresponding losses. *Cardoen et. al. (2015)* carried out an assessment on post-harvest losses for major crops that are generated on the farm at the time of harvest in India. The authors found that postharvest losses contributed to 2% loss in transportation and 10% in harvesting process. These studies broadly suggest that the minimum distance from farm to mill, quality of roads and control on the post-harvest losses will result farmers and mills in increasing gains.

A better coordination between farmers and sugar mills is also required as there are incidences that farmers protest related to high cost of harvesting and transportation. A similar cautioning attempt suggests that the different regulations in the form of cane reservation area, regulated release mechanism for the produced sugar, levy sugar obligation and dual pricing of sugarcane (centrally determined fair and remunerative price (FRP) and state determined state advised price (SAP)) have adversely affected the competitiveness and growth performance of mills and therefore led to delayed payment to sugarcane farmers (*Shroff, 2014*). Since, the state of

Maharashtra has adopted the change regarding the announcing the harvesting and transportation costs publically by mills in 2019-20. Though the mills have not fully in favour of such a move, this can help in streamlining the payment system to the farmers. This may result in better recovery rates as this pressurise the mills to make all required arrangements for harvesting and transportation of sugarcane to achieve this.

Some of the studies conducted in other countries which highlight the ways of improving the harvesting and transportation operations and reducing cost of such operations may be useful to mention here. *Kaewtrakulpong et. al. (2008)* conducted a field study in Udon Thani province, in north-eastern Thailand to clarify the current shortcomings of the harvesting and transportation processes. The analysis showed that mechanical harvesting is key for reducing harvesting cost by around 8 to 57 US$ per ha, when compared with manual harvesting in the case of burned and green cutting, respectively. The *Sugar Research and Development Corporation (SRDC) (2006)* publishes their report on behalf of Australian Government which offers the opportunity to enhance revenue and cost efficiency to the benefit of all Australian sugarcane industry participants. SRDC in their latest report emphasised optimising harvesting and transporting cost of sugarcane by investigating value chain implications. Through value chain implications, they concentrate on the flow of revenue and the amount of value added at each step such as harvesting, growing, transport, milling, storage etc. *Higgins (2004)* concentrated on the reduction of costs of harvesting sugar cane and transport by building a model for optimising siding use by harvesting groups. This model was able to achieve best utilization of rail capacity, reducing the movement of harvesters between the sidings, and achieving satisfaction and fairness for growers in their siding use. Meta-heuristic techniques were used in this research. *Meyer (1999)* proposed some approaches to reduce mechanization cost in South Africa. The paper has highlighted numerous ways by which machinery performance can be improved and operating costs can be reduced. It was found that the main factors affecting machinery performance and utilisation are management related, such as planning and system analysis. The study reported harvesting costs in South Africa ranges from $3.23 to $3.87 per ton of sugarcane harvested. Author proposed that introduction of a mechanical loading system and a reduced haul-out distance can reduce the number of haul-out tractors by 50% and total cane handling costs by about 20%. The paper suggested that the costs can be reduced by operator training and by implementing effective servicing and preventative maintenance programmes. *Chetthamrongchai, Auansakul and Supawan (2001)* estimated transportation and

other relevant costs of sugarcane production in Thailand. The study finds that truck rental and driver wages are the two elements which represent a high proportion of the overall transportation cost. It was found that a delivery system using loading stations has the potential to reduce transportation costs significantly and ensure better management of the supply chain. Most of the above studies were able to reduce the cost of transportation and harvesting operations due to use of latest technologies.

Some research studies which are not exactly related to the estimation of the cost factors of such operations but relay on use of technological advancement. The study by de *Oliveira Florentino et. al. (2017)* proposed a methodology to aid the planning of the sugarcane harvesting aiming to improve the sucrose production and the raw material quality in Brazil, considering the constraints imposed by the mill as well as the sugarcane demand. *Ramos et. al. (2016)* proposed a methodology to determine an optimum planning for planting and harvesting of the sugarcane for 5 years. The main decisions approached in this methodology are related to the determination of the planting date, selection of the varieties to be planted and determination of the harvest date for each plot, aiming to optimize the global production. *da Silva, Marins and Dias (2015)*proposed a Revised Multi-Choice Goal Programming (RMCGP-LHS) model to address uncertainty in sugarcane harvesting planning, production planning and energy cogeneration for a sugarcane mill in Brazil. *Neungmatcha and Sethanan (2015)* carried out a study on optimum planning of the mechanized harvesting route in order to improve transportation in Thailand. The authors proposed a mixed integer programming model aiming to increase profits and reduce costs through the better supply of sugarcane and more efficient mechanized harvesting and transportation. Dines, *Mcrae and Henderson (2012)* described how high levels of operational automation, continuous innovation and technology have substantially improved the efficiency of harvesting and transport operations in NSW Sugar Milling in Australia. *Moodley (2011)* attempt to develop guidelines for loading of sugarcane in South Africa by reviewing transfer systems worldwide and synthesising the sugarcane characteristics with the aim to make the transfer system more efficient and effective. *Salassi and Barker (2008)* conducted a study to estimate the cost of waiting time in harvesting cost and to develop a framework for coordinating harvest and transport of sugarcane to minimize waiting time in Louisiana. *Giles, Bezuidenhout and Lyne (2005)* assessed the potential benefits to the Sezela mill supply area in South Africa through e introduction of a computerised central control transport scheduling system (ASICAM software). Higgins et. al. (2004) developed a framework

to improve the efficiency of the harvesting and transport system in Australia through reducing the number of harvesters in the region and implementing best practice principles for harvesting. *Arjona, Bueno and Salazar (2001)* observed some problems in Mexican sugar-energy sector related to the underutilized machines and difficulties presented by farmers to plan the sugarcane harvesting. The authors developed a computational simulation of the harvesting, transportation and sugarcane processing systems, aiming to aid managers to plan and evaluate actions with a computational tool. The results allowed the correction of the problems underutilization of machinery and the minimization of costs, fuels and processing time of sugarcane. *Díaz and Perez (2000)* described an application involving the simulation and optimization of sugarcane harvest in Cuba. The authors proposed a computational simulation aimed at the optimization of sugarcane harvesting and transportation.

1.5Overview of the sugarcane sector

Sugarcane is one of the major cash crops in India. The crop constitutes nearly 3% area of the total area under major crops (food grains, oilseeds, cotton, jute and mesta and sugarcane) in the country with over 90% acreage under irrigation. Over the past two decades the crop witnessed about 1% growth in acreage and productivity (Table 1.2).Although the acreage registered a decline of nearly 0.75 percentage points in the recent period during 2010-11 to 2017-8. The productivity of the crop increased with nearly same rate as in the previous period during 2001-02 to 2009-10. The production witnessed an annual growth rate of nearly 2 % but stagnated in recent years.

Table 1. 2: India: Sugarcane Area, Production and Yield in past 5 years

Year	Area (Mill. Hectare)	Yield (Tonnes/Hectare)	Production (Mill. Tonnes)
2015-16	5.1	70.7	354.5
2016-17	4.4	69.0	306.1
2017-18	4.8	80.2	385.9
2018-19	5.6	72.4	402.0
2019-20	5.3	70.5	370.0
Growth rate: 2001-02-2009-10	*0.92*	*0.94*	*1.87*
Growth rate: 2010-11-2017-18	*-0.76*	*1.05*	*0.18*
Growth rate: 2001-02-2017-18	*1.14*	*0.95*	*2.06*

Source: Ministry of Agriculture, Govt. of India.

The major 12 sugarcane growing states contribute nearly 97 % of total area under the crop in the country. The average area share in Uttar Pradesh is declined from 48% during previous two time periods (1996-97 - 2002-03, 2003-04 - 2009-10) to 44% during 2010-11- 2017-18(Table 1.3). The area share in Tamil Nadu also declined from 6.5% in 2010-11 to 3.5% in 2017-18. Whereas,

the average share of Maharashtra in India is continuously increase from 13% to 15.6% to 18.7% over time during the same three time periods. During time-period 1996-97 - 2002-03, the country as well as most of major states, except Bihar and other minor states, reported positive growth in acreage. During second phase the country had a positive growth in area under sugarcane but many of the states witnessed decline in area. During the third time-period 2010-11- 2017-18, the country as well as most of the states reported a net decline in sugarcane acreage. The average yield of sugarcane during 2010-11 to 2017-18 at national level is recorded nearly 71.5 tonnes per hectare. Most of the southern states are performing better than the northern states as measured by the average yield ratio with respect to the average national yield of sugarcane during this period. During second time-period the country reported highest yield growth (of nearly 2%). During third phase Madhya Pradesh, Uttar Pradesh and Punjab reported highest yield growth (about 3% to 4%). There is still high need of technological advancement to increase the yield of sugarcane.

Table 1. 3: Sugarcane area - average % share and growth rate

States	Phase I: 1996-97 - 2002-03		Phase II: 2003-04 - 2009-10		Phase III: 2010-11 - 2017-18	
	% share	Growth rate	% share	Growth rate	% share	Growth rate
Andhra Pradesh	5.1	2.65	5.0	-3.18	2.7	-6.88
Bihar	2.6	-2.13	2.6	1.98	4.9	-0.05
Gujarat	4.3	2.29	4.5	-0.38	3.7	-1.60
Haryana	3.6	3.08	2.8	-10.00	2.0	2.55
Karnataka	8.5	6.14	6.2	8.27	8.6	-1.21
Madhya Pradesh	1.1	0.60	1.4	7.31	1.7	7.85
Maharashtra	13.0	3.22	15.6	15.81	18.7	-3.05
Punjab	3.1	0.18	2.1	-6.91	1.7	3.62
Tamil Nadu	7.0	1.09	6.8	7.00	5.6	-8.77
Telangana	0.0	N.A.	0.0	N.A.	0.8	-4.23
Uttar Pradesh	48.0	0.30	48.2	0.21	44.2	0.29
Uttarakhand	1.2	4.74	2.6	-2.32	2.1	-2.75
Others	2.6	-5.58	2.2	1.79	2.2	2.35
All India	100.0	1.92	100.0	2.66	100.0	-0.76
12 States	97.4	2.13	97.8	2.68	96.7	-1.12

Source: Ministry of Agriculture, Government of India.

The country produced on an average nearly 250 lakh tonnes of sugar annually during 2010-11 to 2017-18. During the same period the average production of gur, khandsari and seed was nearly 50, 42 and 8 lakh tonnes, respectively. The average consumption of sugar during the same period was close to 240 lakh tonnes. Overall, annual per capita consumption of sugar was growing by about 1.5% per year during 2001-02 to 2015-16, while that of gur was declining by 4.2 %. Of the total sugarcane produced in the country, nearly 66% is used for production of white sugar (1.25

% growth), 22% for gur and khandsari (-3.25% growth), and remaining 12% for seed and feed purposes.

International Trade in Sugar (Report 2018-19) highlights that the countries like Australia and Thailand export more than 75 percent of their sugar production, while Brazil exports around 70 percent. India was the third largest exporter of sugar in the world in 2015-16 but exports fell during 2016-17 due to lower domestic production and high prices. In India, the export usually higher than the import in quantity as well as in value terms.

1.6 Plan of report

Chapter 1 provides the brief background of the research study, its objectives, methodology and review of literature. An overview of sugarcane sector is also provided. Chapter 2 to Chapter 5cover the analysis based on the primary data. Demographic profile of farmers in selected states is given in Chapter 2. Production and marketing of sugarcane are presented in Chapter 3. Harvesting and loading-unloading of sugarcane are discussed in Chapter 4. Transportation of sugarcane for farmers to the sugar mill is given in Chapter 5. Chapter 6 covers on status, capacity and cost factors of sugar mills. Finally, the results, conclusions and policy implications are given in Chapter 7.

Chapter 2: Demographic profile of farmers

2.1 Land holding distribution

Among the sample states, nearly 30% farmers are marginal farmers. The largest proportion of marginal farmers is in Uttar Pradesh. Nearly 54% of surveyed farmers out of a sample of 400 farmers are marginal (Table 2.1).In western Uttar Pradesh such farmers are nearly 60%. This is followed by Bihar and Uttarakhand covering 45% and 39% marginal farmers. Contrary to this, in the states like Haryana and Punjab, the representation of marginal farmers is just 4% to 8%. Most of the households are large farmer in these states as compared to other states; (nearly 46%-48% of farmers). The small farmers are ranging between 14% in Punjab and Haryana to 32% in Tamil Nadu. Similarly, the share of medium farmers is 10% in Uttar Pradesh to nearly 33% in Punjab and Haryana. The farm class distribution across the states in the study broadly follows the similar distribution as in secondary data records of the government.

Table 2. 1: Number of sample households in various land-holding categories

State	Number of sample households (%)				
	Marginal	**Small**	**Medium**	**Large**	**Overall**
Andhra Pradesh	29.5	27.0	25.5	18.0	100
Bihar	45.0	24.0	13.5	17.5	100
Haryana	4.0	14.5	33.5	48.0	100
Punjab	7.5	14.0	33.0	45.5	100
Tamil Nadu	12.0	32.0	28.0	28.0	100
Telangana	20.5	30.5	31.5	17.5	100
Uttarakhand	39.0	23.5	25.0	12.5	100
Uttar Pradesh -W	60.5	25.5	10.0	4.0	100
Uttar Pradesh -E	48.0	33.0	17.0	2.0	100
Uttar Pradesh -T	54.3	29.3	13.5	3.0	100
All states	**29.6**	**24.9**	**24.1**	**21.4**	**100**

2.2 Household population, education and caste composition

The 1800 sample households across 8 states have population of 9402 persons. The overall average family size is 5.22 persons per household (Table 2.2). The large farmers having the largest family size (5.58 persons per household) followed by marginal, small and medium farmers. All the farm classes have an average family size of 5or more persons per household. At state level,

eastern Uttar Pradesh has the overall average family size of nearly 7.7 persons per household (biggest among the sampled states). All the farm categories have family size of above 7 in this region. This makes farmers in Uttar Pradesh having the largest family size of 6.19. This is followed by other northern study states – Bihar, Punjab and Haryana. Uttar Pradesh, Punjab and Haryana reported the biggest average family size for large category farmers, nearly 6 or above persons per household family. Overall, Andhra Pradesh reported the minimum average family size of 4.4 persons per households. The state is followed by Telangana and Tamil Nadu with 4.5 and 4.7average family size, respectively.

Overall, for all the selected states, nearly 52.9% are male and 47.1% females, shows the basic sex ratio of 889 female per 1000 male population (Figure 2.1, Appendix 1 – Table A1.4). This is nearly followed for all the farm classes. At the state level, Tamil Nadu performs best for this social indicator, followed by Punjab, Uttarakhand and Andhra Pradesh. There is only one case, small farmers in Tamil Nadu, where out of total population about 52%is female population. In all the other categories, across all the states, male population dominates female population. The marginal farm class in Haryana reported only 34% female population, lowest ratio among all the study states.

Nearly half of the households (49.9%) belong to 'general' category. About 43% are 'OBC' and rest 7% are either 'SC' or 'ST' category farmers (Figure 2.2, Appendix 1 – Table A1.4). Above 62% large households and 59% of medium households belong to general category. For small and marginal categories nearly 46% and 36% farmers belong to this category, respectively. Punjab (84%) and Haryana (74%) reported the highest share of 'general' category farmers, while, Tamil Nadu (2%) and Bihar (14%) reported the lowest share of such farmers. The reason is, both of these state, Tamil Nadu (86%) and Bihar (82%), have highest share of 'OBC' category farmers. Nearly 13% to 15% farmer in Tamil Nadu and Telangana, respectively, belongs to SC & ST category, highest share within that share among all the states. This is followed by eastern Uttar Pradesh (nearly 11% SC & ST farmers) contributing to total 8% SC & ST farmers in the Uttar Pradesh on overall basis. Punjab and Haryana reported the lowest number of 'OBC' (13% and 25%, respectively) and 'SC &ST' (3% and 1%, respectively) category households across all the study states.

The education profile of selected states suggests about 83.4% of household heads are either "intermediate' pass or less (Figure 2.3, Appendix 1 – Table A1.5). Nearly 16.6% household heads are graduate or more and of them nearly one-fourth (overall at 4.3%) are post-graduate. The proportion of 'graduate or above' education level is reported highest for large farmers (nearly 20.5%) and lowest for marginal and small farmers (14.1%). Contrary to this, the share of farmers with 'primary level education or less' is reported highest for marginal farmers (nearly 43.8%), whereas for large farmers this share is just 14.8%. Only 4.9% of large farmers are illiterate, but 15.6% of small and 19.5% of marginal farmers never went to school.

At state level, Bihar reported the highest share of 'graduate and above' farmers (27.5%) as compared to the same share in other states. This is followed by eastern Uttar Pradesh (25%, but just 9% in western Uttar Pradesh, hence 17.3% in Uttar Pradesh on overall basis), and Haryana (22%) household heads received graduate level or above education. Telangana (11%) Punjab (11.5%) and Uttarakhand (13%) reported lowest share of such farmers. Nearly half of the household heads in Andhra Pradesh (51.5%) and Uttar Pradesh (41.5%, overall) are either 'primary' educated or less. Included in this, nearly 31% of household heads are Andhra Pradesh never went to school. Haryana, Punjab (3%, each) and Bihar (4%) reported the least number of illiterate household heads. Overall, nearly in all the study states, household heads in large and medium farm-classes have better educational background as compared to the marginal and small household heads.

Table 2. 2: Average family size per household

State	Marginal	Small	Medium	Large	Overall
Andhra Pradesh	3.76	4.54	4.35	5.33	4.41
Bihar	5.51	5.83	4.93	5.20	5.46
Haryana	4.38	3.66	4.90	5.93	5.19
Punjab	4.47	4.71	5.00	6.01	5.38
Tamil Nadu	4.88	4.55	4.57	5.07	4.74
Telangana	4.34	4.21	4.78	4.60	4.49
Uttarakhand	4.69	4.91	5.20	5.52	4.98
Uttar Pradesh -W	4.64	4.41	5.05	5.38	4.66
Uttar Pradesh -E	7.51	8.26	7.09	9.25	7.72
Uttar Pradesh -T	5.91	6.58	6.33	6.67	6.19
All states	**5.20**	**5.16**	**5.00**	**5.58**	**5.22**

Figure 2. 1: Demographic profile of the sample households

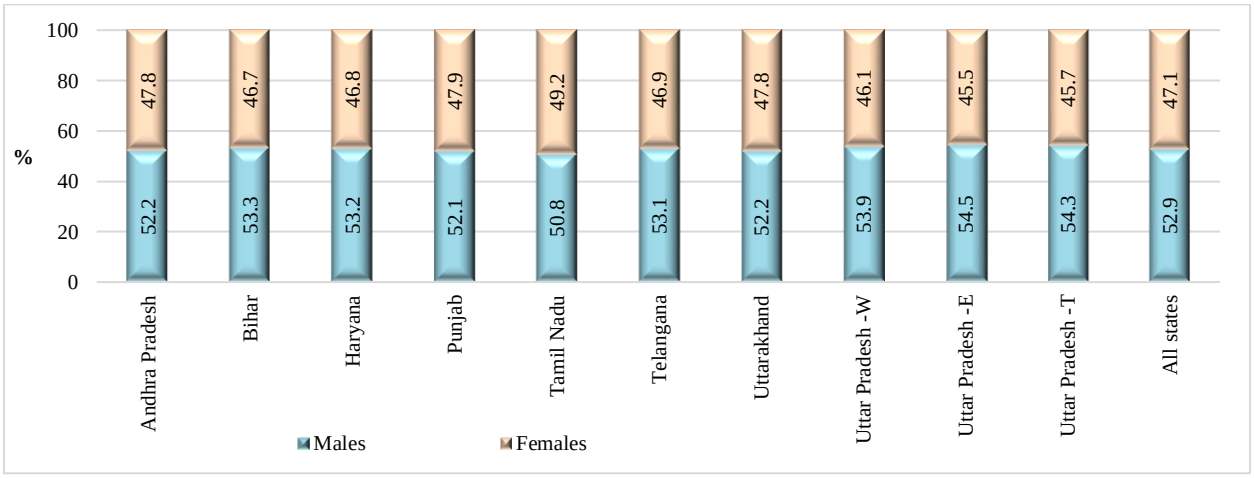


Figure 2. 2: Caste profile of the sample households – % distribution

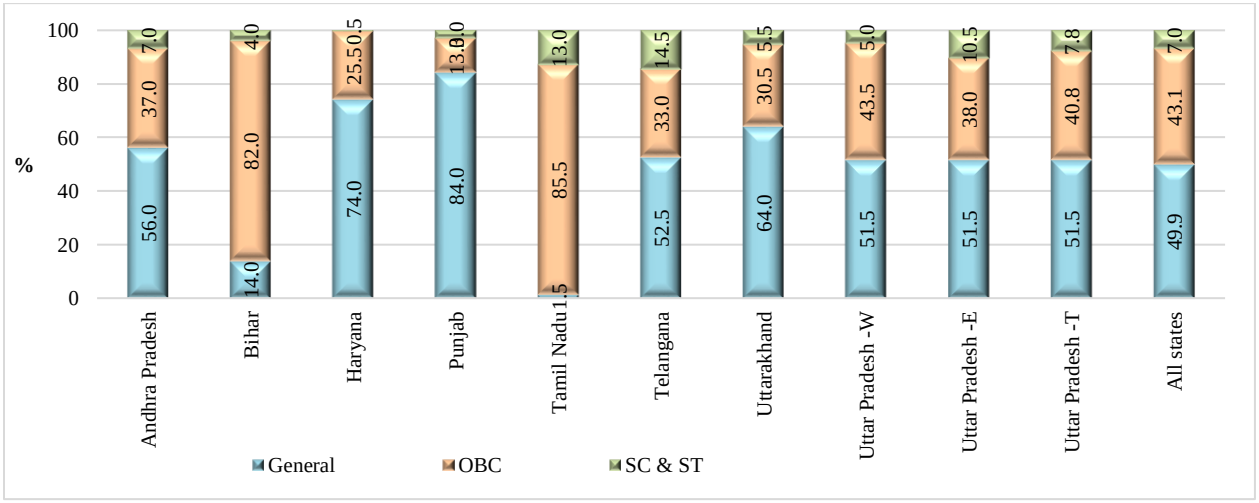


Figure 2. 3: Education level categories of the Head of the sample households (%)

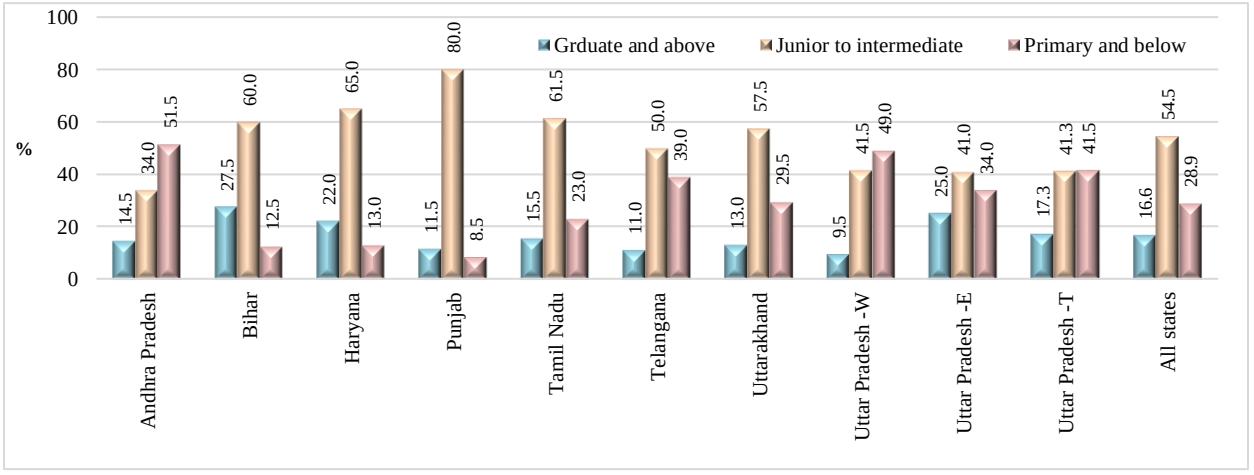
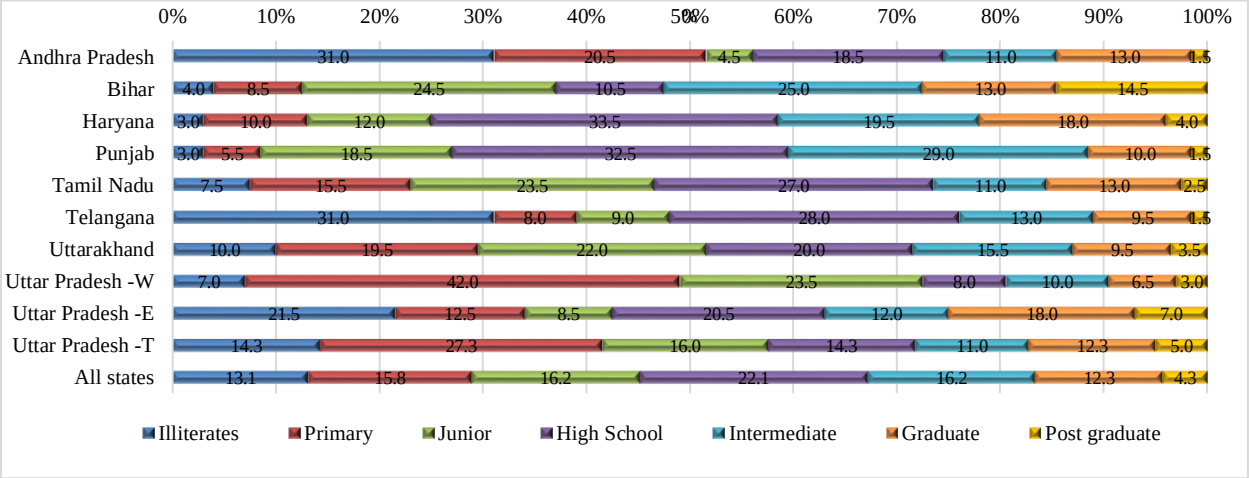


Figure 2. 4: Education level of the Head of the sample households–Overall (%)



2.3 Distance of household's farm from village centre

The numbers of farmers transporting sugarcane were enquired about the distance they cover to the village centre from the sugarcane fields. The distance is categorized broadly into three categories i) within the range of 2 km, ii) between 2 km to 4 km; and iii) above 4 km. The categorisation was planned based on responses received from farmers during the pilot survey regarding the location of fields within the village cluster range, in general. The survey results suggest that almost 71.6% of the household's farms are within the range of 2 km (Figure 2.5, Appendix 1 – Table A1.6). 19.8% farms are between 2 km to 4 km of distance. Only 8.6% farms have reported this distance of above 4 km. Excluding the eastern Uttar Pradesh, only 3% farms are located at a distance of above 4 km. In eastern Uttar Pradesh, nearly 51% farmers have their sugarcane fields at a distance of above 4 km from the village centre. Andhra Pradesh (8% farmers) and Tamil Nadu (11% farmers) are two other states, where farms are located at a distance of 4 km and above. In Bihar, all the farmers reported the location of their farms is within 2 km. This is followed by Punjab (95%) and western Uttar Pradesh (83%) contributes to nearly 48% farmers in Uttar Pradesh have closely located fields. In Telangana and Andhra Pradesh only up-to two third of farms are located closest to the village centre. These states reported nearly 40% and 28% farms between 2 km. to 4 km. distance, respectively, which is highest among all the study states in that distance range.

It is observed that the average distance of all the farms covered in this study is nearly 1.78 km from the village centre (Figure 2.6, Appendix 1 – Table A1.7). Overall, the range based average

distance of the farms is closely 0.84 km. (for range 0-2 km.), 2.36 km (for 2-4 km.) and 8.25 km (for above 4 km.) far from the village centre. This average distance distribution is very closely followed by all the study states except few outliers. Across the farm class too, the similar pattern is observed. The only observable note is that the large farmer's farms are located closer to the village centre at 0.75 km. (within the 2 km distance category) and 7.2 km. (in the above 4 km distance category), overall at 1.54 km. The small and marginal farmers have their fields far from the village centre (2.01 km and 1.92 km, respectively) on overall basis.

At the state level, farmers in eastern Uttar Pradesh reported the longest distance of their fields from the village centre (average 5.5 km) (Figure 2.7). In all the other states the average distance is nearly 1 to 2 km, except Bihar and Punjab where the sugarcane fields are located within 1 km to village centre.

Figure 2. 5: Distance of farm from village centre (% of farmers reported)

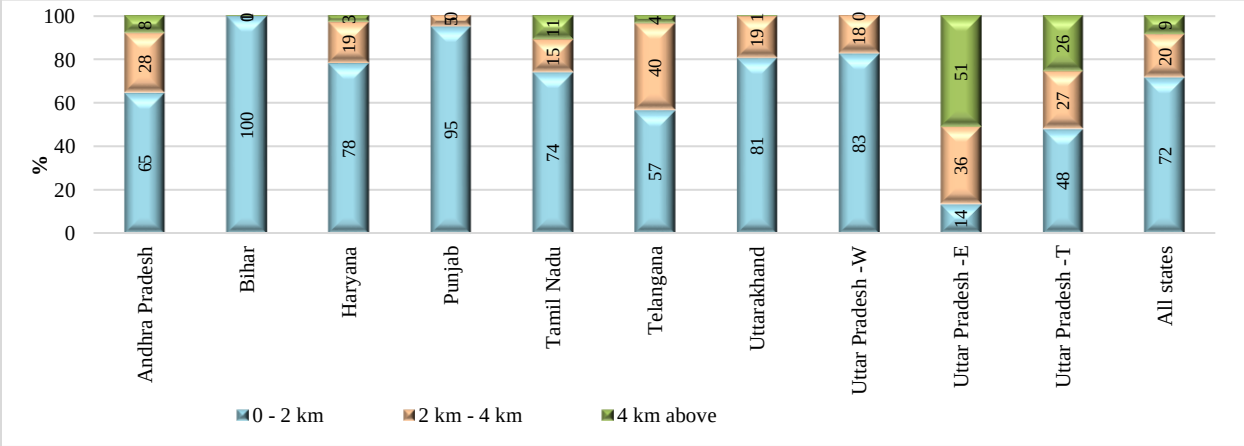


Figure 2. 6: Average distance of farm from village centre (km.)–All states - by farm class

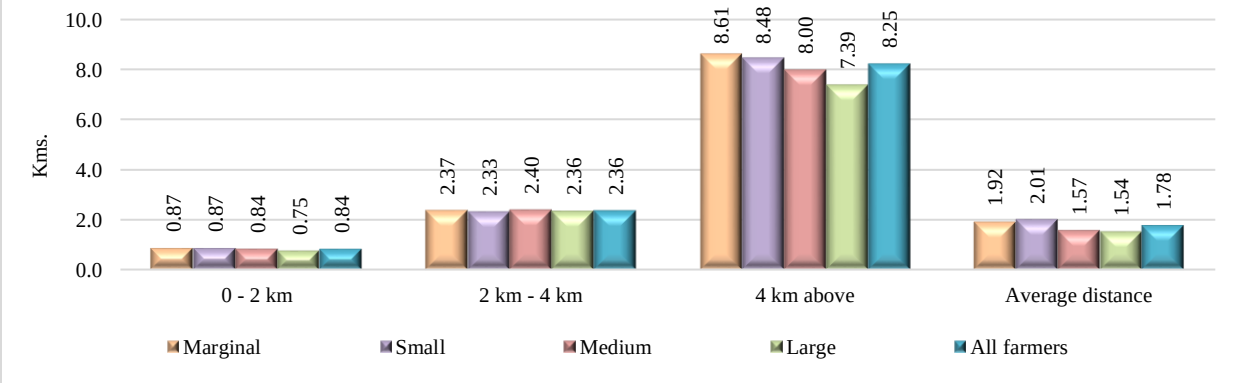
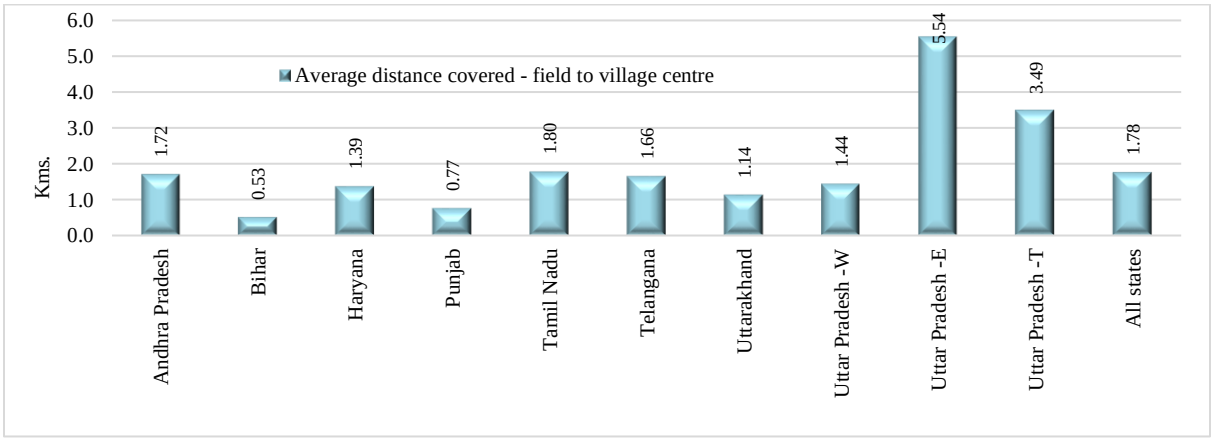


Figure 2. 7:State-wise average distance of farm from village centre (km.) –All farm classes



Chapter 3: Area, production and marketing of sugarcane

3.1 Land, irrigation and production

The total crop area cultivated by the sample farmers in the study states is 12.17 thousand acres (Table 3.1, Appendix 1- Table A1.8). Out of this total operated land, nearly 7.18 thousand acres (about 59%) of area is under sugarcane crop.

Nearly 57% of the total operated land is owned and cultivated by the large farmers and the average land holding is about 18 acres per farmer. The medium farmers occupy approximately 24% of total land with average holding of 6.7 acres per farmer. The small and marginal sampled farmers have about 12.7% and 6.4% of total agricultural land and their average land holding is nearly 3.4 acres per farmer and 1.5 acres per farmer, respectively. About 93% of the total land is irrigated. It is observed that, almost all category farmers have access to irrigation resources as nearly all farm classes have reported above 92.5% of their land as irrigated.

At state level, Punjab and Haryana reported the highest 'average land holding' with 13.7 acres/farmer and 10.7 acres/farmer of land, respectively (Table 3.2). The reason for this is, in Punjab (78.9% land, 45.5% farmers) and Haryana (72.5% land, 48% farmers) above 72% of operated area is assigned with large farmers (above 45% of total surveyed farmers in these two states).For Uttar Pradesh, the overall average land holding is just 2.94 acres per farmer, least among the study states (large farmers are just 3%, holding just 11.8% of total land). All other states, the average land holding is about 5 acres to 7.5 acres per farmer.

Of the total net operated land, nearly 59% of land is under sugarcane crop. In the large farm class, nearly 55% net operated land is under sugarcane crop, whereas, for marginal farmers, the share is about 82% (Table 3.1). The share of medium and small farmers is 57% and 70%. This shows sugarcane is also a preferred crop for sowing among marginal farmers. As the land holding decreases, area under sugarcane crop is, proportionately, increases. This pattern is followed by most of the study states, except Punjab and Uttar Pradesh, the highest and the least 'average land holding' states, respectively. Proportionately, the highest area under sugarcane within the 'marginal' farmer class is in Tamil Nadu, Bihar and Telangana (about 95% of total land area).

Whereas, the lowest area share under sugarcane within the 'large' farmer class is in Uttarakhand and Haryana (about 40%of total land area).

At the state level, farmers in Uttar Pradesh reported the highest area under sugarcane, as nearly three-fourth of the nest operated area is under sugarcane crop (Table 3.2). The sugarcane crop to net operated ratio is observed least for Haryana (44%) and Uttarakhand (49%). The land holding under sugarcane crop is reported highest for farmers in Punjab (average 8.5 acres per household). The Punjab state holds largest share in 'net operated area' and in 'area under sugarcane' among the study states (about 22.6% and 23.8%, respectively) due to its large holdings.

Overall, 96% of area under sugarcane crop is reported irrigated (Table 3.1). Except the states – Bihar (79%), Andhra Pradesh (88%) and Telangana (98%), all the other states reported 100% irrigation under sugarcane (Figure 3.1, Appendix 1- Table A1.8). Bihar is the only state, where in percentage terms the area irrigated under sugarcane crop is less than the net operated area irrigated. Overall, all the surveyed farmers in the study states have better irrigation facilities.

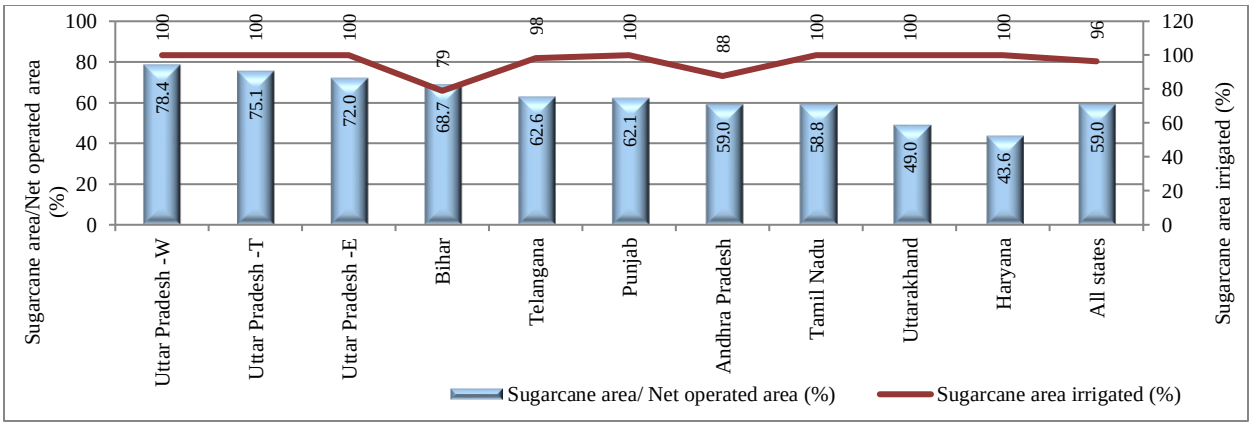
Table 3. 1: Land, crop and irrigation details of the sample households (in Acres)–All states

Farm class	Area under all crops			Area under sugarcane			Sugarcane area/ Net operated area (%)
	Operated Area	Irrigated Area	Irrigated (%)	Operated Area	Irrigated Area	Irrigated (%)	
Marginal	775.8	743.0	95.8	635.7	614.3	96.6	81.9
Small	1539.7	1438.7	93.4	1069.6	1033.3	96.6	69.5
Medium	2921.3	2703.3	92.5	1663.6	1594.9	95.9	56.9
Large	6932.4	6458.9	93.2	3808.9	3667.9	96.3	54.9
Total	12169.2	11343.9	93.2	7177.8	6910.4	96.3	59.0

Table 3. 2: Share of states in crop land and per household land holding – all farm classes

States	Sugarcane area/ Net operated area	Land holding per household (Acres)	Sugarcane area per household (Acres)	State share - Net operated area (%)	State share - sugarcane area (%)
Andhra Pradesh	59.0	5.9	3.5	9.7	9.7
Bihar	68.7	5.8	4.0	9.5	11.0
Haryana	43.6	10.7	4.7	17.6	13.0
Punjab	62.1	13.7	8.5	22.6	23.8
Tamil Nadu	58.8	7.5	4.4	12.2	12.2
Telangana	62.6	6.3	4.0	10.4	11.0
Uttarakhand	49.0	5.1	2.5	8.3	6.9
Uttar Pradesh -W	78.4	2.9	2.3	4.7	6.3
Uttar Pradesh -E	72.0	3.0	2.1	4.9	6.0
Uttar Pradesh -T	75.1	2.9	2.2	9.7	12.3
All states	59.0	6.8	4.0	100	100

Figure 3. 1: Sugarcane area irrigated and state-wise shares in net operated area



The sampled households produced about 2296 thousand quintals of sugarcane from 7.18 thousand acres of area with a yield rate of 320 quintal/acre (Table 3.3). The states like Punjab with sugarcane area share of about 23.8% among study states, reported almost same share in production (23.7%). Tamil Nadu with 12% area share recorded 19% share in total production. This is due to high productivity of sugarcane in Tamil Nadu (just below 500 quintal/acre), highest among the study states. Compared to this, Bihar reported the sugarcane yield just 228 quintal/acre, less than half of the Tamil Nadu state, the lowest yield across all states. For all other states, the yield is ranging from 283 quintal/acre (in Uttar Pradesh) to 330 quintal/acre (in Andhra Pradesh). Across the farm class, there is not much variability in the sugarcane yield.

Table 3. 3: Area, Production, Yield and sold quantity of sugarcane

States	Area (in Acres)	Production (in '000 Qtl.)	Yield (Qtl./acre)	Sugarcane sold (in '000 Qtl.)	Sold/Production (%)	State share - sugarcane sold (%)
Andhra Pradesh	696.7	230.0	330.2	230.0	100.0	10.2
Bihar	791.6	180.4	227.9	180.0	99.8	8.0
Haryana	935.9	268.2	286.5	258.2	96.3	11.5
Punjab	1705.0	543.3	318.6	541.5	99.7	24.1
Tamil Nadu	876.5	437.2	498.9	437.2	100.0	19.4
Telangana	792.3	240.1	303.1	240.1	100.0	10.7
Uttarakhand	496.8	146.8	295.4	138.7	94.5	6.2
Uttar Pradesh -W	453.3	142.8	314.9	125.5	87.9	5.6
Uttar Pradesh -E	429.9	107.5	250.2	97.7	90.9	4.3
Uttar Pradesh -T	883.2	250.3	283.4	223.2	89.2	9.9
All states	7177.8	2296.3	319.9	2248.9	97.9	100.0

Almost the entire sugarcane production (97.9% of total production, see Table 3.3) is marketed in the study states. Farmers keep a small part of the produce for seed and other purposes in many states, majorly in Uttar Pradesh, Uttarakhand and Haryana. In these states the percentage of sugarcane marketed ranges from 89% in Uttar Pradesh, 96% in Haryana to 94% in Uttarakhand.

In few states (i.e. Tamil Nadu and Telangana), the entire production is sold to the sugar mills, gur manufacturers and khandsari units.

3.2 Quantity sold to destinations and by states

Of the total sugarcane marketed, nearly 85.8% is sold at the sugar mill gate, 10.4% at the sugar mill purchase centres, 3.7% to the local gur manufacturer and just 0.1% to the khandsari units (Table 3.4). However, in some states such as Andhra Pradesh, Punjab, Tamil Nadu and Telangana the entire sale is done at the sugar mill gates. In other states too, majority of the sale occurred at the sugar mill gates – ranging from 57% in Uttar Pradesh to 95% in Bihar.

However, Uttarakhand is an exception, where only 8% is sold at the sugar mill gates and 90% is sold to the purchase centres. This is because some of the sugar mills are closed due to economic loss they are incurring, and sometimes mills get break down as most the mills in the states needs infrastructural up-gradation. The farmers have to wait in queues for long hours if the mill gets un-operational. Beside this, the mills are at far distance in several sub-districts. Sometimes mill have to establish purchase centre above 100 km distance. Hence, establishing purchase centre at various locations near the village clusters is a feasible solution for both, mills as well as farmers. In particular, one sugar mill in the U.S. Nagar district of Uttarakhand was not operating at the time of survey, so the nearby mill has established purchase centres in that study region. In western Uttar Pradesh, a significant quantity (27%) is sold to the gur manufacturers. Nearly 16% of total sold produce in Haryana is carried to gur manufacturers. Farmers do not prefer to sell to the khandsari units in any of the states, except few farmers in Uttar Pradesh and Bihar.

Table 3. 4: Quantity sold by destinations (%)

States	Sugar mill	Mill purchase centre	Gur manufacturer	Khandsari unit	All destinations
Andhra Pradesh	100.0	0.0	0.0	0.0	100.0
Bihar	94.8	4.3	0.7	0.2	100.0
Haryana	66.8	16.6	16.5	0.0	100.0
Punjab	100.0	0.0	0.0	0.0	100.0
Tamil Nadu	100.0	0.0	0.0	0.0	100.0
Telangana	100.0	0.0	0.0	0.0	100.0
Uttarakhand	7.7	90.5	1.9	0.0	100.0
Uttar Pradesh-W	56.0	15.1	27.4	1.5	100.0
Uttar Pradesh-E	58.6	39.1	2.3	0.0	100.0
Uttar Pradesh-T	57.2	25.6	16.4	0.8	100.0
All states	85.8	10.4	3.7	0.1	100.0

The sampled households sold about 2245 thousand quintals of sugarcane to various destinations. Of the total sold quantity, the major two states (Punjab and Tamil Nadu) constitute

nearly 43.5% share. Haryana, Telangana, Andhra Pradesh and Uttar Pradesh contribute close to 10% share each (Table 3.5). Nearly 86% produce is sold directly to the sugar mill. Of this, nearly above half (51%) is coming from Punjab (28%) and Tamil Nadu (23%). Similarly, Uttarakhand (53%), Uttar Pradesh (25%) and Haryana (18%), together share about 97% share of the total quantity sold to sugar mill purchase centres. Haryana (51%) and Uttar Pradesh (44%) constitute a large share of overall quantity sold to the gur manufacturers. Uttar Pradesh (82%) and Bihar (18%) are the only two states reported to have sold to the khandsari units, though the total produce sold at khandsari unit is less than 1.5% of their produce.

The farmers in these states sell sugarcane to gur manufacturers and khandsari units due to various reasons. First, some farmers are in need of urgent money which they get in hand instantly although at reduced profit, whereas the payment from the mill usually gets delayed by up-to one year. Secondly, either the mills are far due to the limited availability of mills per unit area or they are non-operational, which increases the farmers' transportation costs. Third is the higher demand for gur and khandsari in the local market. Manufacturers approach the farmers or make a prior contract with them. Fourth, the farmers usually don't want to delay the harvest of in-field sugarcane. They prefer to prepare the field for the next crop on time and if they don't get the 'ticket/slip' on time, they either sell on some other farmer's ticket or prefer to sell to unorganised players such as gur manufacturers and khandsari units near the village. Also, as the sugar season passes on, the harvesting charges also increase sharply due to onset of summer and shortage of labour. The reasons usually vary by state and season and even at the household level.

Table 3. 5: Quantity sold by states (%)

States	Sugar mill	Mill purchase centre	Gur manufacturer	Khandsari unit	All destinations
Andhra Pradesh	11.9	0.0	0.0	0.0	10.2
Bihar	8.8	3.3	1.5	17.6	8.0
Haryana	8.9	18.4	51.3	0.0	11.5
Punjab	28.1	0.0	0.0	0.0	24.1
Tamil Nadu	22.7	0.0	0.0	0.0	19.4
Telangana	12.4	0.0	0.0	0.0	10.7
Uttarakhand	0.6	53.8	3.2	0.0	6.2
Uttar Pradesh-W	3.6	8.1	41.3	82.4	5.6
Uttar Pradesh-E	3.0	16.4	2.7	0.0	4.3
Uttar Pradesh-T	6.6	24.5	44.0	82.4	9.9
All states(%)	100.0	100.0	100.0	100.0	100.0
All states('000 Qtl.)	1930.3	233.3	83.1	2.3	2248.9

The farmers have not paid any direct market fee for selling the sugarcane to the mill gates or at the purchase centre in the study states. The costs, which the farmer mainly bears, are

transportation cost, harvesting cost and the loading cost. In all the study states (except Tamil Nadu), harvesting is performed completely by farmers (either by themselves or hired labour, contract or daily wage). In the surveyed districts of Tamil Nadu, all the sugarcane harvesting, transportation and loading-unloading related operations are performed by mills and the mill deduct a lump sum amount from the farmers' final payment settlement. In other study states, the farmers transport the harvested sugarcane to the mill gate or at the purchase centre of the mill, either by own or hired arrangement. The cost of this transport is borne by the farmers. If the farmers drop the cane at the purchase centre of the mill, usually established by mill near the village centre, the cost of transporting the cane from the purchase centre to the mill gate is initially borne by the sugar mill but finally a pre-estimated fixed amount of this is deducted from the farmer's payment settlement on per quintal basis or per quintal per kilometre basis. This is the transportation cost (to carry sugarcane from purchase centre to mill gate) in addition to the actual transportation cost which farmers directly bear (to bring their produce from farm to the sugar mill or to its purchase centres). To carry sugarcane from purchase centre to mill gate, the sugar mill usually gives this task on contract to some transportation companies. The transporters charge the cost of transportation from sugar mills at a pre-decided rate. Depending on this pre-decided rate, the sugar mill transfers a part of the cost burden to the farmers at such a rate that it does not affect the margins of the mills nor does it adversely affect the farmer's profit. This amount is finally deducted from the final payment made to the farmer. The farmers pay about Rs. 3.40 per quintal to the gur manufacturers and Rs. 1.75 per quintal to the khandsari unit as marketing fee in Uttar Pradesh. In Haryana, the market fee is nearly Rs. 1 per quintal when the farmers sell sugarcane to the gur manufacturers.

Chapter 4: Harvesting and loading-unloading of sugarcane

4.1 Harvesting of sugarcane

In almost all the study states, harvesting is performed manually by casual labour with the help of hand knives, cutting blade or hand axes, except few incidences of mechanized harvesting in Telangana. In some states, family labour is also used, but such cases are less in number. The tasks involved in harvesting are mainly crop cutting (harvesting), bundling of the produce (usually bunches in different weight groups) and loading the produce on vehicles. Male labourers are employed more in activities that need more physical labour such as cutting, loading, etc. The share of female labourers (in total labour) varies across states but it is usually less than that of male labourers. The wage rate also varies across states if harvesting is undertaken on a daily wage basis. The other mode of harvesting is through a contract. The contract rates also vary by state. Various unaccounted costs are also involved in harvesting. These are broadly various hidden costs that farmer pays to the labourers including staying arrangements of labours in their villages, ticketing support for their arrival and departure, food arrangements, LPG gas cylinder, liquor, pan supari, various tips time by time etc., are few items to mention. Usually, these costs are taken care while making a deal on harvesting cost with contractual and daily wage labourers. The 'tips' is another hidden cost that affects farmers, especially in southern study states and it became as tradition in such states for harvesting and transportation related operations.

There is a ticketing system mechanism, which is used by the mills in many states to perform the purchase of sugarcane. Mills utilize a random ticket generating mechanism, usually with the help of software, to offer a time-window to the farmers, usually of 2-3 days, to harvest a fixed quantity of sugarcane and to bring to the purchase centre of the mill or directly to the mill gate. This allows all the farmers to participate in this system by turns and to bring the mature crop ready to harvest to the mill on time. Various problems also reported by the farmers related to the misuse of this system in favour large and influencing farmers. Usually harvesting is undertaken during winter. The cost of harvesting and hence that of transportation begins to increase towards the end of February and early March as the summer sets in. The availability of labour becomes a major issue, after that the labour cost also increases.

Both of the ways of harvesting, i.e. contract system and daily wage system, are in practice in the study states. However, in three out of the eight study states, harvesting is completely on contract basis. These are Haryana, Tamil Nadu and Telangana. The district level variations are also observed in such ways of harvesting. In states like Andhra Pradesh and Uttarakhand too, in one out of two study districts, the harvesting is completely on contract. In Uttarakhand, most of the households carry out harvesting on contract basis and very few households reported on harvesting on a daily wage basis. Uttar Pradesh, Bihar and Punjab are states in which harvesting is mainly on a daily wage basis. Table 4.1 reports the farm household cases practicing manual mode of harvesting on contract and on daily-wage basis. Overall, nearly 53% households are practicing harvesting on 'daily-wage' basis and about 47% prefer contract based harvesting

Of the total number of farmers adopted manual harvesting on 'daily-wage' basis, nearly 60% belongs to the marginal class, categorised as per the acreage under the sugarcane crop in the survey year 2018-19 (Table 4.2). The farm classification based on the 'net operated area' is already reported in Chapter 1. Only just above 6% farmers have the acreage under sugarcane above 10 acres. Most of these are from Punjab (nearly 20% farmers). None of the farmers in Andhra Pradesh, Uttarakhand and Uttar east Pradesh have above 10 acre land under sugarcane during the survey year.

Table 4. 1: Number of households by mode of harvesting

State	'Daily wage' based (x~y)	'Contract' based
Andhra Pradesh	97~100	100
Bihar	188~199	
Haryana		200
Punjab	199~200	
Tamil Nadu		200
Telangana		200
Uttarakhand	27~57	141
Uttar Pradesh - West	194~200	
Uttar Pradesh - East	151~197	
Uttar Pradesh - Total	345~397	
Overall	856~953	841

Note: x~y indicates the lower and upper limits for households. *In 'Daily wage', the lower figures (x) represent 'only casual labour cases' and the upper figures (y) represent family labour and casual labour combined. The sum may not add up to 200, as some of the farmers harvested with labour without any wage cost or/and with in-kind payments such as exchange of fodder or other types of exchanges. Some households with contract harvesting also includes family labour*.

Table 4. 2: Households (%) in different farm-classes performing 'daily-wage' harvesting

States	Marginal	Small	Medium	Large	All
Andhra Pradesh	68.0	25.0	7.0	0.0	100.0
Bihar	54.3	27.6	10.1	8.0	100.0
Punjab	28.0	34.5	18.0	19.5	100.0
Uttarakhand	80.7	17.5	1.8	0.0	100.0
Uttar Pradesh-W	80.0	10.5	7.0	2.5	100.0
Uttar Pradesh-E	70.6	21.8	7.6	0.0	100.0
Uttar Pradesh-T	75.3	16.1	7.3	1.3	100.0
All states	60.5	23.4	9.8	6.3	100.0

Note: The calculation is performed for household cases reported performing 'daily-wage' harvesting. This classification of farm class is based on the area the farmers have under sugarcane.

4.2 Harvesting on 'contract' basis

The contract based harvesting (either fully or partially) is reported by the sampled farmers in five states. Overall, nearly 47% households are performing harvesting operation on contract basis. The contract rates of harvesting in various states are reported in Table 4.3. The estimated cost of 'contract' based harvesting is nearly Rs. 44.91 on combined basis. The contract rates vary from Rs. 38.4 per quintal(lowest in Uttarakhand) to Rs 63.7 per quintal (highest in Andhra Pradesh).In Krishna district of Andhra Pradesh, the surveyed farmers are harvesting sugarcane completely on contractual. In Haryana and Telangana, the contract rates are about Rs. 44 to Rs. 48 per quintal. Telangana also reported some instances of mechanized harvesting at a nearly same contract rate as for manual harvesting. In all these reporting states, this contract rate also includes the loading costs in it. Usually, the unloading is performed by mills in all the states; hence no cost is involved on that account, except very few cases in Uttar Pradesh.

In Tamil Nadu, none of the farmers is bearing the harvesting cost, transportation cost and loading and unloading cost, initially. Such costs are usually borne by the mills and finally the cost is deducted from the final payment made to the farmers. The average contract rate including all such costs works out to Rs. 72 per quintal in Tamil Nadu. This involves all the costs after crop harvesting starts but a large portion of this cost is of harvesting operation. In Tamil Nadu, the harvesting cost is calculated on the basis of land covered rather than the intensity of the crop to be harvested. Here, the structure or uniformity of the field is one of the determining factors of the labour cost. Mechanized harvesting is less popular because most of the sugarcane fields are not

suitable for this by nature, and mechanized harvesting results in higher cost and comparatively lower gains.

Table 4. 3: Harvesting cost - Contract rate (Rs. per quintal) – Manual and Mechanized mode

State	Manual mode	Mechanized mode
Andhra Pradesh	63.71	
Haryana	44.65	
Telangana	47.81	47.46[#]
Tamil Nadu	72.10*	
Uttarakhand	38.38	
All states	44.91	

Note:[*]This harvesting cost in Tamil Nadu includes all the sugarcane operations into it - harvesting, transportation and loading costs. [#]A few farmers in Telangana also performed harvesting through mechanised mode. The numbers of farmers practicing 'contract' based harvesting are calculated with respect to total sampled farmers in a particular state.

4.3 Harvesting on 'daily wage' basis

Many of the farmer households (nearly 53%) are harvesting sugarcane manually by arranging labours on 'daily-wage'. The farm labours employed majorly includes both, casual labours and family labours. In few cases household also utilized farm servants for harvesting, which were already working on the monthly salary with the households. A large proportion in the total labour employed (casual labours and family labours) is of casual labours, nearly 10.1 labours used per household, at the all state level. Whereas, in most of the cases only one, or maximum two family person are involve in harvesting (1.3 labour per household) (Table 4.4).Of the total labours employed (11.4 labour per household) 3 are women. The highest number of labour employed in Bihar (15.6 labour per household) and Punjab (14.1 labour per household); and the least employed in Uttarakhand (4 labour per household).

The average wage rates are nearly Rs. 388 per day for men labours and Rs. 189 per day for women labours, on all state level (Table 4.5). The wages are nearly double for men labours as compared to women labours. In Punjab, only male labours are used for harvesting, receiving the highest wages (Rs. 452 per day) across all the study states. The lowest wages are paid in Bihar and west Uttar Pradesh (Rs. 268 per day) to male labours. The wages of women labours vary from Rs 158 to Rs 261, highest in Uttarakhand and lowest in east Uttar Pradesh.

Of the total labours employed nearly three-fourth (74%) are male labours (Table 4.6). Nearly same proportion of male labours is among the casual labours. The share of male labours is highest in Punjab (100%) and Bihar (94%). This is lowest in Andhra Pradesh (33%) and in Uttar

Pradesh (48%) contributed by the eastern Uttar Pradesh (only 37% male labours). The participation of women as family labour is also observed high in Andhra Pradesh.

On an average nearly 12 days of harvesting is practiced during a sugar season by the sugarcane farmers (Table 4.7). Although, the average labour use during sugarcane season is reported highest in Bihar (nearly 15 to 16 labours) but the average days utilised are least in Bihar (about 2-3 days).Highest number of days in the field is reported in Uttarakhand (21.5 days) with about 4 labours during sugarcane season. Average 7.4 hours are spent on field per day in most of the states. The highest average cost spent per household for wages to the labourers are appearing in Punjab (nearly Rs. 1.27 lakh/household) as the land holding is also bigger. The average cost on combined basis spent by the households in the study states is Rs. 42415 per household during the sugar season.

Table 4. 4: Harvesting - Labours use per household

State	Family labour	Casual labour	Combined		
	All	All	Men	Women	All
Andhra Pradesh	1.9	8.0	3.2	6.6	9.9
Bihar	0.2	15.4	14.7	0.9	15.6
Punjab	1.0	13.1	14.1	0.0	14.1
Uttarakhand	2.0	1.8	2.7	1.1	3.8
Uttar Pradesh-W	1.4	7.3	5.4	3.3	8.7
Uttar Pradesh-E	2.2	7.9	3.7	6.3	10.1
Uttar Pradesh-T	1.8	7.6	4.6	4.8	9.4
All states	**1.3**	**10.1**	**8.4**	**3.0**	**11.4**

Table 4. 5: Harvesting - Wage rates (Rs. per day)

State	Family labour		Casual labour		Combined	
	Men	Women	Men	Women	Men	Women
Andhra Pradesh	383	185	387	190	386	189
Bihar	268	164	268	169	268	169
Punjab	467		451		452	
Uttarakhand	313	259	304	262	310	261
Uttar Pradesh-W	280	248	265	249	268	249
Uttar Pradesh-E	303	151	302	158	303	158
Uttar Pradesh-T	293	171	279	187	283	186
All states	**352**	**189**	**394**	**189**	**388**	**189**

Table 4. 6: Harvesting - Share of men and women labours - states

State	Family labour		Casual labour		Combined	
	Men	Women	Men	Women	Men	Women
Andhra Pradesh	55.4	44.6	27.3	72.7	32.8	67.2
Bihar	53.5	46.5	94.6	5.4	94.0	6.0
Punjab	100.0	0.0	100.0	0.0	100.0	0.0
Uttarakhand	83.6	16.4	55.3	44.7	70.3	29.7
Uttar Pradesh-W	91.6	8.4	56.8	43.2	62.3	37.7
Uttar Pradesh-E	72.7	27.3	27.1	72.9	37.0	63.0
Uttar Pradesh-T	80.1	19.9	41.5	58.5	48.8	51.2
All states	**78.9**	**21.1**	**73.4**	**26.6**	**74.0**	**26.0**

Table 4. 7: Harvesting – Components on manual mode (per household)

States	Labour use	Hours (per day)	Days utilized	Average Cost (Rs.)
Andhra Pradesh	9.88	6.33	13.63	22245.1
Bihar	15.63	7.99	2.62	11921.3
Punjab	14.09	7.62	18.00	127432.0
Uttarakhand	3.89	7.28	21.47	15376.9
Uttar Pradesh-W	8.78	7.79	12.47	25441.7
Uttar Pradesh-E	10.06	6.71	13.06	22202.3
Uttar Pradesh-T	9.41	7.19	12.76	23834.2
All states	11.41	7.36	12.38	42415.4

Note: Labour used are all kind of labour used (gender and type i.e. casual and family) per household. Days employed are considered 'maximum' number of days for which any category of labour employed by that household.

Cost of manual harvesting on 'daily wage' basis

The cost of harvesting based on the daily-wage system practiced is worked out. The weighted average of cost incurred by each farm class is used to estimates the harvesting cost, considering the number of farmers in each category as weights. Given the differences in proportion of farm class across states the weighted average approach yield more accurate estimate. The cost of harvesting is worked out to nearly Rs. 37 per quintal when family labour is included in the costs (Table 4.8). The cost of harvesting based on 'only casual labours', and 'only family labours', separately, are also calculated. The weighted average harvesting cost is about Rs. 35.7 per quintal, when only casual labours are considered. The highest harvesting cost (nearly Rs. 48 per quintal) including the family labour, is paid by farmers in Punjab and Andhra Pradesh (Visakhapatnam district). The harvesting cost in Uttar Pradesh is Rs. 38.42. The farmers in eastern Uttar Pradesh paid higher charges as compared to the farmers in western Uttar Pradesh. The lowest cost of harvesting is estimated in Bihar (just Rs. 13.1 per quintal). The reasons for such large differences in harvesting cost across state are mainly due to variation in wage rates, average number of labour

employed and average days utilised across study states. The wage rates of men and women are observed least in Bihar and west Uttar Pradesh. The days utilised for harvesting are also lowest in Bihar. Whereas in Uttarakhand, the least man power is used for harvesting. In Andhra Pradesh and Punjab, the wage rates are high for the male labours employed and the labour and days employed are also high, reflecting on high cost of harvesting.

The farm class wise harvesting cost is also worked out across the study states. On overall basis, the highest cost for harvesting is paid by large farmers, nearly Rs. 40.5 per quintal (Table 4.9). The harvesting cost paid by small and medium farmers is close to Rs. 38 per quintal. Whereas, the marginal farmers paid nearly Rs. 36 as harvesting cost on per quintal basis. The marginal farmers in Andhra Pradesh and Punjab have paid nearly Rs. 50 or above per quintal for harvesting.

Table 4. 8: State-wise average harvesting cost 'Rs. per quintal' (Daily-wage based)

States	Casual labour	Family labour	Overall harvesting cost
Andhra Pradesh	39.74	9.67	47.90
Bihar	13.30	3.20	13.06
Punjab	46.36	1.83	48.10
Uttarakhand	36.40	20.54	33.80
Uttar Pradesh-W	34.05	3.30	36.61
Uttar Pradesh-E	44.13	12.17	41.08
Uttar Pradesh-T	37.77	8.46	38.42
All states	**35.73**	**9.23**	**36.99**

Note: The overall harvesting cost includes the cost spent on casual and family labour by the households on the combined basis. The two costs will not add up, as the cases are not mutually exclusive. Only the reported cases are considered while calculating the cost. The overall cost is based on all the 'intersected' cases in denominator, which employed the labours.

Table 4. 9: Farm class wise average harvesting cost 'Rs. per quintal' (Daily-wage based)

States	Marginal	Small	Medium	Large	Weighted cost
Andhra Pradesh	51.20	38.89	48.05	n.a.	47.90
Bihar	12.69	14.05	12.01	13.43	13.06
Punjab	49.88	48.24	47.03	46.29	48.10
Uttarakhand	32.66	37.37	50.38	n.a.	33.80
Uttar Pradesh-W	36.12	44.45	32.88	29.85	36.61
Uttar Pradesh-E	41.20	40.63	41.27	n.a.	41.08
Uttar Pradesh-T	38.02	41.89	36.40	29.85	38.42
All states	**35.94**	**38.40**	**37.85**	**40.51**	**36.99**

Note: The calculation is performed for household cases reported performing 'daily-wage' harvesting. n.a. indicates 'not applicable', as no household exists in particular farm class in the survey state. Numbers of households in a particular farm class are considered as weights for calculating overall harvesting cost.

4.4 Loading and un-loading of sugarcane

Loading of sugarcane is performed manually in all the study states. The loading charges are included in the contract amount if harvesting is done on contractual basis. In most of the states, unloading system is mechanized and this is undertaken by sugar mills in all the states, except Uttar Pradesh, where in a few cases payment was made for unloading on a per quintal/ per trolley basis. The wage rates for loading are also similar to that of harvesting in most of the states. The rates are lower, in Punjab and Uttarakhand as loading is being done in these states by using the labour deployed for harvesting on a part time basis. The loading cost on per quintal basis is worked out in selected states at nearly Rs. 3.4 per quintal (Table 4.10). In Uttar Pradesh, the cost is nearly Rs. 6.5 per quintal. Only male labourers are performing the loading operations. The hours of labour use per day are nearly half of that of harvesting and vary by state. On an average five to six labourers are employed for loading, nearly 3.4 hours per day were spent and nearly 9 to 10 days per season were spent in loading (Table 4.11).

Table 4. 10: State-wise average loading cost 'per quintal' borne by farmers

State	Loading cost
Andhra Pradesh	2.64
Bihar	3.71
Punjab	2.37
Uttarakhand	3.80
Uttar Pradesh-W	5.89+2.63*
Uttar Pradesh-E	7.68
Uttar Pradesh-T	6.54
All states	3.42

*Note: Loading is performed manually in all the states. *'Unloading' is performed manually in few cases in Uttar Pradesh with an average cost of Rs. 2.63 per quintal.*

Table 4. 11: Loading - Components on manual mode

Loading/un-loading	State	Wage rate (Rs./Day) - Men	labour use (per household)	Hours (per day)	Days utilized	Average Cost (Rs.)
Loading	Andhra Pradesh	331.4	5.2	4.0	6.3	6067.3
	Bihar	267.9	4.1	4.0	2.6	3362.8
	Punjab	94.0	12.3	2.2	17.9	6428.3
	Uttarakhand	141.4	2.5	3.3	14.9	1926.8
	Uttar Pradesh-W	267.1	2.8	4.0	11.1	4206.6
	Uttar Pradesh-E	418.2	2.1	3.2	11.3	3950.3
	Uttar Pradesh-T	315.5	2.5	3.7	11.2	4093.9
	All states	**177.2**	**5.4**	**3.4**	**9.7**	**4624.3**
Un-loading	Uttar Pradesh-W	247.6	2.2	4.0	4.5	1274.6

4.5Problems and perceptions of farmers- Harvesting related

Andhra Pradesh

- The harvesting is done manually by contract labours as well as through daily wages basis. In contract system, the contract labour group (Gang) gets some advance sum of money (Rs. 50000-100000/ Gang).
- For these gang workers, the farmers have to arrange shelter, gas and milk throughout the harvesting period. All the contract labourers go to their native villages for 'pongal festival' (sankranthi). The harvesting cost increases after the festival. Few members don't return back after the festival.
- In some surveyed villages, due to MGNREGS scheme there is a shortage of labourers, leading to delays in harvesting. Under this MGNREGS scheme each labour receives Rs.200/- per day on an average working for 2 to 3 hours. Farmers suggested the inclusion of sugarcane and other crops into the MGNREGS scheme.

Bihar

- There is lack of mechanization facilities for harvesting.

Haryana

- Sugarcane is harvested manually in Haryana. Harvesting and loading are performed on contract and the charges per quintal vary by season. The dependency on labour from other states, particularly from Bihar and Uttar Pradesh is high for harvesting. It is very difficult to arrange labour during peak season and labour demand high charges during peak season and also during summer.
- In spite of having large acreage under sugarcane, the farmers do not prefer harvesting by machine because of sowing norms such as distancing to be followed while harvesting sugarcane through machine. Also, the machine does not work effectively in wet/moist lands. Also, the machine cuts down sugarcane into pieces and this causes problems while loading in trolleys. Sometimes, the mills also do not prefer the sugarcane in pieces, as it dries quite rapidly as compared to complete staple and contains less juice, hence less sugar extraction. The mechanised harvesting also increases the loading charges for farmers.

Tamil Nadu

- Farmers in the state do not have any idea about cost they pay for harvesting, transportation and loading. Hence, they are also not aware about labour shortage and transportation problems even during peak season since they are completely taken by the sugar mills.
- Mechanization in the sugarcane sowing and harvesting still remains less popular mainly due to the structure of fields.

Telangana

- Sometimes, the contract groups (gangs) do not return to work after the festival break during harvesting, hence the amount given as an advance to the gang is the loss to the farmer. If the contract group returns late, it delays harvesting. After February/March, the harvesting and transport costs increase sharply, usually Rs. 100 to Rs. 150 per quintal. Hence, the delay in harvesting is a major problem to the farmers. In the study district of Kamareddy, by the month of March, the tip amount usually increases up to Rs.10000/- to Rs.30000/- per acre.
- The contract workers usually collect tip (beta) at a general rate of Rs. 400 to Rs. 500 per load of 10 to 15 tonnes. This is an additional burden on farmers, other than the harvesting cost.

Uttarakhand

- Sugarcane harvesting is manual and mostly farmers are depending on the labour for harvesting. These labourers are mostly from Uttar Pradesh and Bihar. The labour charges for harvesting vary from Rs 25 to Rs 50 per quintal from beginning (usually November) to the end of the sugarcane harvesting season (April - May). The harvesting rate usually increases after March due to the demand of labour for other crop harvesting (e.g. wheat) and also due to summer season.

4.6*Other issues faced by farmers and general observations from field survey*

Bihar

- Sugarcane farmers in the state face some of the basic infrastructure problems. The irrigation infrastructure is not sufficient and there is shortage of irrigation facilities to the

sugarcane farmers. Farmers also reported that the incentives for producing premium quality of sugarcane are not available. The prices of agricultural inputs such as pesticides are high.

- There is delay in payment despite enacted provision for making payment within 14 days. The delay caused by the sugar mills, to make the mill operation in the sugar season creates problem to the farmers. The sugar mills usually delay the start of the season as they need the large scale of harvested sugarcane initially, so that the mills do not get closed/un-operational in between the sugar season due to insufficient supply to sugarcane at the mill gate.

Haryana

- Farmers prefer early season opening and late season closing of sugar mills. The sugar mills usually push farmers to deliver mature crop at mill gate with high sugar juice content, hence deliberately delay in dispatching slips, and this causes problems to the farmers. The farmers requested opening more mills, because during peak season due to over-supply they forcefully have to sell their crop to gur manufacturers at a low cost. If, sometimes, the sugar mill operation stopped due to fault or repairing issues, they face a huge problem.
- Farmers demanded to increase SAP of sugarcane due to increasing harvesting and transportation costs. Farmers suggested inclusion of sugarcane crop in PMFBY. At the same time, having experienced poor implementation of the scheme in the past, they demand a guaranteed return in case of crop loss.

Punjab

- The farmers rated private sugar mills as better compared to co-operative sugar mills due to prompt payments. The co-operative sugar mill was found to be having some payment issues with the farmers. The farmers reported there is biased distribution of purchase slips by the sugar mills in favour of large farmers or politically sound/connected people.

Tamil Nadu

- The small and marginal farmers are struggling due to delayed payments from sugar mills. Sometimes it is delayed by more than a year. This situation pushes them to a low recovery. Being a mono crop, farmers have no other means of income.

- There is a severe water scarcity in most of the surveyed regions in the state and it becomes more serious during summers. Only large farmers are able to tackle the water scarcity problem through modern means such as drip irrigation and sprinkler irrigation.
- Farmers demanded subsidy for popular fertilizers and pesticides, channelled through sugar mills. They also urged to increase the FRM and SAP to deal with the increasing costs of harvesting.
- There are incidences that the farmers are exploited by the middlemen such as labour contractors or truck drivers.

Uttar Pradesh

- Policy measures should be implemented for timely payment of all dues to the cane growers by the Sugar Mills.

Uttarakhand

- Farmers' practice of over use of the fertilizers spikes their input cost. Few educated farmers followed scientific methods and demonstrated higher yield with lower input. Overall, mostly expensive conventional practices are followed by majority of farmers due to lack of proper knowledge about latest technology and scientific cropping.
- Most of the farmers are dissatisfied with low FRP and SAP of sugarcane, delay in announcement and delay in payment. Farmers are slowly tending not to grow the sugarcane due to delay in payment, which sometimes gets delayed by a year.
- Most of the famers prefer to grow early variety of sugarcane i.e. Co-0238, Co-0239. Farmers report that these varieties contain more sugar and get mature for harvesting on time, before the cost of harvesting increases due to onset of summer and shortage of labour. Farmers have to sell some of the 'black listed' varieties which are not accepted by sugar mills, to the gur manufacturers at lower rate.

Chapter 5: Transportation of sugarcane

5.1 Overview of transportation process across states

The transportation of sugarcane is carried out either by farmers themselves or by the mills, in cases the farmers sold at the purchase centre of the sugar mill or if mill transport sugarcane directly from the field. The prevalent modes of transportation in the study region are manual and mechanized mode. The manual mode utilizes various types of carts and is basically used for shorter distances around the mill peripheral areas or, when the mechanized transportation facility is not available. The mechanized mode majorly makes use of the tractor trolleys and trucks. The sugarcane sold to the sugar mills is either taken by farmers directly to the mill gate or to the purchase centre of that mill. The mill transports the stored sugarcane at the purchase centre (of the mill) to the mill gates using the mechanized mode, i.e. large vehicles like truck. Transportation companies are hired for this purpose. The transportation charges are deducted from the final payments made to the farmers. These charges depend on the average distances of various purchase centres of the mills from the mill. Purchase centres are usually located closer to a village or a cluster of villages. Sometimes, the mills also transport sugarcane directly from the farm to the mill gate.

Usually farmers make their own arrangements to transport sugarcane to the gur manufacturers or the khandsari units. In these sales, the farmers receive lesser compensation for their produce as compared to a sale to the sugar mills but the advantage is that they get ready cash directly into their hands. It needs to be noted here that there is usually some delay in payment by the sugar mills, which sometimes may extend up-to more than one year, which makes it financially burdensome for the farmer to carry on crop operations for the next season. Thus, some farmers, particularly the small and marginal ones, prefer to sell to the gur manufacturers and khandsari units.

The important field insights reported during the field visits are noted for different states. In Bihar, the transportation expenses to sugar mills or to the purchase centres are borne by the farmers themselves. About 15 to 20 quintals are transported in a single trip by a bullock cart whereas a tractor trolley transports about 70 to 80 quintals in each trip. Generally, there are functional

purchase centres around these villages/areas, which are located at a distance of more than 15 kilometres from the mill gate. The command area of the mills is spread over 45 to 50 kilometres. On an average 20 to 35 purchase centres are being operated by each sugar mill. The responsibility of transporting the produce from the purchase centres to the mill gate lies with the sugar mills. Mills deploy only hired trucks of medium and large size for transporting these quantities to the mills. As per discussions with the mills' officials, transportation cost incurred by the mills on this account is estimated to be Rs.35 to Rs. 37per quintal. A truck carries 170-180 quintals in each of its trip. The mill deducts at a rate of Rs.20 per quintal out of the payments made by the mills to the farmers as transportation cost.

In Andhra Pradesh and Telangana, farmers prefer manual and mechanised, both the modes of transportation, together contributes highest share of manually transported quantity as well as farmers. Both the states paid high cost of transportation as compared to other study states. In Haryana, the transportation of sugarcane is fully mechanized. Almost all the produce in the study districts is carried out using tractor trolley. Most of the farmers sell their crop at mill gate. The sugar mill does not deduct any charges from farmers' final payment.

In Punjab too, the transportation of sugarcane from farm to sugar mills is fully mechanized, and tractor trolley is the main mode of transportation. Average load per trolley is in the range of 150-170 quintals. There are no purchase centres near the villages in the study area. Transportation cost in the state is totally borne by the farmers and sugar mills do not contribute anything. The State Advisory Price (SAP) for sugarcane is Rs. 310 in the state. Private sugar mills make payment on time to the farmers as compared to the co-operative sugar mills.

In Tamil Nadu, usually the harvesting and its transportation are carried out through a contract for a lump sum amount for a particular farm. Hence, the farmers do not have exact information about the break-up of cost separately for each of these operations. They are also not aware about the labour shortage and existing transportation problems during the sugarcane harvesting season. It is the responsibility of the sugar mills to undertake these operations under the contract and manages all the tasks. The mill makes the final payment to the farmers after deducting the cost incurred in these operations.

In Uttar Pradesh, the main mode of transportation is tractor trolley, especially in the western survey region. The size of the trolley, allowed at the mill gate or at the purchase centre is

of 55-60 quintals. In the eastern Uttar Pradesh, farmers are also using the transformed mode along with tractor trolley mode (called it as 'tractor tyre gadi' or jutta or buggi) using a low base open ended trolley with lower carrying capacity (between 30-40 quintal) attached to the tractor engine. The cost of transportation from purchase centre to mill gate is initially borne by mills and while paying to the overall dues to the farmers, they deduct about Rs. 8.35 per quintal as the transportation cost.

In Uttarakhand, the most preferred mode of transportation of sugarcane is the tractor trolley which carries up-to 80-90 quintals of sugarcane. Small trolleys with 40 quintal capacity are also used to transport sugarcane to the purchase centres. The sugar mill deducts Rs. 11 to 22 per quintal basis (vary from mill to mill, and depend on average distance of mill from its purchase centres) from farmer's final payment as transportation charges from the purchase centre to the mill gate. The cost of transporting cane from farm directly to the mill gate or from farm to purchase centre are borne by the farmers. If, for any particular reason, any mill is closed during the sugarcane season, the load comes to the nearby mill or its purchase centres to support purchasing from villages located far. It is observed that the mills have to establish the purchase centres up-to 110 kms to carry produce to the mill gate, especially when the nearby mill is non-operational. This increases the transportation cost for the mill. Since the mills cannot put too much burden on the farmers' head, the mills itself end up bearing the losses.

5.2 Quantity transported

Quantity transported to various destinations is reported in Figure 6.1. Nearly 85% of the total quantity marketed is sold to sugar mills, 11% is sold to the purchase centres and about 4% to gur manufacturers. In majority of the states, namely Andhra Pradesh, Bihar, Punjab, Tamil Nadu and Telangana, nearly 95% or more quantity is transported directly to the sugar mill gate. The quantity transported on per household and per acre basis is reported in Figure 6.2. On an average, the quantity transported per household is highest for Punjab (2707 quintals/household). Nearly558quintals per household is the lowest quantity reported for Uttar Pradesh, on combined basis. This also sets a sense about the landholding patterns by farmers in these states. The quantity transported per acre basis is observed high in Tamil Nadu (499 quintal per acres), followed by Andhra Pradesh and Punjab (330 quintal per acre and 318 quintals per acre, respectively). The

lowest quantity transported on per acre basis is in Bihar (nearly 227 quintals) and in Uttar Pradesh (nearly 253 quintals).

Figure 5. 1: Quantity transported to various destinations

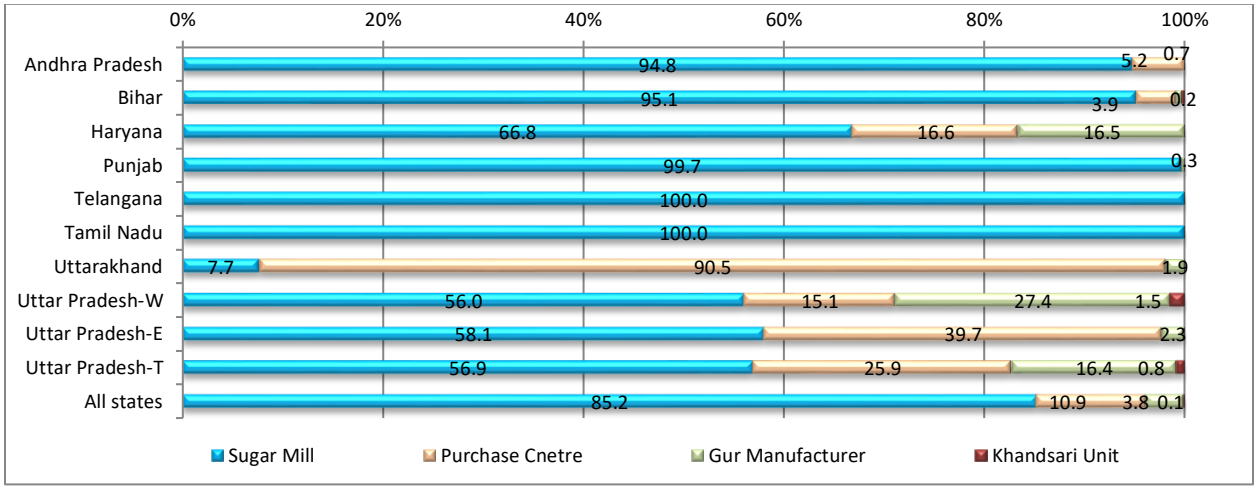
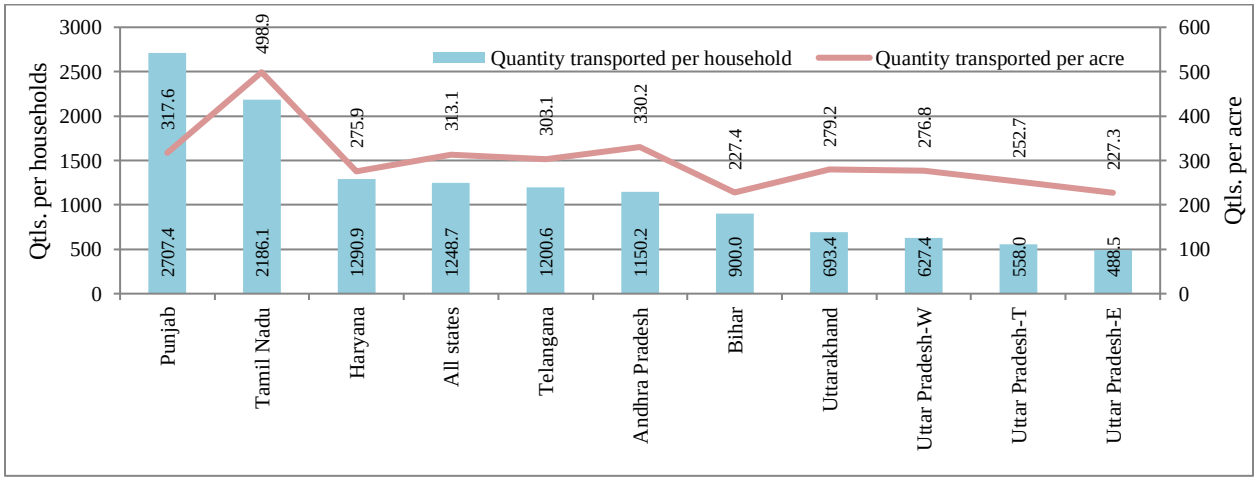


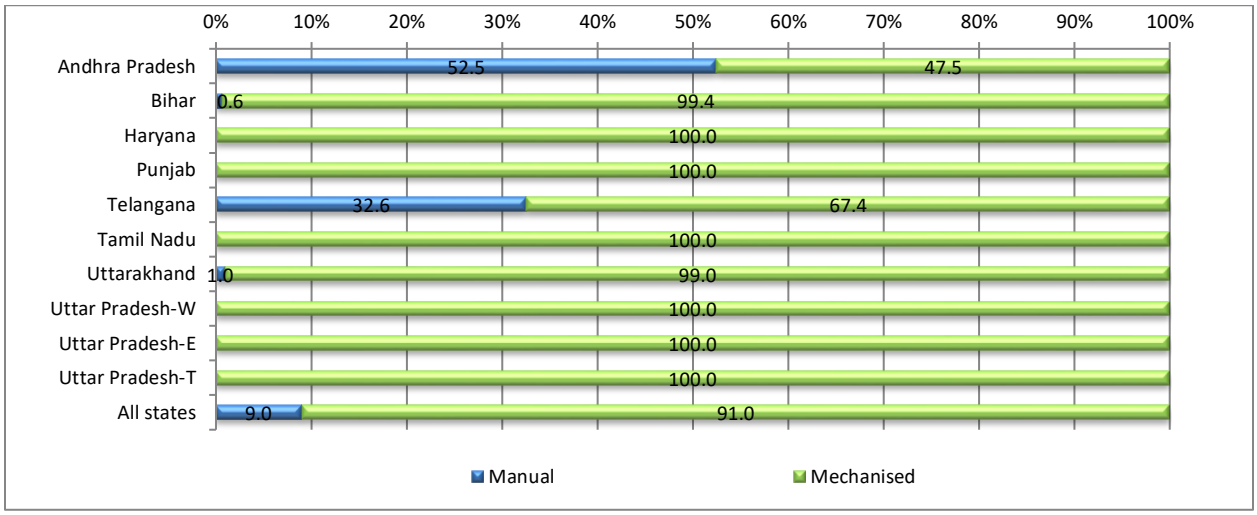
Figure 5. 2: Quantity transported on per household and per acre



The manual carts, tractor trolleys and trucks are the main carriers used to transport sugarcane from farm to various destinations. The tractor trolley is the most common mode of transportation as nearly more than two-thirds of the sugarcane produce in the study states is transported by this source. Of the total quantity sold, 91% is transported using the mechanized mode (Figure 6.3). In about 5 states (Bihar, Haryana, Punjab, Uttar Pradesh and Uttarakhand) mechanized mode carried almost 100% of the sugarcane sold. The sugar mills perform the transportation operations in Tamil Nadu, majorly using the mechanized mode. In Andhra Pradesh, more than 52% of total quantity is transported through manual mode and remaining 47.5% through

tractor trolleys. In Telangana, nearly one-third of total quantity sold is transported through manual mode and the remaining two-third is transported through mechanized mode, using tractor trolley and truck, both. Overall, nearly 91% of the marketed sugarcane is transported through mechanized mode only 9% through manual mode.

Figure 5. 3: Quantity transported by mode (% distribution)



The distribution of total sugarcane transported to various destinations by mode is reported in the Table 5.1. Of the total quantity transported to the sugar mill and purchase centre, respectively, nearly 90% and 95% is transported through mechanized mode. Whole of the quantity transported to the gur manufacturer and to the khandsari units is transported through mechanised mode. In Andhra Pradesh and Telangana, about 33% to 50% produce carried to sugar mills by manual carts. Bihar (to mill gate and purchase centre) and Uttarakhand (to purchase centre), farmers also carry a small proportion of sugarcane (nearly 1% to 2% of total sugarcane sold) through manual carts. Quantity transported to various destinations by mode and by states is reported in Table 5.2. Of the overall quantity transported by all modes, the proportion of Punjab is highest, nearly one-fourth (24.1%). This is followed by Tamil Nadu (nearly 20%). Andhra Pradesh, Haryana, Telangana and Uttar Pradesh contribute nearly 10% to 11%, each. Of the total quantity transported at purchase centre, above 50% is carried in Uttarakhand.

Table 5. 1: Quantity transported to various destinations - by modes (% distribution)

Destinations	Sugar Mill			Purchase Centre			Gur Manufacturer	Khandsari Unit	All Destinations		
Modes	Manual	Mechanized	Combined	Manual	Mechanized	Combined	Mechanized	Mechanized	Manual	Mechanized	Combined
Andhra Pradesh	49.9	50.1	100.0	100.0		100.0			52.5	47.5	100.0
Bihar	0.6	99.4	100.0	2.2	97.8	100.0	100.0	100.0	0.6	99.4	100.0
Haryana		100.0	100.0		100.0	100.0	100.0			100.0	100.0
Punjab		100.0	100.0				100.0			100.0	100.0
Telangana	32.6	67.4	100.0						32.6	67.4	100.0
Tamil Nadu		100.0	100.0							100.0	100.0
Uttarakhand		100.0	100.0	1.1	98.9	100.0	100.0		1.0	99.0	100.0
Uttar Pradesh-W		100.0	100.0		100.0	100.0	100.0	100.0		100.0	100.0
Uttar Pradesh-E		100.0	100.0		100.0	100.0	100.0			100.0	100.0
Uttar Pradesh-T		100.0	100.0		100.0	100.0	100.0	100.0		100.0	100.0
All states	9.8	90.2	100.0	5.5	94.5	100.0	100.0	100.0	9.0	91.0	100.0

Table 5. 2: Quantity transported to various destinations –by mode and by states (% distribution)

Destinations	Sugar Mill			Purchase Centre			Gur Manufacturer	Khandsari Unit	All Destinations		
Modes	Manual	Mechanized	Combined	Manual	Mechanized	Combined	Mechanized	Mechanized	Manual	Mechanized	Combined
Andhra Pradesh	57.9	6.3	11.4	88.9		4.9			60.0	5.3	10.2
Bihar	0.5	9.9	8.9	1.2	3.0	2.9	1.5	17.6	0.6	8.7	8.0
Haryana		10.0	9.0		18.5	17.5	50.4			12.6	11.5
Punjab		31.2	28.2				1.9			26.5	24.1
Telangana	41.6	9.4	12.5						38.8	7.9	10.7
Tamil Nadu		25.3	22.8							21.4	19.5
Uttarakhand		0.6	0.6	9.9	53.6	51.2	3.1		0.7	6.7	6.2
Uttar Pradesh-W		4.0	3.6		8.2	7.7	40.5	82.4		6.1	5.5
Uttar Pradesh-E		3.3	3.0		16.7	15.8	2.6			4.8	4.3
Uttar Pradesh-T		7.3	6.6		24.9	23.5	43.1	82.4		10.8	9.9
All states	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

5.3 Farmers transporting sugarcane

On the overall basis, of the total sampled farmers transporting sugarcane through various modes, nearly 62% are carrying to the mill gate and 24% are dropping at the purchasing centre (Table 5.3). Nearly 13% of farmers are selling to the gur manufacturers and just 1% are selling to the khandsari units. At the state level, in Telangana all the surveyed farmers and in Punjab nearly 97% farmers are selling the sugarcane at the mill gate. In Andhra Pradesh and Bihar, nearly above three-fourth of farmers are selling at the mill gate. The highest percentage of farmers dropping sugarcane at the purchasing centre is reported in Uttarakhand (nearly 90%). This is followed by Uttar Pradesh (nearly 27%). In Andhra Pradesh, Bihar and Haryana, proportion of such farmers is about 10% to 20%. A small proportion of the farmers are selling sugarcane to the gur manufacturer in many states except Andhra Pradesh, Tamil Nadu and Telangana. In Uttar Pradesh (27.5%), Haryana (19%) and Bihar (11%) farmers are selling to the gur manufacturers. Farmers from Bihar (5%) and western Uttar Pradesh (2%) are also selling small proportion of sugarcane at the khandsari units.

Table 5. 3: State-wise number of farmers (%) transporting sugarcane to various destinations (Manual and Mechanized, combined)

States	Mill Gate	Purchase Centre	Gur manufacturer	Khandsari unit	All destinations
Andhra Pradesh	85.5	14.5	0.0	0.0	100
Bihar	73.6	10.0	11.3	5.0	100
Haryana	61.3	20.0	18.7	0.0	100
Punjab	97.1	0.0	2.9	0.0	100
Telangana	100.0	0.0	0.0	0.0	100
Tamil Nadu	100.0*	0.0	0.0	0.0	100
Uttarakhand	5.6	89.7	4.7	0.0	100
Uttar Pradesh-W	38.8	19.4	39.4	2.3	100
Uttar Pradesh-E	52.5	38.6	9.0	0.0	100
Uttar Pradesh-T	44.2	26.9	27.5	1.4	100
All states	62.0	23.9	13.1	1.1	**100**

*Note: The total numbers of farmers transporting sugarcane to all destinations are reported as the cumulative number, as an individual farmer may sell sugarcane to more than one destination. Overall, 91% farmers are using mechanized mode and rest 9% are using manual mode of transportation. *In Tamil Nadu, the sugar mill performs the whole transportation operation.*

The percentage of farmers using manual and mechanized modes to carry sugarcane to all the destinations on combined basis, to the sugar mills and to the purchase centres are reported in Table 5.4 to Table 5.6. The proportion of farmers using manual and the mechanized mode to various destinations is broadly 10% (using manual mode) and 90% (using mechanized mode). Overall, Andhra Pradesh (43% farmers) and Telangana (25% farmers) are the major two states in

which farmers are using manual mode (Table 5.4). Whole of the sugarcane is transported through the mechanized mode to the gur manufacturer and khandsari units.

Table 5. 4: State-wise number of farmers (%) transporting sugarcane from Farm Gate to all the destinations

States	Manual mode	Mechanized mode	Combined
Andhra Pradesh	43.0	57.0	100
Bihar	2.5	97.5	100
Haryana	0.0	100.0	100
Punjab	0.0	100.0	100
Telangana	25.0	75.0	100
Tamil Nadu	n.a.	n.a.	100
Uttarakhand	3.3	96.7	100
Uttar Pradesh-W	0.0	100.0	100
Uttar Pradesh-E	0.0	100.0	100
Uttar Pradesh-T	0.0	100.0	100
All states	8.0	92.0	100

Note: All destinations include – mill gates, purchase centres, gur manufacturers and khandsari units.

Table 5. 5: State-wise number of farmers (%) transporting sugarcane from Farm Gate to Mill Gate

States	Manual mode	Mechanized mode	Combined
Andhra Pradesh	33.3	66.7	100
Bihar	2.3	97.7	100
Haryana		100.0	100
Punjab		100.0	100
Telangana	25.0	75.0	100
Tamil Nadu	n.a.	n.a.	100
Uttarakhand		100.0	100
Uttar Pradesh-W		100.0	100
Uttar Pradesh-E		100.0	100
Uttar Pradesh-T		100.0	100
All states	9.6	90.4	100

Note: Manual modes include all type of carts used and mechanized modes include tractor trolley and trucks used for transportation purpose. For Tamil Nadu, the detailed information on mode of transportation to mill gate is not available with farmers.

Table 5. 6: State-wise number of farmers (%) transporting sugarcane from Farm Gate to Purchase Centre

States	Manual mode	Mechanized mode	Combined
Andhra Pradesh	100.0		100
Bihar	8.0	92.0	100
Haryana		100.0	100
Punjab			
Telangana			
Uttarakhand	3.6	96.4	100
Uttar Pradesh-W		100.0	100
Uttar Pradesh-E		100.0	100
Uttar Pradesh-T		100.0	100
All states	8.5	91.5	100

5.3 Average distance covered

The distance is a major component of transportation cost. Usually, there is at least one sugar mill is located in one district. In a major sugarcane producing district, many mills can be located keeping the minimum distance criteria in consideration. In case, the mill in a particular location is not operational during sugar season, the farmers may have to pay more either for transporting the produce to sugar mill on his own or to transport to the sugar mill purchase centre. As the mill makes a partial deduction of the transportation charges, this increase in distance, results in loss to both, mill as well as the farmer. The average distance by mode and by destinations is worked out for the study states. Overall, the manual carts are used for shorter distances; either it is mill or its purchase centre. Usually, the average distance covered by manual carts is nearly less than 5 km (Table 5.7, Table 5.8 and Table 5.10). The average distance covered by mechanized mode of transportation varies by destination where the sugarcane is disposed. In general, the purchase centres are closely located to the village centre in most of the states except Bihar. Tractor trolley is mainly used as mechanized mode. Trucks are used only in Telangana.

Overall, on combined basis, to all the destinations altogether, the weighted average distance covered by the farmers is 13.5 km. The distance covered by manual modes is 4.7 km and the same covered by mechanized mode is 14.6 km (Table 5.7). The least distance covered by farmers in Uttarakhand (3.15 km), followed by Andhra Pradesh (8.1 km) and Uttar Pradesh (8.3 km). The largest distance covered by farmers in Bihar (19.3 km), followed by farmers in Telangana (19 km).

At the sugar mill, the average distance covered by all the states is nearly 4.81 km through the manual mode and nearly 16.94 km through the mechanized mode. On the combined basis, this is about 15.39 km. In Bihar, farmers travel up-to 16 km to reach at mill gate by manual mode. The average distance covered through mechanised mode to reach at mill gate is ranging between 8.7 km (least in Uttar Pradesh – East) to 26.8 km. (highest in Telangana) (Table 5.8).

At the purchase centre, the average distance covered on the overall basis is nearly 3.66 km. This is nearly same for the manual (3.62 km) and mechanized mode (3.67 km). In Bihar, the average distance covered to reach at purchase centres by the manual mode (10.88 km) and by the mechanized mode (24.87 km) is high as the purchase centres are located at far distances due to the minimum distance criteria to be followed to establish the purchase centres. For other states, the average distance is in range of 2 km to 6 km (Table 5.9).

Only mechanized mode is utilized to transport sugarcane to the gur manufacturer and khandsari units (Table 5.10). The average distance of gur manufacturers is ranging nearly 3 km (least in Punjab) to 16 km (highest in Bihar). In Uttarakhand and Haryana, the distance is nearly 12 km to 13 km. The khandsari units are located in range of 4.8 km (in Uttar Pradesh) to 7.4 km (in Bihar).

The distance from purchase centre to mill gate is covered by the sugar mills. The weighted average distance covered by the sugar mills is nearly 27 km. The average distance varies from 18.4 km (lowest in Bihar) to 32.5 km (highest in Uttarakhand). In eastern Uttar Pradesh, the average distance is nearly 37.8 km, high as compared to the western Uttar Pradesh, making the weighted average at 29.3 km on overall basis in Uttar Pradesh (Table 5.11).

Table 5. 7: State-wise weighted average distance from farm to 'all destinations'

States	Manual mode	Mechanized mode	Combined
Andhra Pradesh	5.93	10.48	8.09
Bihar	15.30	19.33	19.31
Haryana		17.14	17.14
Punjab		14.46	14.46
Telangana	2.78	26.82	19.00
Uttarakhand	2.00	3.16	3.15
Uttar Pradesh-W		10.03	10.03
Uttar Pradesh-E		6.08	6.08
Uttar Pradesh-T		8.30	8.30
All states	4.73	14.59	13.49

Note: All destinations include – mill gates, purchase centres, gur manufacturers and khandsari units. Weighted average is used to calculate the distances to all destinations using quantities transported to different destinations as weights.

Table 5. 8: State-wise average distance from Farm Gate to Mill Gate

States	**Manual mode**	**Mechanized mode**	**Combined**
Andhra Pradesh	6.17	10.48	8.33
Bihar	16.00	19.16	19.14
Haryana	n.a.	20.93	20.93
Punjab	n.a.	14.49	14.49
Telangana	2.78	26.82	19.00
Uttarakhand	n.a.	11.12	11.12
Uttar Pradesh-W	n.a.	15.46	15.46
Uttar Pradesh-E	n.a.	8.70	8.70
Uttar Pradesh-T	n.a.	12.45	12.45
All states	**4.81**	**16.94**	**15.40**

Note: Manual modes include all type of carts used and mechanized modes include tractor trolley and trucks used for transportation purpose. Weighted average is used to calculate the combined distance using quantities of manual and mechanized modes as weights. In the study districts of Tamil Nadu, *the sugar mill performs the harvesting and transportation operations, the detailed information on various costs and distances are not available with farmers. n.a. indicates 'not applicable' in all the tables.*

Table 5. 9: State-wise weighted average distance from farm to purchase centre

States	Manual mode	Mechanized mode	Combined
Andhra Pradesh	3.71		3.71
Bihar	10.88	24.87	24.56
Haryana		6.24	6.24
Punjab			
Telangana			
Uttarakhand	2.00	2.29	2.28
Uttar Pradesh-W		2.09	2.09
Uttar Pradesh-E		2.21	2.21
Uttar Pradesh-T		2.17	2.17
All states	**3.62**	**3.67**	**3.66**

Table 5. 10: State-wise average distance from Farm to gur manufacturer and khandsari units

States	Gur manufacturer	Khandsari units
Andhra Pradesh		
Bihar	15.96	7.4
Haryana	12.77	
Punjab	3.06	
Telangana		
Uttarakhand	12.42	
Uttar Pradesh-W	3.58	4.83
Uttar Pradesh-E	6.75	
Uttar Pradesh-T	3.77	4.83
All states	**8.73**	**5.29**

Note: Only mechanized modes are used for transportation to gur manufacturer and khandsari units.

Table 5. 11:*State-wise average distance from purchase centre to mill (covered by sugar mills)*

States	Mechanized mode
Andhra Pradesh	21.00
Bihar	18.39
Haryana	26.96
Punjab	n.a.
Tamil Nadu	n.a.
Telangana	n.a.
Uttarakhand	32.48
Uttar Pradesh - W	26.15
Uttar Pradesh - E	37.80
Uttar Pradesh - T	29.33
All states	26.94

Note: The state level weighted average distance is calculated based on the distance of the purchase centres from sugar mills covered; using the quantity of sugarcane arrived at the purchase centres as weights. Mechanized mode is the only mode used by sugar mills for transportation. In Punjab, Tamil Nadu and Telangana, all the sugarcane is dropped at the mill gate.

5.4 State-wise average transportation cost 'per quintal' borne by farmers

The cost involved in transporting sugarcane through manual and mechanised modes is estimated in this section. The manual and mechanised transportation are two basic modes but the later one is usually in practice in most of the states.

The manual mode of transportation is used to dispose nearly 9% of the total quantity transported to all the destinations on combined basis. The average distance covered by these farmers is nearly 4.73 km which is nearly one-third of that covered by mechanised mode. The costs involved in manually transporting sugarcane to various destinations include the feed and fodder cost to the livestock used in carts and the hiring charges, if the cart is hired. Very few states are using the carts for transportation and very few farmers are using this mode of transportation (nearly 8% of surveyed farmers). About 50 to 57 farmers each in Andhra Pradesh and Telangana and a minimal number in in Bihar and Uttarakhand have reported using carts for transportation.

The feed and fodder cost of owned manual transport is comparatively low (as in Bihar and Uttarakhand, ranging from Rs. 150 – Rs. 225 per day) as compared to the hired manual transportation. The cost of hired manual transportation in Andhra Pradesh is higher compared to other states using manual mode, sometimes even higher compared to the mechanised transportation modes. This is because the cart has to make multiple rounds around the mill gate on a particular day.

The average transportation cost of manual mode on per quintal basis varies from Rs. 16 to Rs 18 per quintal in Andhra Pradesh and Telangana to the all destinations (Table 5.12). This is nearly same for these states, either the sugarcane is disposed at the mill or at the purchase centre (Table 5.13 and Table 5.14). In Bihar and Uttarakhand, the overall average cost is comparatively lower, nearly Rs. 4.4 per quintal and Rs. 6.7 per quintal, respectively (Table 5.12). The average manual transportation cost on combined basis, for all the states altogether, is nearly Rs 16.9 per quintal.

Mechanised mode of transportation is used in all the study states. If the farmers have their own transportation, they incur expenses on fuel charges, driver's wages and labour. On the other hand, the hiring charges include vehicle, fuel and driver/helper/labour charges etc. The final mechanised cost is worked out by combining all such cases using owned and hired modes. Overall,

on an average, the cost on combined basis, for all the states altogether, is worked out at Rs. 15.2 per quintal (Table 5.12). At the state level, this is ranging from nearly Rs. 8 per quintal (lowest in Punjab) to Rs. 30 per quintal (highest in Bihar). In Bihar, the mill and purchase centres are located far as compared to other states. Factors such as distance and hiring charges affect the transportation cost for various states. Moreover, a minimum basic hiring rate is observed in many states irrespective of the distance travelled to the mill and purchase centres. Higher mechanised cost is observed for Andhra Pradesh, Telangana and Uttar Pradesh – East. Overall, the cost is nearly Rs. 16.3 per quintal in Uttar Pradesh. In Uttar Pradesh, Haryana and Punjab, only mechanised mode of transportation is used by the sampled farmers for transportation purpose.

Overall, combining cases transporting the produce through manual and mechanised modes, the cost of transportation to the entire destination on combined sample basis is nearly Rs. 15.38 per quintal (Table 5.12). On combining both the modes, manual and mechanised, the cost is nearly Rs. 21 to 22 per quintal in southern states Andhra Pradesh and Telangana.

The destination specific costs of transportation on per quintal basis are also worked out. At the mill gate, the overall average cost, combing manual and mechanised modes, and on combined basis for all the states is Rs. 16.45 per quintal (Table 5.13). The cost is nearly same for both, manual and mechanised transportation. The cost is comparatively low for Punjab and Uttarakhand. A high variation in transportation cost is observed in eastern and western Uttar Pradesh, especially while disposing cane at the sugar mill. The overall cost of transportation, combing manual and mechanised cases, and for all the states, altogether is Rs. 11.05 per quintal at the purchase centre (Table 5.14). This is ranging from nearly Rs. 7 per quintal (in Haryana) to Rs. 16 per quintal (in Andhra Pradesh), except Bihar, where the cost is Rs. 31 per quintal due to far located purchase centres. In Uttar Pradesh, this is nearly Rs. 14.5 per quintal on combined basis, for eastern and western region. The surveyed farmers in Punjab and Telangana are not disposing sugarcane at the purchase centres. Farmers use only mechanised mode of transportation to drop sugarcane to the gur manufacturers and khandsari units (Table 5.15). Farmers in all the states are dropping sugarcane at the gur manufacturers, except southern states - Andhra Pradesh and Telangana. Only few farmers in Bihar and western Uttar Pradesh are disposing sugarcane at the khandsari units. The cost is nearly Rs. 9.4 (at the gur manufacturers) and Rs. 14.65 (at the khandsari units) on per quintal basis.

Table 5. 12: State-wise weighted average transportation cost per quintal from farm to 'all destinations'

States	Manual mode	Mechanized mode	Combined
Andhra Pradesh	17.66	26.00	21.92
Bihar	4.39	29.99	29.82
Haryana	n.a.	12.24	12.24
Punjab	n.a.	7.93	7.93
Telangana	16.07	24.23	21.58
Uttarakhand	6.74	9.17	9.14
Uttar Pradesh-W	n.a.	11.75	11.75
Uttar Pradesh-E	n.a.	22.05	22.05
Uttar Pradesh-T	n.a.	16.26	16.26
All states	**16.89**	**15.20**	**15.38**

Note: All destinations include – mill gates, purchase centres, gur manufacturers and khandsari units. Note: The high cost of manual transportation is observed in Andhra Pradesh and Telangana due to higher cart hiring charges. Hence, the transportation cost of 'manual mode' for the reported cases in these states on 'per quintal' and on 'per quintal per km.' basis are high for various destinations. This has been verified with the participating AERC Centre, Waltair. The 'all state' calculation is based on the reported cases in the states. In Tamil Nadu, the contract rate of Rs. 72.1 per quintal includes all the operational costs (i.e. Transportation, Harvesting and loading cost).

Table 5. 13: State-wise weighted average transportation cost 'per quintal' from farm to mill gate

States	Manual mode	Mechanized mode	Combined
Andhra Pradesh	17.81	26.00	21.92
Bihar	3.67	30.05	29.90
Haryana	n.a.	14.19	14.19
Punjab	n.a.	7.95	7.95
Telangana	16.07	24.23	21.58
Uttarakhand	n.a.	7.65*	7.65
Uttar Pradesh-W	n.a.	13.69	13.69
Uttar Pradesh-E	n.a.	25.95	25.95
Uttar Pradesh-T	n.a.	19.16	19.16
All states	**17.02**	**16.37**	**16.45**

Table 5. 14: State-wise weighted average transportation cost 'per quintal' from farm to purchase centre

States	Manual mode	Mechanized mode	Combined
Andhra Pradesh	16.23	n.a.	16.23
Bihar	8.94	31.71	31.00
Haryana	n.a.	7.02	7.02
Punjab	n.a.	n.a.	n.a.
Telangana	n.a.	n.a.	n.a.
Uttarakhand	6.74	9.22	9.19
Uttar Pradesh-W	n.a.	10.51	10.51
Uttar Pradesh-E	n.a.	16.51	16.51
Uttar Pradesh-T	n.a.	14.54	14.54
All states	**15.20**	**10.81**	**11.05**

Note: No farmers are dropping sugarcane at purchase centres in Punjab and Telangana.

Table 5. 15: State-wise average transportation cost per quintal from Farm Gate to gur manufacturer and khandsari units

States	Gur manufacturer	Khandsari units
Andhra Pradesh	n.a.	n.a.
Bihar	16.60	16.88
Haryana	9.60	n.a.
Punjab	2.12	n.a.
Telangana	n.a.	n.a.
Uttarakhand	12.79	n.a.
Uttar Pradesh-W	8.32	14.18
Uttar Pradesh-E	19.0	n.a.
Uttar Pradesh-T	8.97	14.18
All states	**9.39**	**14.65**

Note: Only mechanized modes are used for transportation to gur manufacturer and khandsari units.

5.5 State-wise average transportation cost 'per quintal per km.' borne by farmers

The transportation cost to all the destination on combined sample basis is worked out at Rs. 1.14 per quintal per kilometre (Table 5.16). The transportation cost on per quintal per kilometre is reported least for Punjab and Haryana (Rs. 0.55 and Rs. 0.71 per quintal per kilometre). The cost is Rs. 1.96 per quintal per kilometre in Uttar Pradesh, contributed by a high cost in eastern Uttar Pradesh which is nearly threefold of western Uttar Pradesh on per kilometre basis. This is mainly due to the threshold cost paid by farmers for hiring vehicles even for smaller distance covered. In eastern Uttar Pradesh, the distance covered is just 6.1 km, least among the study states. Andhra Pradesh and Uttarakhand also reported higher cost, mainly due to high wage rates (in Andhra Pradesh) and comparatively higher charges paid by farmers even for closely located purchase centres (in Uttarakhand).

There is variation in cost paid on per quintal per kilometre basis for two modes of transportation. This cost is about Rs. 1.04 per quintal per kilometre through mechanised mode and the same is nearly Rs. 3.57 per quintal per kilometre if manual mode is preferred (Table 5.16). The average cost on per quintal per kilometre is high for manual transportation as this mode is mainly used for shorter distances. This mode is preferred by just 9% surveyed farmers, majorly in Andhra Pradesh and Telangana, paid higher hiring charges.

The cost paid to dispose sugarcane at the mill gate, for the states altogether, is Rs. 1.07 per quintal per kilometre (Table 5.17). Most of the states preferred mechanised mode for this. Andhra Pradesh paid higher charges as compared to all other states. Farmers from eastern Uttar Pradesh and Uttarakhand also paid higher charges for mechanised mode. The cost of transportation is about

Rs. 3 per quintal per kilometre at the purchase centre (Table 5.18). This is close to three-fold of that of dropping at the mill gate. The transportation cost on per quintal per kilometre basis at purchase centre are comparatively high due to factors such as smaller trolley capacity, smaller trolley capacity allowed (hence, higher number of trips) at the purchase centres and due to fixed minimum wages of driver/labour irrespective of the shorter distance from farm to purchase centres, i.e. there are instances where the transportation cost/driver charges are fix for a distance up-to 5 to 10 km. Uttar Pradesh (mechanised mode), Andhra Pradesh (manual mode) and Uttarakhand (both modes) are the major contributors for this increase due to higher charges paid for closely located purchase centres. The transportation cost of disposing sugarcane to the gur manufacturers and to the khandsari units preferring the mechanised mode is nearly Rs. 1.07 and Rs. 2.77 on per quintal per kilometre basis, respectively (Table 5.19). This varies from Rs. 1 to Rs. 3 across the states. A few farmers are dropping sugarcane to the gur manufacturers and a minimal number of farmers to the khandsari units in few states.

Table 5. 16: State-wise weighted average transportation cost 'per quintal per km.' from farm to 'all destinations'

States	Manual mode	Mechanized mode	Combined
Andhra Pradesh	2.98	2.48	2.63
Bihar	0.29	1.55	1.54
Haryana	n.a.	0.71	0.71
Punjab	n.a.	0.55	0.55
Telangana	5.78	0.90	1.14
Uttarakhand	3.37	2.90	2.90
Uttar Pradesh-W	n.a.	1.17	1.17
Uttar Pradesh-E	n.a.	3.62	3.62
Uttar Pradesh-T	n.a.	1.96	1.96
All states	**3.57**	**1.04**	**1.14**

Table 5. 17: State-wise weighted average transportation cost 'per quintal per km.' from farm to mill gate

States	Manual mode	Mechanized mode	Combined
Andhra Pradesh	2.89	2.48	2.63
Bihar	0.23	1.57	1.56
Haryana	n.a.	0.68	0.68
Punjab	n.a.	0.55	0.55
Telangana	5.78	0.90	1.14
Uttarakhand	n.a.	0.69	0.69
Uttar Pradesh-W	n.a.	0.89	0.89
Uttar Pradesh-E	n.a.	2.98	2.98
Uttar Pradesh-T	n.a.	1.54	1.54
All states	**3.54**	**0.97**	**1.07**

Table 5. 18: State-wise weighted average transportation cost 'per quintal per km.' from farm to purchase centre

States	Manual mode	Mechanized mode	Combined
Andhra Pradesh	4.37	n.a.	4.37
Bihar	0.82	1.28	1.26
Haryana	n.a.	1.13	1.13
Punjab	n.a.	n.a.	n.a.
Telangana	n.a.	n.a.	n.a.
Uttarakhand	3.37	4.03	4.02
Uttar Pradesh-W	n.a.	5.03	5.03
Uttar Pradesh-E	n.a.	7.47	7.47
Uttar Pradesh-T	n.a.	6.70	6.70
All states	**4.19**	**2.95**	**3.01**

Table 5. 19: State-wise average transportation cost per quintal per km. from Farm Gate to gur manufacturer and khandsari units

States	Gur manufacturer	Khandsari units
Andhra Pradesh	n.a.	n.a.
Bihar	1.04	2.28
Haryana	0.75	n.a.
Punjab	0.69	n.a.
Telangana	n.a.	n.a.
Uttarakhand	1.03	n.a.
Uttar Pradesh-W	2.33	2.93
Uttar Pradesh-E	2.81	n.a.
Uttar Pradesh-T	2.38	2.93
All states	**1.07**	**2.77**

Note: Only mechanized modes are used for transportation to gur manufacturer and khandsari units.

5.6 Problems and perceptions of farmers- Transportation related

Andhra Pradesh

- Even after the transportation contract, the farmers are, traditionally, bound to give the tip (beta) to the drivers of Rs.300/- to 500/- per load for transportation charges.

Haryana

- Transportation of sugarcane is mechanized in Haryana mostly through tractor and trolley.
- Most of the farmers prefer to sell their crop at mill gate to save the 'extra' amount payable as transportation charges from purchase centre to mill gate.

Punjab

- The farmers face long waiting period for selling sugarcane at the sugar mills. It extends up-to 2 to 3 days during peak season.

- Farmers also reported bearing of extra charges on hiring JCB machines if the trolley gets overturned enroute to sugar mill or if it gets stuck in the sludge, farmers have to hire higher HP tractor to pull it out. There was no provision of any compensation for these extra charges which were quite common during the transportation of cane to sugar mills.

Tamil Nadu

- Farmers are subjected to pay a customary tip (bata) to the transportation driver from each field, irrespective of the volume of yield or status of payment to the farmer from the company. Neither the contract agent nor the company would deal with this tip which is forced on the farmers.

Telangana

- The tradition of paying tips is common in the state. This is other than the actual cost of transportation. A separate tip for transportation is usually Rs. 400/- to Rs. 500/- per load and increases after the summer season starts.

Uttarakhand

- Farmers selling directly at mill gate usually have to face long waiting hours (sometimes days) due to various issues, slow processing at mill gate, traffic jams, factory break down etc., this cost them heavily in term of time and money loss.

Chapter 6: Sugar mills: Information, capacity and cost factors

6.1 Basic information on sugar mills

The harvesting and transportation cost of sugarcane is closely associated with the sugar mill's operations. The sugar mills sometimes are directly involved in the harvesting and transportation operations. The mills also establish the sugarcane purchase centres near the village/cluster of villages to procure the sugar to be further processed to the sugar mills. The mills manage the transfer of sugarcane stored at the purchase centres to the mill gates. The sugar mill usually bears the transportation cost of sugarcane from the purchase centre to the mill gate initially, and the partial or full share of this cost is deducted from the final settlement of the payments made to the farmers. The mills also take the help of transport companies if they do not have own logistic or transfer mechanism.

In this process, often the mills also incurred the loss if the mills have to establish the purchase centres in the villages or the around the cluster of villages which is at a far distance from the location of the mill. Such in case, if the other nearby mill is un-operational. This usually impacts the transportation cost of carrying sugarcane to the mill gate, hence they have an additional burden. Sometimes, the mills also do not wish to entre in the peripheral operations such as harvesting, because it impacts the focus of their business from the sugar processing. Many mills are also facing the problems of deteriorating infrastructures. This all make them the higher cost of sugarcane processing, hence, impact the recovery rate.

Advantages and vice-versa disadvantages due to political intervention, blames to help influencing farmers-large farmers, delays in making payment of long pending dues to the farmers etc. are the other factors those impact the working and performance of the sugar mills. Updating the sugar mills with the latest available technology and infrastructure, providing them the optional means of revenue generation – such as ethanol processing facilitation and licencing, improved logistic and administrative support etc. are some of the supportive mechanisms those can boot the performance of sugar mills.

The study includes 29 sugar mills spread across 20 districts in 8 study states (Table 6.1).

Table 6. 1: List of mills in the study states and their type (2018-19)

State	District	S.N.	Name of Mill	Type
Andhra Pradesh	Krishna	1	Kcp Sugar & Industries Corporation Limited, Vuyyuru, Krishna District, Andhra Pradesh-521165, Chief Operating Officer -08676-232001/02	4
	Krishna	2	Kcp Sugar & Industries Corporation Limited, Lakshmipuram, Krishna District, Pin - 521131, Chief Operating Officer -08671-222046	3
	Visakhapatnam	3	The Chodavaram Co-Operative Sugara Limited, Chodavaram, Visakhapatnam District, Andhra Pradesh, Chief Agricultural Officer -08978881242	3
Bihar	East Champaran	4	Hpclbio-Fuels Ltd,Sugauli,Motihari. G.M - Sri Sukhwinderjeet Singh Babbar, Mob - 8847689121 / 941713981	4
	West Champaran	5	Hpclbio-Fuels Ltd, Lawriya, Bettiah, Bihar. G.M - Shri Anil Kumar Singh, Mob - 9412856734	4
	West Champaran	6	Magadh Sugar &Energy Ltd, New Swadeshi Sugar Mills, Narkatiaganj, Bettiah, Bihar. Shri Parmood Gupta (V.P.) - Mob - 9837434313	4
	West Champaran	7	Harinagar Sugar Mills Ltd, RamnagarBettiah. Abhay Kumar Jha, Cane Development Officer, Mob - 7766917348	4
	West Champaran	8	Tirupati Sugar Ltd. Bagaha, Bettiah, Bihar. Shri B.N Tripathi, Agm(Care), Mob - 6204343604	3
	West Champaran	9	Manjlanlia Sugar Industry Pvt Ltd, ManjlanlaiBettiah (West Champaran). Shri P.N Singh, Mob - 9771475118	2
Haryana	Yamunanagar	10	Saraswati Sugar Mills Ltd., Yamunanagar, Hr. Rajendra Kaushik, Dgm-9728100804	1
	Kurukshetra	11	Shahabad Co-Operative Sugar Mills Ltd. Shahabad, Hr. Jasminder Singh, Cm-9466114107	2
Punjab	Amritsar	12	M/S Rana Sugars Limited Butter SeviyanSantokh Singh, Vice President Mobile: 9815900933	3
	Gurdaspur	13	The Gurdaspur Coop Sugar Mills Paniar, Gurdaspur Phone No. 01875220904	1
	Hoshiarpur	14	A B Sugars Limited, Village: Randhawa, Po: Panwan, Teh: Dasuya, Distt: Hoshiarpur, Phone: 0183503516	4
	Hoshiarpur	15	Indian Sucrose Limited, G T Road, Mukerian, District: Hoshiarpur	1
Tamil Nadu	Erode	16	Sakthi Sugar Mills Limited, Sakthi Nagar, Erode (Dgm)	4
	Viluppuram	17	Chengalrayan Cooperative Sugar Mill Ltd. Periyaselvalai (Dgm)	3
Telangana	Medak	18	Ganapathi Sugar Industries Limited, Fasulibai, Sangareddy-502001, G.DayakarReddy (G.M Cane)-9949556915	3
	Hyderabad	19	Gayatri Sugars Limited, Kamaredy, Telangana, Gm Contact No-9440800573	3
	Nizamabad	20	Gayatri Sugars Limited, Kamaredy, Magi,Telangana,G M Contact No-9440802578	2
Uttarakhand	Haridwar	21	Uttam Sugar Mills Ltd. Roorkee, Haridwar, Uk-247656. Anil Singh, Agm (Cane)-9760092736	4
	Haridwar	22	Rai Bahadur Narain Singh SugarmillLuksar. Haridwar, Uk. Suresh Kumar Sharma, Sdgm (Cane)-9837781693	4
	Udham Singh Nagar	23	The Bazpur Co-Operative Sugar Factory Ltd. Bazpur, U.S. Nagar, Uk-262401. Sachin Singh-9690017101	2
	Udham Singh Nagar	24	Kichha Sugar Company Ltd. Kichha, U.S.N., Uk-263148. Dr. V V Yadav, Cm, 9412412665	1
Uttar Pradesh (West)	Bijnor	25	KisanSahkariChini Mills Ltd., Sneh Road Najibabad, District Bijnor (U.P.) Pin Code-246763, Phone: 01341-255410	2
	LakhimpurKheri	26	DcmShriram Ltd Sugar &Distellery Unit Ajbapur, LakhimpurKheri – 8756991822, R C Chaudhry Jt. Manager	2
	LakhimpurKheri	27	BalrampurChini Mills Ltd Unit KumbhiVill.P.O. Khumbhi, Tehseel Gola Gokarrannath Dist. Lakhimpur, UP	1
Uttar Pradesh (East)	Kushinagar	28	TriveniEngeering& Industries Ltd. Ramkola, Kushinagar	1
	Ayodhya	29	K.M. Sugar Mills Ltd,Motinagar, Ayodhya, Uttar Pradesh	4
Note: Code for 'type of mill': Sugar-1; Sugar + Distillation-2; Sugar + Cogen – 3; Sugar+ Distillation + Cogen - 4.				

Out of these 29 mills, 6 mills are only sugar mills, 6 mills are sugar mills and having distillation facility, 7 mills having sugar production and cogeneration facilities, 10 having sugar production, distillation and cogeneration facilities.

6.2 Installed capacity, capacity utilization and recovery rate

Overall, for the study states as a whole, the surveyed 29 mills having the total installed capacity of about 178.95 '000 Tonnes with a capacity utilization rate of above 84 % in year 2018-19 (Table 6.2, Appendix 1- Table A1.12). During the operational period, of the total cane crushed by these sugar mills, a recovery rate of about 10.84% is achieved. Overall, the mills operated during 4 and half month period. The mills in the west Uttar Pradesh performed best in terms of recovery rate (average recovery rate 12.41%) and mills in Tamil Nadu performed the worse in this respect (average recovery rate of 8.96%). On combined basis, of the total sugarcane received by the mills from the farmers, nearly 80% is received at the mill gate (Table 6.3, Appendix 1- Table A1.13). Rest 20 % is received at the purchase centres.

Table 6. 2: Installed capacity, capacity utilization and recovery rate of sugar mills

State	Capacity (TCD)	Capacity Utilization (%)	Cane Crushed (000' T)	Sugar Production (000' T)	Sugar Extraction rate (%)	Days utilized
Andhra Pradesh	15500.00	78.55	1661.57	158.01	9.51	107
Bihar	39500.00	85.10	5553.61	584.44	10.52	141
Haryana	15000.00	91.64	2356.20	265.30	11.26	157
Punjab	21000.00	93.96	3611.91	363.87	10.07	172
Tamil Nadu	16000.00	34.70	1439.08	128.90	8.96	90
Telangana	11500.00	100.0	1324.69	149.49	11.29	115
Uttarakhand	23850.00	78.67	2646.90	292.50	11.05	111
Uttar Pradesh - W	21500.00	91.60	3603.89	447.14	12.41	168
Uttar Pradesh - E	15100.00	80.56	2058.04	239.65	11.64	136
Uttar Pradesh - T	36600.00	87.59	5661.93	686.78	12.13	155
All states	178950.00	84.35	24255.89	2629.29	10.84	136

Table 6. 3: Sugarcane received by the farmers at the mill gate and mill purchase centres

State	Cane from farmers ('000 T)	Cane received at Gate (%)	Cane received at Centre (%)
Andhra Pradesh	1661.57	95.82	4.18
Bihar	5553.61	77.92	22.08
Haryana	2356.20	69.09	30.91
Punjab	3611.91	100.00	0.00
Tamil Nadu	1439.08	100.00	0.00
Telangana	1324.69	100.00	0.00
Uttarakhand	2646.90	54.57	45.43
Uttar Pradesh - W	3603.89	67.46	32.54
Uttar Pradesh - E	1228.74	84.15	15.85
Uttar Pradesh - T	5661.93	71.52	28.48
All states	24255.89	80.05	19.95

The total sugarcane received at mill to farmer's ratios are worked out (Table 6.4, Appendix 1- Table A1.14). Overall, of the total number of farmers disposed sugarcane, nearly 58% brought sugarcane to mill at the rate of nearly 33.7tonnes of sugarcane per farmer. At mill gate, the sugarcane received per farmer is about 17tonnes per farmer by nearly 42% farmers in the covered states.

Table 6. 4: Sugarcane received at the mill gate and mill purchase centres – per farmer

State	Farmer (%)		Sugarcane (tonnes per farmer)	
	Farmers at mill gate	Farmers at p. centre	Sugarcane at mill gate	Sugarcane at p. centre
Andhra Pradesh	96.8	3.17	37.0	49.3
Bihar	37.4	62.6	55.7	9.4
Haryana	69.5	30.5	74.1	75.7
Uttarakhand	41.0	59.0	34.2	19.8
Uttar Pradesh - W	64.8	35.2	27.1	24.1
Uttar Pradesh - E	77.1	22.9	14.4	13.2
Uttar Pradesh - T	71.1	28.9	20.0	19.7
Covered states	57.7	42.3	33.7	17.0

Note: computation excludes mills in Punjab, Telangana and Tamil Nadu due to missing information.

6.3 Transportation cost borne by Sugar Mills

Overall, in the five covered states includes two regions in Uttar Pradesh, the sugar mills have established nearly 700 purchase centres. The weighted average distance at the state level in worked out at nearly 27 km (Table 6.5, Appendix 1- Table A1.15).Uttar Pradesh as a whole and Uttarakhand reported the highest number of purchase centres established by the covered mills, 246 and 231, respectively. This is followed by Bihar (153 centres) with the average distance of nearly 18.4 km, least among the covered states. The average distance of the purchase centres established by the mills visited is observed nearly 32.5 km, highest among the covered states. In Uttar Pradesh this weighted distance is nearly 29.3 km, mainly contributed by eastern region, where the purchase centres of the covered mills are located at an average distance of 37.8 km. Tractor trolleys and trucks are used as preferred mechanised mode of transportation for carrying sugarcane from purchase centre to sugar mill gate.

The weighted average cost of transportation borne by the sugar mills to transport sugarcane from these purchase centres to its mill gate is nearly Rs. 16.83 per quintal, on overall basis. At the state level, the cost is ranging from Rs. 15 per quintal (lowest in Andhra Pradesh, based on only one sugar mill) to Rs. 19.55 per quintal (highest in Haryana). In all other states, the cost is ranging close to Rs. 16 per quintal. Eastern Uttar Pradesh reported a high cost of Rs. 20.59 per quintal. This makes the average cost of transportation at Rs. 16.46 per quintal in Uttar Pradesh. The

weighted transportation cost on per quintal per kilometre is worked out and this is ranging from Rs. 0.50 per quintal per kilometre (lowest in Uttarakhand) to Rs. 0.89 per quintal per kilometre (highest in Bihar), contribute to Rs. 0.62 per quintal per kilometre as weighted transportation cost on overall basis by combining all mills in different covered states.

Table 6. 5: State-wise weighted average transportation cost borne by mills (Mechanized mode)

State	No of Purchase Centers	Average Distance Purchase Centre to Mill Gate (km)	Transportation Cost from Purchase Centre to Mill Gate (Rs/qtl)	Transportation Cost from Purchase Centre to Mill Gate (Rs/qtl/km)
Andhra Pradesh	8	21.00	15.00	0.71
Bihar	153	18.39	16.37	0.89
Haryana	62	26.96	19.55	0.73
Uttarakhand	231	32.48	16.17	0.50
Uttar Pradesh - W	148	26.15	14.91	0.57
Uttar Pradesh - E	98	37.80	20.59	0.54
Uttar Pradesh - T	246	29.33	16.46	0.56
Covered states	700	26.94	16.83	0.62

Note: In Andhra Pradesh, the cost of transporting sugarcane is only reported for one mill in Visakhapatanam district. In Punjab, Telangana and Tamil Nadu, all the farmers are transporting sugarcane to the mill gate.

Harvesting cost borne by sugar mills

In addition to the transportation cost, in some states the sugar mills also involved in the harvesting operations. The harvesting cost incurred by the sugar mills is nearly Rs 33 per quintal in Hyderabad district in Andhra Pradesh. In Tamil Nadu, the cost is Rs 44 to Rs 48 per quintal for mechanized harvesting and Rs 56 to Rs 68 per quintal for manual harvesting. In Andhra Pradesh the cost is comparatively high, nearly Rs 60 per quintal for mechanized harvesting and Rs 80 per quintal for manual harvesting. The extent of trash is comparatively low in manual mode of harvesting (about 1% to 6%), whereas this in mechanised mode of harvesting is about 5% to 12%.

Table 6. 6: Harvesting cost of sugar mills - Reported cases

State	District	Mill S. no.	Mode of Harvesting ('000 T)		Average Cost (Rs/qtl)		Extent of Trash (%)	
			Manual	Mechanized	Manual	Mechanized	Manual	Mechanized
Andhra Pradesh	Krishna	1	896.6	5.9	80.0	60.0	5%	10%
	Krishna	2	278.1	1.9	82.0	60.0	5 to 6 %	10 to 12 %
Tamil Nadu	Erode	16	858.2	26.5	67.7	47.5	1%	5%
	Viluppuram	17	54.3	42.1	56.3	43.7	2%	4%
Telangana	Hyderabad	19	385.9	43.4	n.a.	33.0	1%	5%
	Nizamabad	20	297.7	62.8	n.a.	n.a.	1%	5%

Note: n.a. indicates not available.

6.4 Problems and perceptions of sugar mills

Bihar

- No prompt sugar sale – due to competition with foreign sugar, brought in raw form and after refining sold in domestic market by violating the rules of the land.
- Due to sugar sale problem, enhancement in capacity utilization is difficult, despite the sugar industry being the utmost of public interest.

Haryana

- Due to the lower prices of sugar in market, and high maintenance charges, the sugar mills are reporting losses.
- Sugar mills looking for government support to upgrade their outdated machines (mostly cooperative) to increase crushing capacity as they are not able to meet demand for crushing.
- Sugar mills going through huge pressure of crushing sugarcane because there is only one sugar mill per district in sampled districts.
- The mills are looking for licenses to make any other by-product from sugarcane and to sell those in the market. This will increase their revenue and will help to manage maintenance cost.
- The mill's efficiency improves and recovery rate increases, if the sugarcane is of high juice content. Hence, they suggest government and agriculture departments to make long term plans to increase productivity by using high-yielding varieties, improved technologies, and timely operations.

Tamil Nadu

- Due to economic stringency of the sugar processing units in the state as a result of various government policies, many of such units are at the verge of shutting down or staring at a financial crisis.
- Too much of government intervention in the sugarcane sector is making disturbances in the processing sector and profitability is declining year by year.
- Processing units report that there is popular misconception about sugar processing that it is chemical intensive and hazardous to health. Thereby there is a diversion of regular sugar consumption (mill processed) to indigenous sugar consumption (*Nattu Chakkarai*). In fact,

the local sugar processing (*Nattu Chakkarai*) involves a lot of hazardous chemical directly in the making and the mill processing of sugar is the most scientifically processed sugar, containing less health hazardous content due to precision in treating.

Uttarakhand

- The mills face the extra burden of storage and transportation of sugarcane from far distances due to non-operational status of nearby mills.
- The infrastructure of the mills, especially co-operative sugar mills is not up-to the mark and incapable to meet the current operations. Few pictures of Bazpur Co-Operative Sugar Factory, Bazpur, Uttarakhand are placed in Appendix 4 as an example.

Chapter 7: Summary, Conclusions and Policy Implications

Summary and conclusions

In India, the sugarcane production has increased at 2% per annum from 2001-02 to 2015-16 but this has almost stagnated in recent years. The area and productivity of sugarcane crop have also been increasing at 1%, but there is not much acceleration in these growth rates during last one and half decades. Measures are needed to improve productivity through adoption of high yielding varieties and by improved adoption of technologies for efficient harvesting, timely supply to the mill and improve the sugar extraction rate. The use of digital techniques and time bound operations in unbiased manner can play a major role. This will be beneficial, especially to small and marginal farmers. The time bound digital means of payment will ensure farmers to stay in sowing the crop and help them to buy inputs for timely sowing and harvesting operations for next season.

The secondary data analysis suggests that the consumption of white sugar is increasing at a rate of about 3 % annually during 2001-02 to 2015-16 and about 1.5 % in per capita terms. The consumption of gur and khandsari products is declining at almost the same rate (-3%). The average capacity of sugar industry on per day basis witnessed a growth of 1.5 % during 2001-02 to 2015-16, which is comparatively very low for the recovery rate of sugar to improve. Usually during peak season, the farmers also wish to harvest and supply the crop to the mill on time. The juice content capacity of sugarcane also dries down if the harvested crop is pending for two or more days to enter the mill gate. This is actually the loss of everyone. Again, the technological advancement of the mill infrastructure as well as easing the process of sugarcane delivery at the mill gate, both, can lead to better recovery of sugar from the crop. The recovery rate is stagnant at 10%-10.5% during 2001-02 to 2015-16.

The improvement in production of sugarcane molasses is a positive sign. Further, the announcement to increase in the purchase price of ethanol prepared from different categories of molasses for blending with gasoline; and fixing reasonable transportation charges by OMCs for long distance transportation of ethanol are again some boosting steps in the direction to make sugar mills and sugar industry self-surviving. This makes the balance in production of sugar and by-

products. The timely outlooks in this regard along with estimates of sugarcane production will together facilitate the decision making for various policy making.

The sugarcane area in some of the major producing states, especially in southern states such as - Andhra Pradesh (7%), Karnataka (1%), Maharashtra (3%), Tamil Nadu (9%) and Telangana (4%) has declined during 2010-11 to 2017-18. The reason for this is not clear and more research is needed into this issue. The distress among the farmers in receiving late payments and the emerging water scarcity needs to be tackled in this regard. Gujarat, Karnataka, Tamil Nadu and Telangana states also witnessed a decline in productivity during same period of nearly 2% or more.

In the study states, almost 72% of the household farms are located within the range of 2 km (average distance 0.84 km) from the village centre. 20% of farms are located between 2 km to 4 km (average distance 2.36 km) from village centre and only 9% of farms are located above 4 km distance (average distance 8.25 km) from village centre. About 93.2% of the total cropped area and 96.3% of area under sugarcane crop is irrigated. In the sample region, about 59% of the total area is under sugarcane. All categories of farmers have access to irrigation. Marginal and small farmers, of their total land, have nearly 82% area under sugarcane crop (compared to large farmers, 55%), this shows sugarcane is also a preferred crop for sowing among marginal farmers.

Nearly 98% of total production is sold by farmers. Of the total sold quantity, about 86% transported directly to the sugar mill gates, nearly 10% is transported to the purchase centres, less than 4% is sold to the local gur manufacturers and just 0.1% is sold to the khandsari units. This shows, irrespective of a delay in payments and other issues that the farmers have with sugar mills, they still prefer (or due to lack of other options) to sell to the sugar mills.

Harvesting and transportation operations

Overall, nearly 53% households are practicing harvesting on ‘daily-wage’ basis and about 47% prefer contract based harvesting. The average cost of self-arranged ‘daily-wage’ harvesting which also includes loading is nearly Rs. 37 per quintal when imputed cost of family labour is considered. Across the farm classes, the cost varies from Rs. 36 per quintal (marginal farmers) to Rs. 40.5 per quintal (large farmers). Of the total labour used per household, the ratio of casual labour to family labour is nearly 10 is to 1. Three-fourth of all labours used are male with an average wages nearly double compared to female labour used. Various other costs, which cannot

be directly measured, are involved in harvesting. These costs vary across states and depend upon the labour arrangements in the villages, ticketing support for their arrival and departure, food arrangements, tea and snacks arrangements on daily basis, LPG gas cylinder and stove, liquor, pan supari, costs of various tips from time to time etc. All these arrangements usually inflate the cost of harvesting. On the other hand, the cost of harvesting on 'contract' basis is almost Rs. 45 per quintal, ranges from Rs. 38 to Rs. 64 per quintal across states.

There are various problems associated with the harvesting operations reported by the farmers. Shortage of labour is one such serious problem. It is very difficult to arrange labour, especially during peak season and labour demands high wages during shortage time and during summer seasons if harvesting gets delayed. Farmers do not prefer harvesting of sugarcane using machines because of sowing norms and also because the structure of fields in many parts of the country does not allow this. Another major problem reported by farmer is delay in payments, sometimes more than a year. This delay in payments impacts farmer's capacity to grow crop in next season. Being a perennial crop, the farmers don't have many options to switch the cropping pattern. This also delays the harvesting operations and hence delays the sowing of next season crop and dents farmer's profits.

Farmers prefer early seasonal opening of sugar mills and late closing. Penalty may be imposed on the farmer for bringing over loaded trolley to the mill or purchase centre and also on the mill if the mill is unable to manage the produce brought to the mill gate in the allotted time, except under exceptional circumstances. The farmers allege that the sugar mills deliberately delay providing dispatch slips to them, so that they are forced to deliver mature crop with high sugar juice content to the mill. Farmers also reported biased distribution of purchase slips by the mills in favour of large farmers or politically well-connected people. Farmers demanded subsidy for popular fertilizers and pesticides, directly or channelled through sugar mills. There are some incidences of exploitation of farmers by the middlemen such as labour contractors or truck drivers. In some states farmers suggested to include sugarcane crop in PMFBY. At the same time, having bad experience of scheme implementation, they expect some guaranteed return in case of crop loss.

Mechanised mode, mainly the tractor trolley, is the most preferred mode of transportation in almost all the study states for medium to long distances, above 14 km. Of the total quantity sold,

91% is transported using the mechanized mode. Above 90% to the sugar mill and purchase centre, and whole of the quantity transported to the gur manufacturer and to the khandsari units is transported through mechanised mode. Manual cart is used for shorter distances, below 5 km. Southern states (Andhra Pradesh and Telangana) used the manual cart most. Nearly 86% farmers disposed their produce at the sugar mill or its purchase centres.

The average cost of transporting sugarcane to mill gate borne by farmers is Rs. 16 to 17 per quintal, and this is nearly Rs. 11 per quintal for disposing sugarcane at the purchase centre. The cost is worked out just above Rs. 1 per quintal per kilometre. The cost is observed high in Andhra Pradesh and Telangana for using manual modes as the carts have to make multiple rounds in a day. The main components of cost considered are - fuel cost and the driver and labour cost. The sugar mills use only mechanised mode for transporting sugarcane from purchase centres to mill gate, the average distance covered is nearly 27 km. The average cost incurred by the sugar mills is nearly same as borne by the farmers, Rs. 16 to 17 per quintal (Rs. 0.62 per quintal per kilometre).

Problems involved in transportation are - long waiting time in queues at mill gates due to reasons such as slow processing at mill gate, traffic jams, factory break down etc., These delays cost them heavily in terms of time and money. Extra cost bearing by farmers for any minor and major incidence during transportation - such as trolley overturned, trolleys getting stuck in the sludge are also not uncommon. Farmers are required to pay a customary tip (beta) to the transportation driver from each field basis or trip basis, especially in southern states. Engagement of the skilled manpower, especially with the managerial skills such as operational research, queuing models and digital tracking of transportation operations at the sugar mill level will help farmers as well as mills to save transportation cost and time of sugarcane, reduce long waiting time and enhance recovery of sugar due to timely processing of harvested sugarcane.

The problems faced by sugar mills (mostly cooperative) include lack of government support to upgrade their outdated machinery. Many such mills are dealing with deteriorating infrastructure and hence causing dent on their margins due to reduced capacity. Some such units are on the verge of closure or staring at a financial crisis due to economic stringency of the sugar processing units. The mills face the extra burden of storage and transportation of sugarcane from far-off distances due to non-operational status of nearby mills. The sugar mills also need support

in the form of facilitation with licenses to make other by-products from sugarcane to increase their revenue and improve their viability.

Policy Implications

- Measures are needed to improve technological adoption and up-gradation in procurement, transportation and processing of sugarcane by the mills. Emphasis should be on digital tracking of such operations, ensuring unbiased and timely distribution of dispatch slips without human interface to farmers by the mills for harvesting and transporting produce to mill/purchase centre in time bound manner. Ensure timely payment of dues online on farmer's account.
- Wherever possible, include sugarcane harvesting and transportation operations under the mill's jurisdiction for efficient and unbiased processing.
- Facilitate the sugar mills with licenses to make by-products from sugarcane to increase their efficiency and revenue to manage maintenance cost. Sugar mills need to be helped to upgrade deteriorating infrastructure.

***

References

- Arjona, E., Bueno, G., & Salazar, L. (2001). An activity simulation model for the analysis of the harvesting and transportation systems of a sugarcane plantation. *Computers and electronics in agriculture*, *32*(3), 247-264.
- CACP (2019-20). Price Policy for Sugarcane- The 2019-20 Sugar Season. The Commission for Agricultural Costs & Prices. Ministry of Agriculture and Farmers Welfare. https://cacp.dacnet.nic.in/KeyBullets.aspx?pid=41
- CACP (2020-21). Price Policy for Sugarcane- The 2020-21 Sugar Season. The Commission for Agricultural Costs & Prices. Ministry of Agriculture and Farmers Welfare. https://cacp.dacnet.nic.in/KeyBullets.aspx?pid=41
- Cardoen, D., Joshi, P., Diels, L., Sarma, P. M., & Pant, D. (2015). Agriculture biomass in India: Part 2. Post-harvest losses, cost and environmental impacts. *Resources, Conservation and Recycling*, *101*, 143-153.
- Chetthamrongchai, P., Auansakul, A., & Supawan, D. (2001). Assessing the transportation problems of the sugar cane industry in Thailand. *Transport and Communications Bulletin for Asia and the Pacific*, *70*(2001), 31-39.
- da Silva, A. F., Marins, F. A. S., & Dias, E. X. (2015). Addressing uncertainty in sugarcane harvest planning through a revised multi-choice goal programming model. *Applied mathematical modelling*, *39*(18), 5540-5558.
- de Oliveira Florentino, H., Irawan, C., Jones, D. F., Cantane, D. R., &Nervis, J. J. (2018). A multiple objective methodology for sugarcane harvest management with varying maturation periods. *Annals of Operations Research*, *267*(1-2), 153-177.
- Díaz, J. A., & Perez, H. G. (2000, December). Simulation and optimization of sugar cane transportation in harvest season. In *2000 Winter Simulation Conference Proceedings (Cat. No. 00CH37165)* (Vol. 2, pp. 1114-1117). IEEE.
- Dines, G., McRae, S., & Henderson, C. (2012). Sugarcane harvest and transport management: A proven whole-of-systems approach that delivers least cost and maximum productivity. In *Proceedings, Australian Society of Sugar Cane Technologists, 34th Conference*.
- Financial express (2018),*Maharashtra cane farmers protest high harvesting, transportation bills*, by Nanda Kasabe, July 7, 2018
- Gentil, L. V. B., &Ripoli, T. C. (1977). Analysis and simulation of sugarcane transport, reception and mechanical harvesting systems. *Journal of American International Society for Sugar Cane Technologists*, *16*(2), 2093-2103.
- Giles, R. C., Bezuidenhout, C. N. &Lyne, P.W.L. (2005). A simulation study on cane transport system improvements in the Sezela mill area. In *Proc S African Sugarcane Technology Association* (Vol. 79, p. 402).
- Gomez, A. L., Cobo, D. F., Castro, P. W., & Isaacs, C. H. (2010). Improvements to a sugarcane road transportation system. In *Proc. Int. Soc. Sugar Cane Technol* (Vol. 27).

- Harvest, T. V. I. A. S. (2006). Incorporation of sugarcane harvesting and transport variables into a sugarcane harvest and transport scheduling model. In *Proc S AfrSugTechnol Ass* (Vol. 80, p. 71).
- Higgins, A., & Davies, I. (2004). Capacity planning in a sugarcane harvesting and transport system using simulation modelling. In proceedings, Australian Society of Sugarcane Technologists. (pp. 16-16). PK Editorial Services; 1999.
- Higgins, A., 2004. Australian sugar mills optimise siding rosters to increase profitability. Annals of Operations Research, 128: 235-249.
- Higgins, A., Antony, G., Sandell, G., Davies, I., Prestwidge, D., & Andrew, B. (2004). A framework for integrating a complex harvesting and transport system for sugar production. *Agricultural Systems*, *82*(2), 99-115.
- Higgins, A., Laredo, L., 2006. Improving harvesting and transport planning within a sugar value chain. Journal of Operational Research Society, 57: 367-376.
- IISR (2011), Vision 2030, Indian Institute of Sugarcane Research, Lucknow, ICAR, India
- Kaewtrakulpong, K., Takigawa, T., Koike, M., Hasegawa, H., &Bahalayodhin, B. (2008). Mechanization for the improvement of the sugarcane harvesting and transportation system in Thailand. *Journal of the Japanese Society of Agricultural Machinery*, *70*(2), 51-61.
- Meyer, E. (1999). Improving performance and utilization to minimize machinery costs. In *Int. Soc. Sugar Cane Tech., Proceedings of the XXIII ISSCT Congress*, Vol. 11, pp. 155-163.
- Meyer, E., Domleo, K., Bliss, J., & Maher, G. W. (2000). Assessing the viability of a fully mechanised harvesting operation for a large sugarcane estate. In *Proc S AfrSugTechnol Ass* (Vol. 74, pp. 188-191).
- Moodley, S. (2011). *An Investigation Into Sugarcane Vehicle Loading with Respect to Influences on Overall Transport Efficiency* (Doctoral dissertation, University of KwaZulu-Natal, Durban).
- Neungmatcha, W., &Sethanan, K. (2015). Optimal mechanical harvester route planning for sugarcane field operations using particle swarm optimization. *Engineering and Applied Science Research*, *42*(2), 125-133.
- Ramos, R., Isler, P., de Oliveira Florentino, H., Jones, D., &Nervis, J. (2016). An optimization model for the combined planning and harvesting of sugarcane with maturity considerations. *African Journal of Agricultural Researchj*, *11*(40), 3950-3958.
- Rao, A.S. (2014). Input use and cost of cultivation of sugarcane–A study in Telangana region of Andhra Pradesh. *Journal of Economics and Finance*, *5*(5), 67-74.
- Rout, R.K., L.K. Das, S. Behera, A.K. Padhiary, N.R. Mohapatra and Ranasingh, N. 2017. A Comparative Analysis in Cost and Returns of Sugarcane Production in Odisha, India. *International Journal of Current Microbiology and Applied Sciences* 6(11): 3827-3839.
- Salassi, M. E., & Barker, F. G. (2008). Reducing harvest costs through coordinated sugarcane harvest and transport operations in Louisiana. *Journal Association Sugar Cane Technologists*, *28*, 32-41.

- Santoro, E., Soler, E. M., & Cherri, A. C. (2017). Route optimization in mechanized sugarcane harvesting. *Computers and Electronics in Agriculture*, *141*, 140-146.
- Saravanamoorthi, P., &Navaneethekumar, V. (2012). A Mathematical Model in Reduction of Cost on Transportation of Sugarcane and the Loss Due To the Accident in Transportation. *Journal of Applied and Computational Mathematics*, *1*(3).
- Shroff, S. and Kajale, J. 2014. Sugar Sector: Is It Sustained by Subsidies? *Indian Journal of Agricultural Economics*, 69(3): 375- 384.
- Singh, G., &Abeygoonawardana, K. A. R. (1982). Computer simulation of mechanical harvesting and transporting of sugarcane in Thailand. *Agricultural systems*, *8*(2), 105-114.
- Singh, S., Singh, P. R., Singh, A. K., & Gupta, R. (2016). Present status and future need of mechanizing sugarcane cultivation in India. *Agricultural Mechanization in Asia, Africa and Latin America*, *47*(1), 75-81.
- Sugar Research and Development Technical Report (2006), The Value Chain of the Australian Sugar Industry- Development in the period 1970-2005 and future opportunities, Australian Government. ISSN 1327-9475.
- The Hindu (2018), *Mechanisation of sugarcane farming only way forward*, say experts, June 02, 2018.
- Upreti, P and Singh, A. (2017), An Economic Analysis of Sugarcane Cultivation and its Productivity in Major Sugar Producing States of Uttar Pradesh and Maharashtra, *Economic Affairs*, Vol. 62, No. 4, pp. 711-718.

Appendix

Appendix 1

Table A1. 1: Area under sugarcane: Major states (in '000 Hectares)

STATES / UT	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
Uttar Pradesh	2125.0	2162.0	2212.0	2228.00	2140.80	2169.00	2160.00	2234.00
Maharashtra	965.0	1022.0	933.0	937.00	1030.00	987.00	633.30	902.00
Karnataka	423.0	430.0	425.0	420.00	480.00	450.00	397.00	370.30
Bihar	248.0	218.3	250.3	258.07	254.34	244.02	239.57	233.77
Gujarat	190.0	202.0	176.0	174.00	208.00	157.00	169.00	182.00
Tamil Nadu	316.0	346.4	347.2	313.34	263.07	252.27	218.26	171.86
Haryana	85.0	95.0	101.0	102.00	97.00	93.00	102.00	114.00
Others	99.0	100.8	106.0	102.6	109.9	128.0	111.6	111.1
Andhra Pradesh	152	159	155	152.96	139.00	122.00	103.00	99.00
Madhya Pradesh	65.1	69.2	59.5	73.10	111.00	103.00	92.00	98.00
Punjab	70.0	80.0	83.0	89.00	94.00	90.00	88.00	96.00
Uttarakhand	106.7	108.0	109.9	104.26	101.72	96.85	93.00	90.00
Telangana	40.0	45.0	41.0	39.04	38.00	35.00	29.00	35.00
All India	4884.8	5037.7	4998.9	5095.93	5176.63	5055.11	4435.69	4848.20
12 States	4785.8	4936.8	4893.0	4890.8	4956.9	4799.1	4324.1	4625.9

Table A1. 2: Production of sugarcane: Major states (in '000 Tonnes)

STATES / UT	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
Uttar Pradesh	120545.0	128819.0	132427.7	134688.62	133061.42	145385.00	140169.20	177033.33
Maharashtra	81895.7	86733.1	69648.1	76901.00	84698.96	73679.55	52262.45	82984.00
Karnataka	39657.0	38808.0	35732.0	37905.00	43776.00	37833.75	27378.00	31135.19
Bihar	12763.6	11288.6	12741.4	12881.78	14034.12	12649.32	13036.00	13824.63
Gujarat	13760.0	12750.0	12690.0	12550.00	14330.00	11120.00	11950.00	12072.06
Tamil Nadu	34251.8	38575.7	33919.2	32454.14	28092.78	25494.09	18987.56	17153.98
Haryana	6042.0	6959.0	7437.0	7499.00	7169.00	6692.00	8223.00	9632.89
Others	5167.9	5776.2	5691.6	6088.8	6069.4	6062.9	5812.8	5949.6
Andhra Pradesh	11893	12842	11993	12008.78	9987.00	9353.00	7830.00	7789.62
Madhya Pradesh	2667.0	2677.0	2641.9	3173.67	4567.00	5281.00	4730.00	5430.00
Punjab	4170.0	5653.0	5919.0	6675.00	7039.00	6607.00	7152.00	8023.68
Uttarakhand	6497.6	6311.0	6784.8	5939.80	6165.07	5885.76	6477.00	6271.38
Telangana	3070.5	3843.5	3574.0	3376.22	3343.00	2405.00	2061.00	2604.46
All India	342381.6	361036.5	341199.7	358230.66	368402.19	354511.32	306069.00	385854.49
12 States	337213.7	355260.2	335508.1	346053.0	356263.4	342385.5	300256.2	373955.2

Table A1. 3: Yield of sugarcane: Major states (in Kg./Hectare)

STATES / UT	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
Andhra Pradesh	78247	80770	77374	78509	71849	76664	76019	78683
Bihar	51466	51714	50896	49916	55179	51837	54415	59138
Gujarat	72421	63119	72102	72126	68894	70828	44841	66330
Haryana	71082	73253	73634	73520	73907	71957	80618	84499
Karnataka	93752	90251	84075	90250	91200	84075	68962	84081
Madhya Pradesh	40968	38685	44401	43415	41144	51272	51413	55408
Maharashtra	84866	84866	74650	82072	82232	74650	82524	92000
Punjab	59571	70663	71313	75000	74883	73411	81273	83580
Tamil Nadu	108392	111378	97688	103575	106788	101059	86995	99814
Telangana	76763	85410	87171	86481	87974	68714	71069	74413
Uttar Pradesh	56727	59583	59868	60453	62155	67029	64893	79245
Uttarakhand	60896	58435	61736	56971	60608	60772	69645	69682
Others	52185	57295	53703	59358	55252	47373	52103	53536
All India	70091	71668	68254	70522	71511	70720	69001	80198
12 States	70461	71961	68570	70756	71872	71343	69437	80839

Table A1. 4: Demographic profile and Caste profile of the surveyed farmers - % distribution

States	Farm class	Demographic profile (%)			Caste profile (%)			
		Males	Females	Total	General	OBC	SC & ST	Overall
Andhra Pradesh	Marginal	50.0	50.0	100	45.8	37.3	16.9	100
	Small	57.1	42.9	100	50.0	44.4	5.6	100
	Medium	50.9	49.1	100	62.7	37.3	0.0	100
	Large	50.0	50.0	100	72.2	25.0	2.8	100
	Total	52.2	47.8	100	56.0	37.0	7.0	100
Bihar	Marginal	53.2	46.8	100	6.7	87.8	5.6	100
	Small	52.9	47.1	100	20.8	79.2	0.0	100
	Medium	53.4	46.6	100	18.5	74.1	7.4	100
	Large	54.4	45.6	100	20.0	77.1	2.9	100
	Total	53.3	46.7	100	14.0	82.0	4.0	100
Haryana	Marginal	65.7	34.3	100	87.5	12.5	0.0	100
	Small	51.9	48.1	100	72.4	27.6	0.0	100
	Medium	55.8	44.2	100	74.6	23.9	1.5	100
	Large	51.1	48.9	100	72.9	27.1	0.0	100
	Total	53.2	46.8	100	74.0	25.5	0.5	100
Punjab	Marginal	52.2	47.8	100	86.7	13.3	0.0	100
	Small	53.8	46.2	100	67.9	25.0	7.1	100
	Medium	50.6	49.4	100	81.8	12.1	6.1	100
	Large	52.7	47.3	100	90.1	9.9	0.0	100
	Total	52.1	47.9	100	84.0	13.0	3.0	100
Tamil Nadu	Marginal	54.7	45.3	100	4.2	91.7	4.2	100
	Small	48.3	52.1	100	0.0	73.4	26.6	100
	Medium	50.8	49.2	100	1.8	91.1	7.1	100
	Large	52.3	48.1	100	1.8	91.1	7.1	100
	Total	51.0	49.3	100	1.5	85.5	13.0	100
Telangana	Marginal	52.8	47.2	100	39.0	34.1	26.8	100
	Small	53.7	46.3	100	45.9	32.8	21.3	100
	Medium	53.8	46.2	100	58.7	33.3	7.9	100
	Large	50.0	48.2	100	68.6	31.4	0.0	100
	Total	52.9	46.8	100	52.5	33.0	14.5	100
Uttar Pradesh (overall)	Marginal	54.1	45.9	100	38.7	52.1	9.2	100
	Small	53.6	46.4	100	64.1	29.1	6.8	100
	Medium	57.9	42.1	100	70.4	24.1	5.6	100
	Large	48.8	51.3	100	75.0	25.0	0.0	100
	Total	54.3	45.7	100	51.5	40.8	7.8	100
Uttarakhand	Marginal	52.5	47.5	100	51.3	43.6	5.1	100
	Small	52.4	47.6	100	59.6	34.0	6.4	100
	Medium	51.5	48.5	100	78.0	14.0	8.0	100
	Large	52.2	47.8	100	84.0	16.0	0.0	100
	Total	52.2	47.8	100	64.0	30.5	5.5	100
All states	Marginal	53.4	46.6	100	36.5	53.9	9.6	100
	Small	53.0	47.0	100	46.4	43.3	10.3	100
	Medium	53.3	46.7	100	59.0	35.7	5.3	100
	Large	51.8	48.2	100	62.2	36.3	1.6	100
	Total	52.9	47.1	100	49.9	43.1	7.0	100

Table A1. 5: Education level of the Head of the sample households - % distribution

States	Farm class	Education of head: % distribution							
		Illiterates	Primary	Junior	High School	Intermediate	Graduate	Post graduate	Overall
Andhra Pradesh	Marginal	40.7	18.6	6.8	18.6	5.1	10.2	0.0	100
	Small	35.2	25.9	0.0	9.3	13.0	16.7	0.0	100
	Medium	19.6	19.6	5.9	29.4	13.7	9.8	2.0	100
	Large	25.0	16.7	5.6	16.7	13.9	16.7	5.6	100
	Total	31.0	20.5	4.5	18.5	11.0	13.0	1.5	100
Bihar	Marginal	5.6	10.0	21.1	15.6	21.1	13.3	13.3	100
	Small	2.1	6.3	27.1	6.3	29.2	10.4	18.8	100
	Medium	3.7	3.7	18.5	11.1	29.6	14.8	18.5	100
	Large	2.9	11.4	34.3	2.9	25.7	14.3	8.6	100
	Total	4.0	8.5	24.5	10.5	25.0	13.0	14.5	100
Haryana	Marginal	12.5	25.0	12.5	0.0	37.5	0.0	12.5	100
	Small	3.4	6.9	6.9	44.8	24.1	13.8	0.0	100
	Medium	6.0	10.4	16.4	35.8	17.9	11.9	1.5	100
	Large	0.0	9.4	10.4	31.3	17.7	25.0	6.3	100
	Total	3.0	10.0	12.0	33.5	19.5	18.0	4.0	100
Punjab	Marginal	0.0	6.7	20.0	13.3	40.0	13.3	6.7	100
	Small	14.3	7.1	21.4	32.1	21.4	3.6	0.0	100
	Medium	1.5	4.5	22.7	34.8	24.2	9.1	3.0	100
	Large	1.1	5.5	14.3	34.1	33.0	12.1	0.0	100
	Total	3.0	5.5	18.5	32.5	29.0	10.0	1.5	100
Tamil Nadu	Marginal	12.5	25.0	41.7	8.3	4.2	4.2	4.2	100
	Small	10.9	18.8	20.3	23.4	15.6	9.4	1.6	100
	Medium	3.6	8.9	26.8	33.9	5.4	17.9	3.6	100
	Large	5.4	14.3	16.1	32.1	14.3	16.1	1.8	100
	Total	7.5	15.5	23.5	27.0	11.0	13.0	2.5	100
Telangana	Marginal	46.3	4.9	7.3	14.6	14.6	12.2	0.0	100
	Small	37.7	13.1	13.1	23.0	4.9	8.2	0.0	100
	Medium	25.4	7.9	6.3	36.5	14.3	6.3	3.2	100
	Large	11.4	2.9	8.6	37.1	22.9	14.3	2.9	100
	Total	31.0	8.0	9.0	28.0	13.0	9.5	1.5	100
Uttar Pradesh (Overall)	Marginal	18.9	36.4	19.8	8.3	5.5	8.3	2.8	100
	Small	11.1	17.9	11.1	22.2	16.2	15.4	6.0	100
	Medium	5.6	13.0	14.8	20.4	16.7	18.5	11.1	100
	Large	0.0	16.7	0.0	16.7	33.3	25.0	8.3	100
	Total	14.3	27.3	16.0	14.3	11.0	12.3	5.0	100
Uttarakhand	Marginal	14.1	24.4	23.1	14.1	11.5	10.3	2.6	100
	Small	4.3	10.6	29.8	27.7	19.1	6.4	2.1	100
	Medium	12.0	24.0	16.0	14.0	14.0	14.0	6.0	100
	Large	4.0	12.0	16.0	36.0	24.0	4.0	4.0	100
	Total	10.0	19.5	22.0	20.0	15.5	9.5	3.5	100
All states	Marginal	19.5	24.2	19.0	12.0	11.1	9.8	4.3	100
	Small	15.6	15.0	15.4	21.9	16.7	11.4	4.0	100
	Medium	9.9	11.5	15.9	28.8	16.4	12.4	5.1	100
	Large	4.9	9.8	13.7	28.5	22.5	16.6	3.9	100
	Total	13.1	15.8	16.2	22.1	16.2	12.3	4.3	100

Table A1. 6: Distance of farm from village centre (% of farmers reported)

States	Farm class	0 - 2 km	2 km - 4 km	4 km above
Andhra Pradesh	Marginal	66	22	12
	Small	69	22	9
	Medium	63	35	2
	Large	58	33	8
	Total	65	28	8
Bihar	Marginal	99	0	1
	Small	100	0	0
	Medium	100	0	0
	Large	100	0	0
	Total	100	0	1
Haryana	Marginal	100	0	0
	Small	72	28	0
	Medium	87	12	1
	Large	72	23	5
	Total	78	19	3
Punjab	Marginal	93	7	0
	Small	89	11	0
	Medium	94	6	0
	Large	98	2	0
	Total	95	5	0
Tamil Nadu	Marginal	92	4	4
	Small	89	9	2
	Medium	71	21	7
	Large	52	20	29
	Total	74	15	11
Telangana	Marginal	56	44	0
	Small	52	44	3
	Medium	63	32	5
	Large	51	43	6
	Total	57	40	4
Uttar Pradesh (Overall)	Marginal	58	23	20
	Small	35	31	34
	Medium	39	30	31
	Large	42	42	17
	Total	48	27	26
Uttarakhand	Marginal	76	23	1
	Small	83	17	0
	Medium	88	12	0
	Large	76	24	0
	Total	81	19	1
All states	Marginal	71	19	10
	Small	67	22	11
	Medium	75	19	6
	Large	74	19	7
	Total	72	20	9

Table A1. 7: Average Distance of farm from village centre (km.)

States	Farm class	0 - 2 km	2 km - 4 km	4 km above	Overall
Andhra Pradesh	Marginal	0.98	2.27	6.71	1.95
	Small	1.02	2.33	5.40	1.72
	Medium	0.94	2.28	5.00	1.49
	Large	0.89	2.21	5.33	1.70
	Total	0.97	2.27	5.94	1.72
Bihar	Marginal	0.52		5.00	0.57
	Small	0.47			0.47
	Medium	0.46			0.46
	Large	0.55			0.55
	Total	0.51		5.00	0.53
Haryana	Marginal	1.31			1.31
	Small	0.90	2.44		1.32
	Medium	0.78	2.44	12.00	1.15
	Large	0.87	2.39	7.80	1.58
	Total	0.86	2.41	8.50	1.39
Punjab	Marginal	0.68	2.00		0.77
	Small	0.82	2.00		0.95
	Medium	0.75	2.00		0.82
	Large	0.65	2.00		0.68
	Total	0.71	2.00		0.77
Tamil Nadu	Marginal	0.84	2.00	5.00	1.06
	Small	0.84	2.17	6.00	1.04
	Medium	0.88	2.50	7.50	1.70
	Large	0.76	2.36	7.75	3.07
	Total	0.83	2.37	7.50	1.80
Telangana	Marginal	0.88	2.61		1.64
	Small	1.00	2.37	4.00	1.70
	Medium	0.93	2.48	4.67	1.60
	Large	0.78	2.50	4.50	1.73
	Total	0.92	2.48	4.43	1.66
Uttar Pradesh (Overall)	Marginal	1.12	2.24	9.15	2.96
	Small	1.27	2.37	9.15	4.30
	Medium	1.24	2.47	8.65	3.94
	Large	1.44	2.50	9.50	3.23
	Total	1.17	2.33	9.07	3.49
Uttarakhand	Marginal	0.80	2.58	6.00	1.28
	Small	0.74	2.13		0.97
	Medium	0.89	2.40		1.07
	Large	0.81	2.25		1.16
	Total	0.81	2.41	6.00	1.14
All states	Marginal	0.87	2.37	8.61	1.92
	Small	0.87	2.33	8.48	2.01
	Medium	0.84	2.40	8.00	1.57
	Large	0.75	2.36	7.39	1.54
	Total	0.84	2.36	8.25	1.78

Table A1. 8: Land, crop and irrigation details of the sample households (in Acres)

States	Farm class	Area under all crops			Area under sugarcane		
		Operated Area	Irrigated Area	Irrigated (%)	Operated Area	Irrigated Area	Irrigated (%)
Andhra Pradesh	Marginal	91.4	68.2	74.6	69.0	54.7	79.2
	Small	175.3	137.7	78.5	125.2	103.9	83.0
	Medium	358.9	284.1	79.2	210.0	171.8	81.8
	Large	554.5	478.5	86.3	292.5	280.5	95.9
	Total	1180.0	968.5	82.1	696.7	610.9	87.7
Bihar	Marginal	141.8	134.5	94.9	133.5	126.5	94.8
	Small	170.2	147.3	86.5	135.6	123.6	91.2
	Medium	186.3	148.8	79.9	117.5	87.0	74.0
	Large	654.0	505.0	77.2	405.0	288.0	71.1
	Total	1152.3	935.6	81.2	791.6	625.1	79.0
Haryana	Marginal	15.5	15.5	100.0	9.8	9.8	100.0
	Small	103.3	103.3	100.0	62.5	62.5	100.0
	Medium	470.6	470.6	100.0	203.9	203.9	100.0
	Large	1557.0	1557.0	100.0	659.8	659.8	100.0
	Total	2146.4	2146.4	100.0	935.9	935.9	100.0
Punjab	Marginal	28.0	28.0	100.0	15.0	15.0	100.0
	Small	91.5	91.5	100.0	51.5	51.5	100.0
	Medium	460.0	460.0	100.0	252.5	252.5	100.0
	Large	2166.0	2166.0	100.0	1386.0	1386.0	100.0
	Total	2745.5	2745.5	100.0	1705.0	1705.0	100.0
Tamil Nadu	Marginal	41.4	41.4	100.0	39.4	39.4	100.0
	Small	227.3	194.8	85.7	173.6	173.6	100.0
	Medium	354.5	304.5	85.9	212.0	212.0	100.0
	Large	867.0	745.5	86.0	451.5	451.5	100.0
	Total	1490.2	1286.2	86.3	876.5	876.5	100.0
Telangana	Marginal	70.5	68.2	96.7	66.3	66.3	100.0
	Small	213.0	205.0	96.2	154.5	151.5	98.1
	Medium	399.1	343.3	86.0	231.5	231.5	100.0
	Large	583.6	456.6	78.2	340.0	328.0	96.5
	Total	1266.2	1073.1	84.8	792.3	777.3	98.1
Uttar Pradesh (Overall)	Marginal	285.3	285.3	100.0	227.6	227.6	100.0
	Small	397.6	397.6	100.0	279.4	279.4	100.0
	Medium	353.2	353.2	100.0	258.6	258.6	100.0
	Large	139.1	139.1	100.0	117.6	117.6	100.0
	Total	1175.2	1175.2	100.0	883.2	883.2	100.0
Uttarakhand	Marginal	101.9	101.9	100.0	75.1	75.1	100.0
	Small	161.7	161.7	100.0	87.4	87.4	100.0
	Medium	338.8	338.8	100.0	177.7	177.7	100.0
	Large	411.1	411.1	100.0	156.6	156.6	100.0
	Total	1013.5	1013.5	100.0	496.8	496.8	100.0
All states	Marginal	775.8	743.0	95.8	635.7	614.3	96.6
	Small	1539.7	1438.7	93.4	1069.6	1033.3	96.6
	Medium	2921.3	2703.3	92.5	1663.6	1594.9	95.9
	Large	6932.4	6458.9	93.2	3808.9	3667.9	96.3
	Total	12169.2	11343.9	93.2	7177.8	6910.4	96.3

Table A1. 9: Area, Production, Yield and sold quantity of sugarcane

States	Farm class	Area (in Acres)	Production (in Qtl.)	Yield (Qtl./acre)	Total sold (in Qtl.)	Sold/ production (%)
Andhra Pradesh	Marginal	69.0	21115.0	305.9	21115.0	100.0
	Small	125.2	40250.0	321.5	40250.0	100.0
	Medium	210.0	71220.0	339.1	71220.0	100.0
	Large	292.5	97450.0	333.2	97450.0	100.0
	Total	696.7	230035.0	330.2	230035.0	100.0
Bihar	Marginal	133.5	30289.8	226.9	30113.8	99.4
	Small	135.6	30019.0	221.4	29911.0	99.6
	Medium	117.5	26490.0	225.4	26432.0	99.8
	Large	405.0	93640.0	231.2	93553.0	99.9
	Total	791.6	180438.8	227.9	180009.8	99.8
Haryana	Marginal	9.8	2925.0	300.0	2785.0	95.2
	Small	62.5	17647.5	282.4	16992.5	96.3
	Medium	203.9	58003.8	284.5	55883.8	96.3
	Large	659.8	189584.5	287.4	182522.5	96.3
	Total	935.9	268160.8	286.5	258183.8	96.3
Punjab	Marginal	15.0	4620.0	308.0	4620.0	100.0
	Small	51.5	15907.5	308.9	15907.5	100.0
	Medium	252.5	79370.0	314.3	79360.0	100.0
	Large	1386.0	443355.0	319.9	441585.0	99.6
	Total	1705.0	543252.5	318.6	541472.5	99.7
Tamil Nadu	Marginal	39.4	18750.0	475.9	18750.0	100.0
	Small	173.6	85265.0	491.3	85265.0	100.0
	Medium	212.0	107585.0	507.5	107585.0	100.0
	Large	451.5	225625.0	499.7	225625.0	100.0
	Total	876.5	437225.0	498.9	437225.0	100.0
Telangana	Marginal	66.3	24060.0	362.8	24060.0	100.0
	Small	154.5	47785.0	309.4	47785.0	100.0
	Medium	231.5	76035.0	328.4	76035.0	100.0
	Large	340.0	92230.0	271.3	92230.0	100.0
	Total	792.3	240110.0	303.1	240110.0	100.0
Uttar Pradesh (Overall)	Marginal	227.6	66595.1	292.6	59528.8	89.4
	Small	279.4	76005.9	272.1	68128.0	89.6
	Medium	258.6	74909.5	289.7	66588.1	88.9
	Large	117.6	32775.5	278.7	28946.4	88.3
	Total	883.2	250286.0	283.4	223191.3	89.2
Uttarakhand	Marginal	75.1	21093.1	280.9	20271.4	96.1
	Small	87.4	25328.3	289.7	24380.0	96.3
	Medium	177.7	54037.3	304.1	50261.2	93.0
	Large	156.6	46298.7	295.7	43774.2	94.5
	Total	496.8	146757.5	295.4	138686.8	94.5
All states	Marginal	635.7	189447.9	298.0	181243.9	95.7
	Small	1069.6	338208.2	316.2	328618.9	97.2
	Medium	1663.6	547650.5	329.2	533365.1	97.4
	Large	3808.9	1220958.7	320.6	1205686.2	98.7
	Total	7177.8	2296265.4	319.9	2248914.1	97.9

Table A1. 10: Sugarcane sold to various destinations - % distribution

Quantity sold to	Farm Class	Andhra Pradesh	Bihar	Haryana	Punjab	Tamil Nadu	Telangana	Uttar Pradesh	Uttarakhand	Overall
Sugar mill	Marginal	4.4	3.8	0.3	0.1	1.3	2.8	14.9		2.5
	Small	22.3	26.1	8.6	3.7	22.5	27.1	38.0	3.9	17.8
	Medium	31.0	15.3	20.2	14.7	24.6	31.7	28.8	68.9	22.8
	Large	42.4	54.8	70.9	81.6	51.6	38.4	18.3	27.2	56.9
	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Sugar mill purchase centre	Marginal		85.8					18.0	11.4	13.4
	Small		14.2	9.6				42.4	23.6	25.3
	Medium			30.1				35.2	33.5	32.2
	Large			60.3				4.3	31.6	29.1
	Total		100.0	100.0				100.0	100.0	100.0
Gur manufacturer	Marginal		14.0					24.0	3.1	10.8
	Small		57.2	0.7				44.8	12.2	21.3
	Medium		17.6	18.9				22.7	35.1	21.1
	Large		11.2	80.4				8.5	49.6	46.7
	Total		100.0	100.0				100.0	100.0	100.0
Khandsari unit	Marginal		65.0					2.7		13.7
	Small		27.5					22.4		23.3
	Medium		7.5					74.9		63.0
	Large							0.0		0.0
	Total		100.0					100.0		100.0
All destinations	Marginal	4.4	7.5	0.2	0.1	1.3	2.8	17.1	10.4	4.0
	Small	22.3	25.8	7.4	3.7	22.5	27.1	40.1	21.8	18.7
	Medium	31.0	14.7	21.6	14.7	24.6	31.7	29.8	36.2	23.7
	Large	42.4	52.0	70.7	81.6	51.6	38.4	13.0	31.6	53.6
	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table A1. 11: Coverage of study - sugarcane season2018-19 –Villages detail

State	District	Name of Blocks /Sub-district	Name of Villages/village cluster & (No. of villages)	Marginal	Small	Medium	Large	Overall
Andhra Pradesh	Krishna	Charlapalli	Chintalamadu	7	8	9	9	33
		Thotlavalluru	Penamakuru Cluster (2)	22	16	17	12	67
	Visakhapatnam	Buchiyyapeta	Buchiyyapeta	1	0	0	7	8
		chodavaram	Lakkavaram Cluster (7)	29	30	25	8	92
Bihar	E. Chamaparan	Sugauli	Mali Cluster (7)	45	23	12	20	100
	W. Champaran	Bagaha	Majharia Cluster (5)	8	6	3	8	25
		Lauriya	Dumra Cluster (5)	12	6	7	0	25
		Manjhaulia	Dhokraha Cluster (5)	12	8	0	5	25
		Narkatiaganj	Baitapur Cluster (5)	13	5	5	2	25
Haryana	Kurukshetra	Shahabad	CharuaniJattan Cluster (3)	8	23	34	35	100
	Yamunanagar	Bilaspur	Marwah Kalan Cluster (4)	0	1	14	34	49
		Jagadhari	Kunjal	0	3	1	3	7
		Radaur	Dhorang Cluster (3)	0	2	18	24	44
Punjab	Gurdaspur	Batala	Bolewal Cluster (2)	6	6	17	21	50
		Gurdaspur	Paniar Cluster (3)	4	9	17	20	50
	Hoshiarpur	Dasuya	Heerahar Cluster (12)	3	5	18	24	50
		Mukerian	Dhanua Cluster (7)	2	8	14	26	50
Tamil Nadu	Erode	Bhavani	Jambai Cluster (3)	5	10	16	19	50
		Gopichettipalayam	Nagadevapalayam Cluster (5)	3	10	17	20	50
	Villuppuram	Kallakurichi	Ariperumanur Cluster (4)	9	22	12	10	53
		Cinnaselam	Sadaiyampattu	0	5	7	2	14
		Sankarapuram	S.Kolathur	7	17	4	5	33
Telangana	Kamareddy	Lingampet	Mothe	8	14	17	8	47
		Machareddy	Arepalli	14	15	18	6	53
	Sangareddy	Kondapur	Garakurthi Cluster (5)	13	18	18	20	69
		Nyalkal	Mirzapur	6	10	6	1	23
		Patancheruvu	Lakdaram	0	4	4	0	8
Uttarakhand	Haridwar	Haridwar	Ferupur Cluster (2)	28	14	4	5	51
		Jwalapur	Rani Majra Cluster (2)	27	9	10	3	49
	Udham Singh Nagar	Kichha	Kanakpur Cluster (3)	9	17	18	6	50
		Sitarganj	Pandri Cluster (4)	14	7	18	11	50
Uttar Pradesh (West)	Bijnor	Najibabad	Lukadadi	40	9	5	1	55
		Najibabad	Mandavali	26	13	5	1	45
	Lakhimpur Khiri	Gola	Muda Pasi	34	10	4	2	50
		Mohamdi	Bagrethi	21	19	6	4	50
Uttar Pradesh (East)	Faizabad	Sadar	Anjana	22	22	5	1	50
		Sohawal	ChiraMohamadpur	17	14	17	2	50
	Kusinagar	Padaruna	Sirsiya Kala	35	12	2	0	49
		Kaptanganj	Kusmaha	22	18	10	1	51
8 States	**18 Districts**	**39 Blocks**	**115 Villages**	532	448	434	386	1800

Table A1. 12: Installed capacity, capacity utilization and recovery rate of sugar mills (2018-19)

State	District	S No.	Capacity (TCD)	Capacity Utilization (%)	Cane Crushed (000' T)	Sugar Production (000' T)	Sugar Extraction rate (%)	Days utilized
Andhra Pradesh	Krishna	1	7500.00	80.22	902.47	86.09	9.54	97
	Krishna	2	4000.00	60.39	279.94	26.59	9.50	42
	Visakhapatnam	3	4000.00	86.00	479.16	45.33	9.46	103
Bihar	East Champaran	4	3500.00	100.00	371.47	34.24	9.22	106
	West Champaran	5	3500.00	100.00	356.13	34.90	9.80	102
	West Champaran	6	8000.00	76.00	1219.00	137.50	11.28	116
	West Champaran	7	11500.00	80.00	1751.80	188.00	10.73	122
	West Champaran	8	8000.00	90.00	1210.10	125.20	10.35	136
	West Champaran	9	5000.00	90.00	645.12	64.60	10.01	116
Haryana	Yamunanagar	10	10000.00	94.00	1660.00	191.00	11.51	156
	Kurukshetra	11	5000.00	86.00	696.20	74.30	10.67	120
Punjab	Amritsar	12	5000.00	100.00	956.63	96.77	10.12	191
	Gurdaspur	13	2000.00	87.27	273.30	25.42	9.30	119
	Hoshiarpur	14	7500.00	100.00	1143.74	110.20	9.63	152
	Hoshiarpur	15	6500.00	85.19	1238.24	131.48	10.62	162
Tamil Nadu	Erode	16	9000.00	37.78	884.65	80.47	9.10	37
	Viluppuram	17	7000.00	29.78	554.43	48.43	8.74	24
Telangana	Medak	18	5500.00	95.00	534.92	59.30	11.09	92
	Hyderabad	19	3500.00	102.21	429.31	49.48	11.52	125
	Nizamabad	20	2500.00	108.00	360.46	40.72	11.30	156
Uttarakhand	Haridwar	21	6250.00	72.84	733.00	87.20	11.90	85
	Haridwar	22	10000.00	80.00	1105.00	121.50	11.00	88
	Udham S. Nagar	23	4000.00	82.55	393.90	41.80	10.61	81
	Udham S. Nagar	24	3600.00	81.76	415.00	42.00	10.12	94
Uttar P. - West	Bijnor	25	3000.00	89.53	475.39	59.51	12.52	142
	LakhimpurKheri	26	10500.00	85.72	1770.89	217.69	12.29	145
	LakhimpurKheri	27	8000.00	100.00	1357.60	169.94	12.52	170
Uttar P. - East	Kushinagar	28	6500.00	77.32	829.30	99.50	12.00	99
	Ayodhya	29	8600.00	82.74	1228.74	140.14	11.41	118
All states	**20 districts**	**All**	**178950.00**	**84.27**	**24255.89**	**2629.29**	**10.84**	**111**

*Note: No of days utilized are calculated as (Cane Crushed/ Inst. Capacity)*Capacity utilized (%).*

Table A1. 13: Sugarcane received by the farmers at the mill gate and mill purchase centres

State	District	S No.	Cane from farmers ('000 T)	Cane received at Gate (%)	Cane received at Centre (%)
Andhra Pradesh	Krishna	1	902.47	95.0	5.0
	Krishna	2	279.94	95.0	5.0
	Visakhapatnam	3	479.16	97.8	2.2
Bihar	East Champaran	4	371.47	87.1	12.9
	West Champaran	5	356.13	78.0	22.0
	West Champaran	6	1219.00	70.5	29.5
	West Champaran	7	1751.80	80.0	20.0
	West Champaran	8	1210.10	80.0	20.0
	West Champaran	9	645.12	77.0	23.0
Haryana	Yamunanagar	10	1660.00	63.0	37.0
	Kurukshetra	11	696.20	83.6	16.4
Punjab	Amritsar	12	956.63	100.0	0.0
	Gurdaspur	13	273.30	100.0	0.0
	Hoshiarpur	14	1143.74	100.0	0.0
	Hoshiarpur	15	1238.24	100.0	0.0
Tamil Nadu	Erode	16	884.65	100.0	0.0
	Viluppuram	17	554.43	100.0	0.0
Telangana	Medak	18	534.92	100.0	0.0
	Hyderabad	19	429.31	100.0	0.0
	Nizamabad	20	360.46	100.0	0.0
Uttarakhand	Haridwar	21	733.00	60.0	40.0
	Haridwar	22	1105.00	55.0	45.0
	Udham S. Nagar	23	393.90	66.2	33.8
	Udham S. Nagar	24	415.00	32.9	67.1
Uttar Pradesh - West	Bijnor	25	475.39	57.8	42.2
	LakhimpurKheri	26	1770.89	74.6	25.4
	LakhimpurKheri	27	1357.60	61.5	38.5
Uttar Pradesh - East	Kushinagar	28	829.30	70.4	29.6
	Ayodhya	29	1228.74	84.15	15.85
All states	**20 districts**	**All**	**24255.89**	**80.05**	**19.95**

Table A1. 14: Sugarcane received at the mill gate and mill purchase centres – per farmer

State	District	S No.	Farmer (%)		Sugarcane (Tonnes per farmer)		
			Farmers at mill gate	Farmers at p. centre	Sugarcane at mill & centre, combined	Sugarcane at mill gate	Sugarcane at p. centre
Andhra Pradesh	Krishna	1	95.0	5.0	74.1	74.1	74.1
	Krishna	2	95.0	5.0	79.4	79.4	79.4
	Visakhapatnam	3	97.8	2.2	16.7	16.7	16.7
Bihar	East Champaran	4	76.9	23.1	21.5	24.3	12.0
	West Champaran	5	67.6	32.4	33.0	38.1	22.4
	West Champaran	6	72.5	27.5	59.8	58.1	64.2
	West Champaran	7	54.7	45.3	77.9	114.0	34.3
	West Champaran	8	31.6	68.4	18.7	47.2	5.5
	West Champaran	9	13.2	86.8	8.9	52.3	2.4
Haryana	Yamunanagar	10	63.0	37.0	75.5	75.5	75.5
	Kurukshetra	11	84.5	15.5	72.6	71.8	76.9
Uttarakhand	Haridwar	21	44.0	56.0	33.2	45.3	23.7
	Haridwar	22	40.0	60.0	24.6	33.8	18.4
	Udham S. Nagar	23	50.0	50.0	21.0	27.8	14.2
	Udham S. Nagar	24	30.0	70.0	24.1	26.5	23.2
Uttar Pradesh - West	Bijnor	25	57.8	42.2	32.8	32.8	32.8
	LakhimpurKheri	26	74.4	25.6	26.4	26.5	26.2
	LakhimpurKheri	27	55.3	44.7	24.0	26.7	20.6
Uttar Pradesh - East	Kushinagar	28	75.1	24.9	10.7	10.0	12.7
	Ayodhya	29	79.4	20.6	18.0	19.1	13.8
Covered states		All	57.66	42.34	26.65	33.71	17.03

Note: computation excludes mills in Punjab, Telangana and Tamil Nadu due to missing information

Table A1. 15: Average transportation cost borne by mills (Mechanized mode)

State	District	S No.	No of Purchase Centers	Average Distance Purchase Centre to Mill Gate (km)	Transportation Cost from Purchase Centre to Mill Gate (Rs/qtl)	Transportation Cost from Purchase Centre to Mill Gate (Rs/qtl/km)
Andhra Pradesh	Visakhapatnam	3	8.00	21.00	15.00	0.71
Bihar	East Champaran	4	18.00	22.00	16.00	0.73
	West Champaran	5	11.00	15.00	18.00	1.20
	West Champaran	6	27.00	20.00	16.00	0.80
	West Champaran	7	26.00	18.00	16.00	0.89
	West Champaran	8	34.00	16.00	16.00	1.00
	West Champaran	9	37.00	20.00	18.00	0.90
Haryana	Yamunanagar	10	42.00	29.00	20.00	0.69
	Kurukshetra	11	20.00	16.00	17.15	1.07
Uttarakhand	Haridwar	21	64.00	35.00	16.00	0.46
	Haridwar	22	78.00	25.00	14.00	0.56
	Udham S. Nagar	23	32.00	48.34	23.50	0.49
	Udham S. Nagar	24	57.00	35.61	16.72	0.47
Uttar Pradesh - West	Bijnor	25	36.00	19.24	16.81	0.87
	LakhimpurKheri	26	60.00	27.10	12.18	0.45
	LakhimpurKheri	27	52.00	28.00	16.54	0.59
Uttar Pradesh - East	Kushinagar	28	35.00	32.08	17.43	0.54
	Ayodhya	29	63.00	45.00	24.56	0.55
Covered states		All	700.00	26.94	16.83	0.62

Note: In Andhra Pradesh, the cost of transporting sugarcane is only reported for one mill in Visakhapatanam district. In Punjab, Telangana and Tamil Nadu, all the farmers are transporting sugarcane to the mill gate.

Table A1. 16: Transportation of sugarcane - Sample size of farm households and sugar mills

States	Farmers transporting sugarcane - to all the destinations (combined)			Mills covered
	Manual mode	Mechanized mode	Combined	
Andhra Pradesh	86	114	200	3
Bihar	6	234	240	6
Haryana	0	235	235	2
Punjab	0	206	206	4
Telangana	50	150	200	3
Tamil Nadu	n.a.	n.a.	n.a.	2
Uttarakhand	7	207	214	4
Uttar Pradesh -W	*0*	*345*	*345*	*3*
Uttar Pradesh -E	*0*	*223*	*223*	*2*
Uttar Pradesh -T	0	568	568	5
All states	149	1714	1863	29

Note: A maximum of 200 farmers are surveyed in a particular state, in person. For the farmers transporting sugarcane, the entries for number of farmers reported may be higher than 200, this is because an individual farmer is transporting sugarcane to various destination and through various modes.

Appendix 2

Appendix 2 (A) - Farmer's Schedule

AGRICULTURAL ECONOMICS RESEARCH CENTRE
University of Delhi, Delhi - 110007

"SUGARCANE TRANSPORTATION AND HARVESTING COST"
FARMER SCHEDULE
Reference Period (Sugar Season 2018-19)

Date of the interview: _____ Name of the Interviewer: _____

State		District	
Taluk/Tehsil		Village	

I. Particulars of the farmer

Farmer's Name	
Contact No (Mobile phone/landline)	
Age (in years)	
Gender (Male/Female)	
Education[1]	
Caste (GEN-1/OBC-2/SC&ST-3)	
Members in family	Male: _____ Female: _____ Total: _____
Main and subsidiary occupation	Main: _____ Subsidiary: _____
Average Distance of farm from village centre (km.)	

[1]*Education Code: 1=Illiterate, 2= Primary (1-5), 3=Junior (6-8), 4 =High School (9-10), 5=Intermediate (11-12), 6=Graduate, 7=Post graduate*

II. Land and crop details (in acres)

II (a): Land details (in acres)

Land - owned	
Land – Leased-in	
Land – Leased-out	
Net Operated Area[2]	
Net operated area Irrigated	
Net operated area Un-irrigated	

[2]*Net Operated Area = owned + leased in – leased out*

II (b): Crop details

Area under sugarcane (acres)	
Area under sugarcane - Irrigated (acres)	
Area under sugarcane - Un-irrigated (acres)	
Sugarcane - Production (quintals)	
Sugarcane - Sold/Marketed (quintals)	
Sugarcane - Self-consumption (quintals)	

III. Marketing

III (a): Quantity sold (quintals) to:

Sugar mills	
Gur manufacturers	
Khandsari units	
Any other place	
Total sold[3]	

[3]*Note: 'Total sold' quantity here should match with "Sugarcane - Sold/Marketed (quintals)" reported in II(b)*

III (b): Details of Quantity Marketed

Quantity sold to	Quantity sold (Quintals)	Market fees paid (Rs./Quintal)	Any other cost/fee paid
Sugar mill …….			
Sugar mill purchase centre ……..			
Gur manufacturer …….....			
Khandsari unit …….			
Village market …….			
Commission agents ……			
Any other place (specify) ……			
Total sold		X	X

Note: 'Total sold' quantity here should match with that reported in II(b) and III(a)

IV. Harvesting

How do you harvest sugarcane? (Tick√)

1. Using hand knives, cutting blade or hand axes	2. Using sugarcane harvester	Both (1 & 2)

IV (a): Expenditure on Manual Harvesting

	Family labour			
	Number employed	Hours/Day	Number of Days employed	Wage rate (Rs./Day)
Men				X
Women				X
Children				X
	Farm servants			
	Number employed	Hours/Day	Number of Days employed	Wage rate (Rs./Day)
Men				
Women				
	Casual labour			
	Number employed	Hours/Day	Number of Days employed	Wage rate (Rs./Day)
Men				
Women				

IV (b): Expenditure on Machine Harvesting

If owned		Harvest combine	Thresher	Loader	Other
Expenditure on Fuel	Rate (Rs./Litre)				
	Total quantity (Lit.)				
Labour/driver charges	Rate (Rs./Day)				
	Number of Days				
Repair and Maintenance	Total Amount (Rs.)				
Any other (specify) ….....	Total Amount (Rs.)				
If hired		Harvest combine	Thresher	Loader	Other
Rent paid	Rate (Rs./Day)				
	Number of Days				
Expenditure on Fuel	Rate (Rs./Litre)				
	Total quantity (Lit.)				
Labour/driver charges	Rate (Rs./Day)				
	Number of Days				
Repair and Maintenance	Total Amount (Rs.)				
Any other (specify) ….....	Total Amount (Rs.)				

V. Transportation

V (a): Expenditure on manual transportation

Travelled to	Information	Cart			Any other mode (specify)
		Owned	Hired	Jointly hired	
Sugar mill (Name) ……	Type of cart[4] used (code) ----------				
	Total quantity (qtls)				
	Total distance (km)[5]				
	Number of days				
	Feed/Fodder cost (Rs./Day)				
	Hiring charges (Rs./Day)	X			
	Any other cost (Rs.)				
Sugar mill purchase centre (Name) ……	Type of cart[4] used (code) ----------				
	Total quantity (qtls)				
	Total distance (km)[5]				
	Number of days				
	Feed/Fodder cost (Rs./Day)				
	Hiring charges (Rs./Day)	X			
	Any other cost (Rs.)				
Gur manufacturer ……	Type of cart[4] used (code) ----------				
	Total quantity (qtls)				
	Total distance (km)[5]				
	Number of days				
	Feed/Fodder cost (Rs./Day)				
	Hiring charges (Rs./Day)	X			
	Any other cost (Rs.)				
Khandsari unit ……	Type of cart[4] used (code) ----------				
	Total quantity (qtls)				
	Total distance (km)[5]				
	Number of days				
	Feed/Fodder cost (Rs./Day)				
	Hiring charges (Rs./Day)	X			
	Any other cost (Rs.)				
Any other place (specify) ……	Type of cart[4] used (code) ----------				
	Total quantity (qtls)				
	Total distance (km)[5]				
	Number of days				
	Feed/Fodder cost (Rs./Day)				
	Hiring charges (Rs./Day)	X			
	Any other cost (Rs.)				

[4]Code for type of cart: 1) Bullock cart 2) Horse cart 3) Buffalo cart 4) any other (specify)

[5] *Total distance from the farm to the destination*

V (b): Expenditure on mechanized transportation

Travelled to	Details	Tractor trolley		Truck		Any other	
		Owned	Hired	Owned	Hired	Owned	Hired
Sugar mill (Name)	Total quantity (qtls)						
	Total distance (kms)						
	Number of days						
	Fuel charges (Rs./Litre)						
	Fuel consumed (litres)						
	Labour/driver cost (Rs./Day)						
	Total Maintenance cost (Rs.)						
	Hiring charges (Rs./Day)	X		X		X	
	Any other cost (Rs.)						
Sugar mill purchase centre (Name)	Total quantity (qtls)						
	Total distance (kms)						
	Number of days						
	Fuel charges (Rs./Litre)						
	Fuel consumed (litres)						
	Labour/driver cost (Rs./Day)						
	Total Maintenance cost (Rs.)						
	Hiring charges (Rs./Day)	X		X		X	
	Any other cost (Rs.)						
Gur manufacturer	Total quantity (qtls)						
	Total distance (kms)						
	Number of days						
	Fuel charges (Rs./Litre)						
	Fuel consumed (litres)						
	Labour/driver cost (Rs./Day)						
	Total Maintenance cost (Rs.)						
	Hiring charges (Rs./Day)	X		X		X	
	Any other cost (Rs.)						
Khandsari unit	Total quantity (qtls)						
	Total distance (kms)						
	Number of days						
	Fuel charges (Rs./Litre)						
	Fuel consumed (litres)						
	Labour/driver cost (Rs./Day)						
	Total Maintenance cost (Rs.)						
	Hiring charges (Rs./Day)	X		X		X	
	Any other cost (Rs.)						
Any other place (specify)	Total quantity (qtls)						
	Total distance (kms)						
	Number of days						
	Fuel charges (Rs./Litre)						
	Fuel consumed (litres)						
	Labour/driver cost (Rs./Day)						
	Total Maintenance cost (Rs.)						
	Hiring charges (Rs./Day)	X		X		X	
	Any other cost (Rs.)						

VI. Loading/Unloading

VI (a): Expenditure on Manual loading/unloading

Expenditure	Loading	Unloading
Number of labourers		
Duration (hours/Day)		
Number of days		
Wage rate (Rs./Day)		

VI (b): Expenditure on mechanized loading/unloading

Expenditure	Loading		Unloading	
	Owned	Hired	Owned	Hired
Number of machines used				
Hiring cost (Total in Rs)	X		X	
Expenditure on fuel, repair & maintenance (Rs)				
Number of labourers and drivers hired (total)				
Duration hired (hours/day)				
Number of days				
Wage rate (Rs./Day)				

Appendix 2 (B) – Sugar mill's Schedule

AGRICULTURAL ECONOMICS RESEARCH CENTRE
University of Delhi, Delhi - 110007

"SUGARCANE TRANSPORTATION AND HARVESTING COST"
Questionnaire for Sugar Mill - Reference Period (Sugar Season 2018-19)

1. Name and Address of Mill (alongwith name and contact number of main official)				
2. Type of Mill (Codes)	Installed Capacity (2018-19)	Capacity Utilization (%)	Total Cane Crushed in tons (2018-19)	Total Sugar Production in tons (2018-19)

Code for 'type of mill': Sugar-1; Sugar + Distillation-2; Sugar + Cogen – 3; Sugar+ Distillation + Cogen - 4

3. Information on Transport Costs paid by the Sugar Mill (2018-19)

Total Cane Received at	Quantity (lakh tonnes)	Total Number of farmers who availed this	Transport Costs Paid by Mill / incurred *(Rs/qtl/km)*	Transport Costs if Paid by Farmers *(Rs/qtl/km)*
A) Farm to Factory Gate				
1) Tractor Trolley				
2) Truck				
3) Bullock cart				
4) Any other (specify) _____				
B) Farm to Purchase Centre				
1) Tractor Trolley				
2) Truck				
3) Bullock cart				
4) Any other (specify)				

4. Cost incurred by the mill for transporting from Purchase Centre to Factory Gate (Rs/qtl/km) _____
5. Mode of Transport (Tractor Trolley -1; Truck- 2) _____
6. Information of Harvesting Costs, if Incurred by the Mill

Mode of Harvesting		Average Cost (Rs/qtl)		Extent (%) of Trash	
Manual (tons)	Machine (tons)	Manual	Machine	Manual	Machine

Appendix 3

Committees on sugar sector (Post 1990s) and the important highlights

Hanumantha Rao Report (1990)

- For the sample size for each crop, there should be a sample of 10 clusters per crop in a state. Precision of the estimates may be worked out on regular basis. Transportation cost to be taken into consideration if farm produce is procured or sold outside the village. Data collected on Cost of Production (CoP) of crops through Agricultural Universities and AERCs in different states under the comprehensive scheme of MoA. The sampling design is prepared by IASRI, New Delhi.
- The present sampling design, followed from 1981-82, is based on crop complex approach (sample is representative of a number of crops rather than a single crop). The better approach will be to identify the important crops for every state based on relative importance of crop in the state and relative contribution of each state to the all India production.
- Limitation of the crop complex approach – 1. Minor crops grown in limited area gets the same weights as major crops at the allocation as well as at the selection stage, 2. Sample is to be adjusted by selecting additional villages/clusters and suitable analytical methods to be developed to pool the information collected. So, the crop complex approach may be combined with the single crop approach for providing representative estimates for special/minor crops.

Y. K. Alagh Report (2005)

- MSP helps in encouraging production in line with comparative advantage of various regions through incentives/disincentives but excludes the consideration of transportation costs. This acts as a disincentive for deficit regions where production picks up.

C. Rangarajan Report (2012)

The committee headed by Dr. C. Rangarajan on Sugar Industry submitted its report to the Government on 5th October, 2012. The Committee, inter-alia, recommended removal of the levy sugar obligation and dispensing with the regulated release mechanism on non-levy sugar, rationalisation of sugarcane pricing, abolition of cane area reservation system and bonding, doing away with the minimum distance norms as States discontinue cane area reservation, liberalisation of sugar trade, market determination of prices of by-products with no earmarked end use allocations and taking out sugar from the purview of Jute Packaging Material (Compulsory use in Packaging Commodities) Act, 1987. The recommendations of the Committee are under consideration of the Government. The focus points of the report are:

- In 1998, step to licensing requirement for new sugar mills was abolished, so installed capacity of private sector mills increased. The dominance of sugar co-operatives decreased from 51.5 % till 1997-98 to 33.6%. Private sector installed capacity increased from 38.2 % to 63.3 %.
- There exist strong economies of scales in sugar industry. With increase in scale of operations, the cost of conversion of sugarcane into sugar decreases substantially. Also increase global competitiveness of Indian sugar industry.
- The legal enforcement of supply and purchase of cane within a mill's allocated catchment area is called - Cane Reservation Area. The minimum distance Criterion – restricts the setting up of new mills within 15/25 km of existing mills.
- Fair and Remunerative Price (FRP) and State Advised Price (SAP) are the minimum price set by central and some state governments for sugarcane to be paid by sugar mills to farmers.
- Mills have to deliver a certain percentage of production (at present 10 %) to the government for distribution through PDS is called Levy Sugar. For rest of %, central government issues release quotas, earlier on monthly basis, now on quarterly bases, to ensure availability of sugar throughout the year at a reasonable stable price to consumer.
- Trade policy is controlled by options such as export ban, financial help to firms for export of sugar, import duties, etc.

For the Cane Reservation Area, the distance between sugar mills are mentioned below:

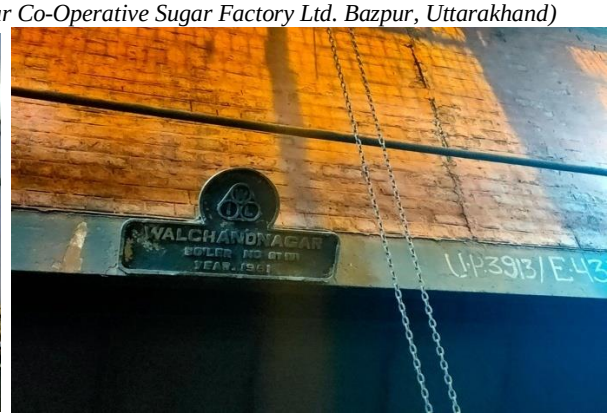
Year	Distance
1980-85 (6^{th} 5 Year Plan) in 1980	30 kms
In 1987	40 kms
In 1991	25 kms
In 1997	15 kms
In 2006	15 kms
Thorat Committee, 2009	Scrap the Cane Area Reservation
C. Rangarajan Committee (2012)	In support to scrap the Cane Reservation Area

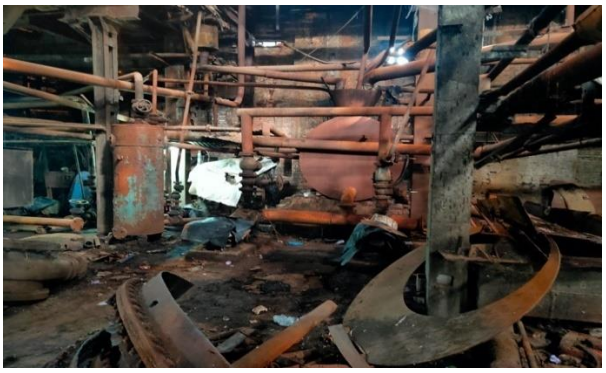
Note: In Punjab, Haryana and Maharashtra this area was increased to 25 kms with approval from centre government in public interest.

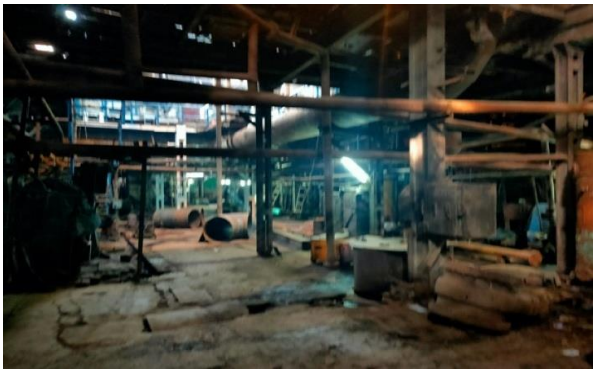
Appendix 4

Pictures showing deteriorating infrastructure of the sugar mill

(Pictures are captured during the survey in November-December, 2019 by taking permission from the officials, the mill was about to operationalized for the sugar season 2019-20, Bazpur Co-Operative Sugar Factory Ltd. Bazpur, Uttarakhand)







***

Responses to the comments on study

Draft report on study shared by AERC Delhi on: July 17, 2020

Presentation on study by AERC Delhi given on: September 11, 2020

Comments on draft report and presentation received on: October 9, 2020

'Updated tables' based on comments shared by AERC Delhi on: Nov 17, 2020

Comments on 'Updated tables' received by AERC Delhi on: Dec 10, 2020

Response to the Comments on 'Updated tables' shared by AERC, Delhi on: Dec 14, 2020

Re-survey data from AERC, Allahabad (Uttar Pradesh) received on: January 6, 2021

Responses to the comments:

1. The sampling procedure needs to be more representative. Selecting two districts from a State like Uttar Pradesh at the second stage of sampling may not generate representative estimates for entire State. Similarly, in the third stage of sampling there should be more than two villages from each district to have reliable estimates. In addition, selecting equal number of districts from each State, irrespective of the size and share in national acreage/production is not appropriate to get representative sample size, which would influence the results of the study. More reliable estimates would have been obtained by stratifying the districts based on acreage/production/productivity and then selecting more districts covering various agro-climatic regions of the State and more villages covering various parts of the district and an appropriate number of farmers from different size classes in each selected village.

Response: The methodology has been revised, to the extent possible. Earlier, in the second stage of sampling, two districts had been selected from each of the state following the CACP sampling frame. As suggested, special emphasis is given to the largest state, i.e. Uttar Pradesh in the study states. The revised methodology is covering four districts in the Uttar Pradesh covering different agro-climatic regions. Two districts from each, the western Uttar Pradesh and the eastern Uttar Pradesh regions have been considered. In the third stage of sampling, the unit is the village cluster (earlier wrongly typed as village in the methodology). A cluster of sugarcane growing villages were randomly chosen such that a total of 100 farmers are surveyed from each district. A cluster of villages is preferred from each district to give more reliable estimate and more representation to the sample. Overall, the 18 districts are covering 115 villages, i.e. on an average, 6.4 villages per district. The actual number of villages covered in each village cluster varies across district. A village cluster is also preferred, because the required sample size was not available from the villages which are smaller in size. Stratified random sampling was used to select the sample farmers from the list of farmers growing sugarcane in a particular village/village cluster to give representation to each size-group, i.e. marginal, small medium and large farmers.

2. Further, in case of UP, both districts have been selected from Western UP, while there are vast differences in farm practices, farm sizes and crop pattern between eastern and western UP. Western UP has a lot of similarity with Haryana. Therefore, practically we are having 4-6 districts with similar production behavior and farm practices while none from the eastern part. For example, the study concludes that in some States family labour is also used, but such cases are less in number (P-38), while field surveys undertaken by CACP teams have observed that family labour is utilized in eastern UP on a larger scale. Similarly, at P-52, Table 6.1 the conclusion that 100% cane is being transported by Tractor-trolley, would have been different if eastern UP was taken into consideration. Similarly, for Bihar, two adjacent districts of East and West Champaran have been selected and other regions of the State are not represented.

Response: As suggested, in the state of Uttar Pradesh, two different agro-climatic regions are considered in the study. The revised methodology is now covering four districts in the Uttar Pradesh, two districts from each, the western Uttar Pradesh and the eastern Uttar Pradesh regions. For this purpose, a re-survey is conducted in the eastern Uttar Pradesh region during November-December 2020. The family labour participation is mentioned in Table 4.4. This suggests the family labour use per household is 2.2 labours per household in eastern Uttar Pradesh, as compared to 1.4 labours per household in the western Uttar Pradesh. The re-survey data suggest that, in the eastern Uttar Pradesh, all the farmers prefer the mechanised mode to transport sugarcane to various destinations, as in the case of western Uttar Pradesh. A transformed mode is used by farmers in eastern Uttar Pradesh along with tractor trolley mode (called it as 'tractor tyre gadi' or jutta or buggi) using a low base open ended trolley with lower carrying capacity (between 30-40 quintal) attached to the tractor engine (as mechanised mode).

3. The average harvesting costs varies widely from Rs. 30 per quintal in UP to Rs. 63.7 in AP and Rs. 72.1 in Tamil Nadu on contract basis and from Rs. 13.5/qtl in Bihar to Rs. 67.7/qtl in AP on hired labour on daily wages basis. The reasons for such large differences need to be examined.

Response: The tables have been revised after re-looking at the data. The study participating centres have been approached for the explanation on the field data. Some of the outliers from the sample data are dropped. The revised cost figures are re-estimated as per the required format i.e by mode and by destination; and the methodology to adopt i.e. weighted averages. The reasons for the large differences in harvesting cost across state are mainly due to variation in wage rates, average number of labour employed and average days utilised across study states. The detailed tables and section is explained in Chapter 4. The harvesting cost in Tamil Nadu (Rs. 72.1 per quintal) includes the cost of all the sugarcane operations into it - harvesting, transportation and loading.

4. Given the differences in proportion of marginal, small, medium and large farmers across States, weighted average of estimates would have yielded more accurate results.

Response: As suggested, weighted average of estimates are used to report the harvesting cost considering farmers in different farm classes as weight, reported in Table 4.8 and Table 4.9 in Chapter 4.

5. Since proportion of farmers who use manual and mechanized mode of transportation, differs across States, weighted average cost of transportation should be computed.

Response: As suggested, weighted average of estimates are used to report the transportation cost considering distance covered in each transportation mode as weight, reported in Chapter 5.

6. In particular, Table 6.5 on page 57 depicts cost of own transportation in various States. There are vast differences in fuel cost while rates of diesel are not so different in these states. One can see from Table 6.3 on page 54 that average distance covered in Punjab and UP are almost similar (12.99 Km and 12.96 Km, respectively) but the costs in Table 6.5 are Rs. 5.1 for Punjab and Rs. 10.4 for UP. On the other hand, average distance for Bihar (20.7 Km) is about twice than that of Uttarakhand (10.75), but fuel costs are almost similar (Rs. 5.9 and Rs. 6.6). These data points need to be checked.

Response: The transportation cost figures have been updated as per the revised approach. Some variation still persists in transportation cost calculated based on fuel cost and driver and labour charges. There are variation in 'fuel average' based on the life of the vehicle, road conditions, quantity loaded per trip (trolley size/capacity), vehicle used in mechanised category etc., irrespective of the same range of the fuel cost and distance covered.

7. The overall hiring costs for Haryana (Rs. 37.5) in T6.7 is doubtful since it is higher than both, partial hiring (Rs. 26.8) and complete hiring (Rs. 32.2). Similar discrepancy is seen for Uttarakhand.

Response: The costs reported were not adding-up to the 'overall hiring' as these were mutually exclusive cases, the farmers hiring vehicle in 'partial hiring' cost cases and the cost of 'complete hiring' cases. This section based on 'partial hiring' cost is being removed and now being considered in the 'owned' cost of mechanized transportation. These were the cases in which farmers were arranging vehicles from relatives/neighbors/friends etc. and bearing the only input costs (fuel and driver/labour costs), as same in the case of owned vehicle. Now, such 'hired' and owned' cases are merged in with the type of mode i.e. manual and mechanized.

8. The average transport cost per quintal per km ranged from Rs. 0.49 in Bihar to Rs. 2.21 in UP and Rs. 5.12 in Uttarakhand in case of own mechanized mode of transport, and Rs. 1.1 in Telangana to Rs. 5.5 in Uttarakhand, which needs to be looked into.

Response: The calculation for the transportation cost is updated. The transportation cost on per quintal per kilometre basis at purchase centre are comparatively high across states due to factors such as smaller trolley capacity, smaller trolley capacity allowed (hence, higher number of trips) at the purchase centres and due to fixed minimum wages of driver/labour irrespective of the shorter distance from farm to purchase centres, i.e. there are instances where the transportation cost/driver charges are fix for a distance up-to 5 to 10 km.

9. Similarly, average cost of sugarcane transportation per quintal per km from purchase centre to mill gate ranges from Rs. 0.5 in Uttarakhand to Rs. 5 in Andhra Pradesh.

Response: The transportation cost from purchase centre to mill gate is borne by the sugar mills. The state level weighted average of transportation cost is re-estimated. The cost of transportation from purchase centre to the mill gate is nearly Rs. 0.50 to Rs. 0.89 per quintal per kilometre. The reported figure for the Andhra Pradesh is corrected.

10. The number of sugar mill selected for estimating transportation cost from purchase centre to mill gate, which is common in UP, Bihar and Uttarakhand, is too small to get reliable estimates. The Coverage of sugar mills under the study needs to be increased. Wherever possible weighted average should be used to arrive at transportation cost at State level and all-India level.

Response: As suggested, the weighted average is used to arrive at transportation cost at State level. The sugar mills covered in the study are the mills where the surveyed farmers disposed the sugarcane, either at its purchase centre or at the mill gate. The resurvey in the eastern Uttar Pradesh covered two of the sugar mills in the region, adds up-to a total of 29 sugar mills covered in the study.

11. Since the thrust of study is to estimate State-wise and all-India transportation cost, following information should be clearly available in the study report:

i. State-wise and all-India average distance from Farm Gate to Mill Gate, Farm Gate to Purchase Centre and Purchase Centre to Mill Gate, separately, for manual, mechanized and combined.

ii. State-wise and all-India average transportation cost per quintal from Farm Gate to Mill Gate borne by farmers, separately, for manual, mechanized and combined.

iii. State-wise and all-India average transportation cost per quintal from Farm Gate to Purchase Centre borne by farmers, separately, for manual, mechanized and combined.

iv. State-wise and all-India average transportation cost per quintal from Purchase Centre to Mill Gate borne by Sugar Mills, separately, for manual, mechanized and combined.

v. State-wise and all-India average loading as well as unloading costs per quintal borne by farmers, separately, for manual, mechanized and combined.

Response: All the above mentioned tables and sections are included in the study, wherever applicable.

Response to the additional comments on 'Updated tables':

12. The Purchase centres in the surveyed districts of Haryana

Response: There exists the purchase centres in the survey districts of Haryana. Nearly 20% of the sugarcane farmers in the survey districts (Yamuna Nagar (9% farmers, 4 purchase centres) and Kurukshetra (11% farmers, 1 purchase centre)) transporting sugarcane to the purchase centres. These purchase centres are established and employed by the private sugar mills and supervised and inspected by the government officials. The information is validated through telephonic conversation with the officials and farmers in the surveyed districts.). The information on farmers disposing sugarcane at the purchase centre, average distance covered, quantity disposed and the transportation cost borne by farmers (from farm to purchase centre) and on the transpiration cost borne by the mill (from purchase centre to the mill gate are calculated as per the farmer's responses and mill officials' response, respectively, The detailed tables are reported in Chapter 5.

13. Cost of transporting sugarcane in Andhra Pradesh

Response: The cost 'per quintal' of transporting sugarcane is comparatively high in Andhra Pradesh. In the surveyed districts all the surveyed farmers are hiring the transportation facility and none of them have owned mechanized or manual mode of transportation. The contract rate of hiring the transportation mode is high in the state – nearly Rs. 25 per quintal at least for mechanized mode and in range of Rs. 16 to 20 for the manual mode. This is irrespective of the distance covered in many cases. For the manual carts used (with an average carrying capacity of nearly 20 quintals), in general, nearly Rs. 400 per cart

is the hiring rate for the distance up-to 5 km and Rs. 500 above 5 km distance on per trip basis. Many a times the farmers have to make multiple trips.

Moreover, the average distance from farm to mill gate is less in Andhra Pradesh (nearly 10.5 km through mechanized mode, and nearly 8.3 km through combined mode), comparatively, among the study states. Therefore, for transporting sugarcane from farm to the mill gate on 'per quintal per kilometer' basis through mechanized mode in Andhra Pradesh (also in the eastern Uttar Pradesh) is high, nearly Rs. 2.48. Similar reasons are applicable to the cost of transportation through manual mode in Andhra Pradesh and Telangana. The transportation cost through mechanized mode on 'per quintal' basis in Telangana is nearly Rs. 24.2 at mill gate, but the average distance covered through mechanized mode is also high, nearly 26.8, highest among the states. Therefore, the cost is nearly Rs. 0.90 on 'per quintal per kilometer' basis.

Similarly, the average distance from farm to mill gate is least in eastern Uttar Pradesh (nearly 8.7 km through mechanized mode. Therefore, for transporting sugarcane from farm to the mill gate on 'per quintal per kilometer' basis through mechanized mode in eastern Uttar Pradesh is high, nearly Rs. 2.98.

14. Sample size of farm households and sugar mills in selected states

Response: The required Table is reported in Appendix table 'Table A1.16'

15. Number of farmer transporting sugarcane at purchase centre in Uttarakhand

Response: Nearly 89.7% of the surveyed farmers in the study districts are transporting sugarcane at the purchase centre in Uttarakhand. This is because the mills are located at the far distance from the farms. In particular, a mill in one of the survey sub-district was closed and non-operational. The mills had placed the purchase centres very close to the village clusters; the average distance from farm to purchase centres is just 2.29 km. Although, the cost on 'per quintal per km' basis is also gone high in such cases in the state due to a threshold minimum hiring cost of transportation for smaller distances.

*****

Agricultural Economics Research Centre
University of Delhi
Delhi – 110007

Funded by the Ministry of Agriculture and Farmers' Welfare
Government of India

aerc.du.ac.in
+91-11-27667648
aercdu@rediffmail.com