Towards a sustainable sugarcane industry in India

Baseline results on Solidaridad's programme: Increasing water use efficiency in sugarcane growing in India

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Preface

This baseline report concerning the programme 'Increasing water use efficiency in sugarcane growing in India', of Solidaridad and its partners, provides detailed insight into the socio-economic conditions of sugarcane producers. These producers are located in the command areas (25,000 ha) of three sugar mills in the southern states of Karnataka and Telangana which are implementing the programme in collaboration with the Vasantdada sugar Institute, Osmania University and eLEAF (Wageningen).

The sugarcane industry is India's second-largest agro-based industry and about 6 million farmers and a large number of agricultural labourers are involved in its cultivation. Sugarcane is a major consumer of water and the decreasing level of the natural groundwater resource threatens food security, economic growth and livelihoods. With support from the Sustainable Water Fund (FDW), the project intends to enhance both sustainability of sugarcane growing and to raise smallholder incomes. Major activities include training on good agricultural practices (e.g. water conserving practices), introduction to improved irrigation systems (e.g. drip irrigation instead of furrow irrigation), and farmer training in best farming practices and to improve their financial literacy.

Wageningen Economic Research conducted this baseline study to enable the subsequent evaluation of the socio-economic impact on sugarcane farmers of the Solidaridad field programme. In the absence of a suitable counterfactual, a pipeline approach was used which clusters the farmers in cohorts based on the year they receive initial support and training (e.g. starting in 2016, 2017 or 2108). The survey conducted on 1,008 farmers contained a broad range of data on personal, household, farm, production and income characteristics; the key findings are presented in a concise manner in this report. The mid-term and end-term surveys will be conducted in 2017 and 2018. This will enable to draw robust conclusions regarding the welfare impact and the resource use implications of the project.

The evaluation will offer more insights into the effectiveness of the roll-out of proven farming techniques and the delivery of farmers' training in the application of water-efficient drip irrigation, which leads to the use of good agricultural inputs and practices. The underlying theory of change states that mass adoption of water-efficient farming methods and techniques will improve water use efficiency in sugarcane farming to the point that water extraction is reduced and thus contributes to improved livelihoods as a result of higher productivity.

We kindly acknowledge the support of the field staff of our local research partner Q&Q and the cooperation of the farmers, the mills and staff of the project in the research area. We sincerely hope that this report provides a relevant reference for field staff and stakeholders involved in the implementation of this programme.

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Summary

Improving water use and profits for Indian sugarcane

India is one of the largest producers and consumers of sugarcane and its demand is increasing while productivity is stagnating. Sugarcane is a major consumer of water and the decreasing level of the natural groundwater resource threatens food security, economic growth and livelihoods (GWP 2012, FAO 2013). The proposed project 'The Sustainable Water Fund' (FDW), a public-private partnership led by Solidaridad Network Asia ltd, aims to support the roll-out of proven farming techniques and the training of farmers in the application of water-efficient drip irrigation and good agricultural practices. The project aims to reach out to 40,000 farmers in South India through 3 mills.

The theory of change is that mass adoption of water-efficient farming methods and good agricultural practices will improve water use efficiency and productivity in sugarcane farming, in accordance with the Bonsucro standard, and decrease production costs. Therefore, the intervention has a clear business case.

High importance of solid prove effectiveness

Wageningen Economic Research conducts a study to evaluate the socio-economic impact on sugarcane farmers of the Solidaridad programme. A pipeline approach was used, which clusters the farmers in cohorts based on the year they receive support and training: 2016, 2017 and 2018. A baseline survey was conducted on 1,008 farmers from the command areas in April 2016. This report gives a representative and detailed description of the target group in 2016.

Unique participating mills with diverse profiles of sugarcane farmers

The studied mills have sufficiently large sugarcane production levels, water scarcity and a sound monitoring system. Mills differ in terms of size, capacity, production and also in the climate of the command areas and the soil quality and condition. This diversity of the mills has consequences for technology uptake and implications for the way to assess impact from follow-up surveys.

Farmers are on average 44 years old, male and head of the household and 20% of the farmers are illiterate. For 94% of the farmers, income from sugarcane accounts for more than 75% of their total income. Sugarcane is predominantly produced on owned land (on average 3.3. acres) and over half of farmers cultivate both ratoon and plant crops. Farmers have a long history of sugarcane cultivation with an average of 14 years, but this is only 4 years for farmers in Mill 2. Farmers are not organised in farmer groups, except for Mill 1. There exists a high variation in production and productivity between farmers, where Mill 2 has a relatively low productivity per acre. The price received for sugarcane varies as it is incurred by the government. Half of the farmers received governmental subsidy for fertiliser and electricity and drip irrigation is generally financed with governmental subsidies.

Farmers challenged by low income and water shortage

Half of the farmers are likely to fall below the USD2.50/day poverty line. More than half of the farmers are willing to invest and approximately 50% of the farmers are willing to take a risk when investing in agriculture. Concerning trust, in general, farmers seem to trust the mill they supply to. However, the farmers have a short time horizon, hampering investments which will benefit in the long run. Unavailability of labour is the main challenge according to farmers. Water shortage is a serious challenge for farmers in Mill 2 and 3. Delay in the cutting order, pest and diseases, and low prices of sugarcane are other major challenges. Ninety-eight per cent of farmers never received support on sugarcane cultivation, but 100% are interested in this. The differences between the mills and their challenges ask for unique training needs per mill.

Good agricultural practices compete with traditional methods

Good practices are defined by input use, specific practices and irrigation techniques. Farmers almost exclusively use traditional setts. Eighty-four per cent of farmers use chemical and biological fertilisers. However, application guidelines are neglected. The share of chemical fertiliser used is higher for

female farmers, more experienced farmers and if the farmer has a higher share of land used for other crops. Application of chemical pesticides is a common practice. When own land and cattle is not the source for biological fertilisers, the costs that are incurred for biological fertilisers are relatively high. Farmers apply correct row-to-row spacing, but intercropping hardly occurs. Almost all farmers burn their trash after harvest, and trash shredders are hardly available. Time preferences and risk perception are related to burning trash.

Furrow irrigation predominant at Mill 1, drip irrigation at Mill 2 and 3

Furrow irrigation is the predominant technique (72%), drip irrigation is applied by 28%. Only 3% of farmers from Mill 1 use and prefer drip irrigation. Drip irrigation is more common at Mill 2 (45%) and 3 (61%). Drip irrigation is less common on leased land. More male farmers - compared to female farmers - and landowners have drip irrigation and landowners. Higher drip irrigation occurs under male farmers and landowners. Maintenance of drip irrigation systems is a challenge that may hamper uptake of drip irrigation as well as the satisfaction with the current irrigation system.

Higher production costs in owned sugarcane areas

The average production costs per acre are INR21,291, but there are large differences in production costs between the mills. Differences in costs are partly explained by soil quality and labour shortages. Using plant crop is related to higher production costs and owned sugarcane acreage and use of chemicals (versus organic) is related to lower production costs. Overall 63% of the farmers reported quality improvement of sugarcane in recent years. In Mill 2 though, more than 90% reported a decrease in quality.

Increased profit as ultimate outcome

Profits can only increase thanks to higher efficiency and an increased productivity as the price of sugarcane is regulated and cannot be influenced by the famers or mills. The average gross income from sugarcane of INR242,000 is above GDP per capita of 107,206 INR (WorldBank 2015) (also see Table A3.16) and Mill 1 farmers have the highest gross income. Surprisingly, data show that, using plant crops only, large shares of chemical fertiliser and drip irrigation are significantly related to lower gross profit. This latter relation is somewhat alarming considering that drip irrigation is expected to increase gross income. Household size and sugarcane acreage are correlated with higher gross income. Profit per acre is higher for farmers who received subsidies and lower when using a higher share of organic fertilisers or drip.

Relevance of customised intervention

Farm profiles in terms of personal and farm characteristics differ significantly between the three participating mills and show large differences within the command areas of the mills. Farmers face different challenges and have different training needs. Good agricultural practices are lacking across all mills and the uptake of drip irrigation is only evident among farmers in Telangana state, where water shortage is more of a challenge. Maintenance of the drip irrigation system is an important training need. These findings underline the relevance of the intervention, but also highlight that a one-fits-all approach is probably not the best approach in this context. Farmers face financial barriers in the uptake of good agricultural practices and irrigation systems and government subsidies function as financial enablers. Some farmers are already organised in groups, making use of the existing organisational structures and further mobilising them could be very useful for adoption of learnings. Besides, the reputation of the mills from the perspective of the farmers influences potential uptake of good practices. Adoption of drip irrigation is not related to higher productivity or gross margins and this requires more attention as it is one of the key elements of the projects' intervention logic.

Table 0.1. Heterogeneity between participating mills (*** (α = 0.01), ** (α = 0.05) and * (α = 0.1)

Characteristics per mill	Mill 1	Mill 2	Mill 3	Overview challenges and desired training topics
Socio-demographic characteristics				**Mill 1**
Age***	39.2	39.0	52.7	*Top 5 challenges:*
Male	91%	93%	88%	67% Attack of pest and diseases
Head of household***	69%	96%	78%	67% Delay in getting cutting order
Household size***	3.2	4.5	5.6	61% Unavailability of labour
Illiteracy level***	0.4%	28%	49%	58% Low price of sugarcane
% 75 or more income sugarcane***	91%	98%	98%	47% Unavailability of water for irrigation
Progress out of Poverty Index(PPI)***	40.4	60.7	70.8	
Time horizon (500 INR now or x INR next year)***	903	1,063	914	*Top 3 training topics:*
Farm characteristics				82% Trash shredding and mulching
Owned sugarcane area***	2.93	4.10	3.50	47% Soil testing
Leased sugarcane area***	0.37	0.00	0.12	30% Good agricultural practices
Experience***	14.6	3.83	17.8	
Member of farmer group***	59%	19%	5%	**Mill 2**
Subsidy***	48%	38%	43%	*Top 5 challenges:*
Good agricultural practices				85% Unavailability of water for irrigation
Only plant crop***	13%	59%	17%	73% Unavailability of labour
Only ratoon crop***	65%	41%	66%	71% No resources for agricultural inputs
Setts***	100%	88%	98%	61% Bad condition of drip irrigation
Single bud sets***	18%	46%	92%	61% Attack of pest and diseases
Chemical fertiliser	100%	100%	100%	
Biological fertiliser***	100%	82%	58%	*Top 3 training topics:*
Chemical pesticides***	100%	99%	88%	93% Good agricultural practices
Chemical and organic pesticides***	25%	80%	1%	92% Irrigation practices
Intercropping	1%	3%	1%	87% Soil testing
Burning***	89%	8%	42%	
Irrigation systems				
Furrow***	97%	54%	39%	**Mill 3**
Surface drip***	1%	45%	3%	*Top 5 challenges:*
Sub-surface drip**	1%	0%	2%	89% Unavailability of labour
Drip fertigation***	2%	23%	57%	81% Unavailability of water of irrigation
Production & gross income				67% Delay in getting cutting order mill
Productivity (tonne per acre)***	47.8	25.5	45.2	64% Low price of sugarcane
Labour costs/tonne (INR)***	209	515	532	50% No equipment for soil testing
Input costs/tonne (INR)***	176	421	317	
Price/tonne***	2,272	2,554	2,293	*Top 3 Training topics:*
Total Gross income (INR)***	293,390	193,983	176,953	80% Good agricultural practices
Gross income/acre (INR)***	88,513	44,757	75,218	74% Soil testing
Gross income/tonne (INR)***	1,798	1,618	1,419	55% Irrigation practices

Introduction

1

Introduction

The future of sugarcane production is threatened by unsustainable water use

India is the world's largest consumer of groundwater and its agriculture, in particular sugarcane production, depends on water (WorldBank 2012, Worldwatch 2013). Irrigation has been a major component in agricultural development since the 1960s and enhances agricultural productivity, food security and induced commercialisation of agriculture. However, groundwater is extracted faster than it is naturally replenished and the overexploitation of the groundwater resource threatens food security, economic growth and livelihoods (GWP 2012, FAO 2013).

New strategic alliance to ascertain more sustainable water use

Frontrunner companies in the sugar industry in India are seeking strategic cooperation to effectively address this situation which acutely threatens the very future of the sector. The central government of India has been subsidising the cost of equipment for drip irrigation to accelerate its adoption. However, despite the yield-enhancing and water-conserving advantages of drip technology, the uptake of this technology by farmers has been slow and the water productivity gains so far have been far below potential. The strategic alliance has resulted in the proposed Sustainable Water Fund (FDW) project and a public-private partnership led by Solidaridad Network Asia ltd and Solidaridad. FDW will promote and support the roll-out of proven farming techniques and practices among smallholder sugarcane growers, to significantly raise irrigation water productivity and increase income from sugarcane farming.

The sugarcane business case to increase sustainable water use

The FDW project is designed to achieve water use efficiency on the basis of a clear business case for smallholder sugarcane farmers and the concerned mills. The project will promote water-efficient irrigation techniques such as drip irrigation, input use and farming practices that have proven to increase both water use efficiency and sugarcane yields which can be adopted by farmers on a large scale. This will be based on the Bonsucro standard, the global metric standard for sugarcane. Bonsucro is a global multi-stakeholder non-profit organisation dedicated to reducing adverse environmental and social impacts of sugarcane production while recognising the need for economic viability. The theory of change (also called intervention logic) is that mass adoption of water-efficient farming methods and techniques will improve water use efficiency in sugarcane farming to the point that water extraction is reduced.

The project targets 40,000 farmers in South India through 3 mills

Solidaridad and its regional subsidiary, Solidaridad Network Asia ltd, will be working with two sugar companies[1] to improve water productivity and incomes of some 35,000 farmers in the command areas of three selected mills in the provinces Karnataka and Telangana in South India. Two mills are selected from one company and one from the other. Trainings will be provided to all interested farmers on relevant topics concerning irrigation, input use and agricultural practices in 2016, 2017 and 2018. There are significant differences in personal, household and farm characteristics between the farmers that supply the different mills, but also in soil and climatic perspective. These differences influence the implementation of the project and are taken into account in monitoring and evaluation.

Delivering solid proof of the programmes' effectiveness is important

The project intends to deliver solid proof of the effectiveness of the intervention by monitoring water productivity and directing the intervention by innovative remote sensing techniques, making use of the expertise of eLEAF, and through socio-economic impact assessment, supervised by Wageningen Economic Research. Other local entities partnering with Solidaridad are Vasantdada Sugar Institute and Osmania University. The project is financially supported by the Netherlands Enterprise Agency (RVO).

[1] For confidentiality reasons, no names of the companies and mills are used.

Representative and detailed description of the target group in 2016

We provide a detailed description of the target group, the way they produce sugarcane and the extent to which they are making a profit based on data from 1,008 sugarcane farmers in the scope of a baseline study. The baseline survey was conducted by Wageningen Economic Research and its local research partner Q&Q in July and August 2016. This report provides a detailed description of the intervention logic (Section 3), the methodology used (Section 4), the characteristics of the target group (Section 5), the results of the baseline study and conclusions and recommendations for policy as well as the impact evaluation after the project ends in 2018. First some contextual background information is given of the specific sugarcane industry in India. For confidentiality reasons, the three mills are referred to with the numbers 1, 2, 3 instead of their names.

2

Context

Context

2.1 Sugarcane has an important role in India's economy

India is one of the largest producers and consumer of sugarcane

Eighty per cent of sugar produced worldwide comes from sugarcane, the remaining 20% comes from sugar beets. Brazil, India and China are the top three producers and consumers of sugar globally. As for consumption rates, India and China use about as much as they produce (Fairtrade and Sugar, 2013). With an annual turnover of USD17 billion, the sugar industry is India's second largest agro-based industry, after cotton (Solomon 2011). About 6 million farmers and a large number of agricultural labourers are involved in cane cultivation. More than half a million workers, mostly from rural areas, are engaged in the sugar industry. A total of 642 sugar mills in ten states in Southern and Northern India process cane into around 25 million tonne of sugar per year (Indian Sugar Mill Association 2016). Other than sugar, products derived from sugarcane include molasses and bagasse. See Appendix 1 for a map of the sugarcane companies and a graph of the processing sugar. The area under sugarcane is hovers around 5 million hectares and with an average productivity of 68 tonnes per ha, yielding some 340 million tonnes of cane per year (ibid).

Sugarcane demand increases while productivity is stagnating

It is estimated that by 2030, India will require about 520 million tonnes of sugarcane to keep up domestic consumption of sugar and ethanol. Considering that there is little scope for area expansion, this will entail a productivity requirement of around 100 tonnes per ha (Duttamajumder et al., 2011). After decades of increasing cane yields, however, productivity has stagnated in the last 15 years. And sugar recovery (9%-10%) is one of the lowest in the world.[2] From the sugar mill perspective it is crucial to ensure a guaranteed supply of cane but also to increase recovery in order to have a gross income, as the minimum price which has to be paid to farmers is set. The recovery percentage is influenced by several factors: a) altitude (the higher the altitude, the lower the quality/moisture content), b) variety used, c) efficiency of production process and d) cultivation process. The latter three can be influenced by the mill and the farmers themselves. The sugar mill has immediate benefit from economies of scale if the producer uses the right variety and good agricultural practices to improve quantity, quality and as such recovery percentage.

The sugarcane market in India is highly regulated but not entirely stable

Sugar, being an essential commodity, is controlled through various regulatory mechanism in India. The sugar mills procure sugarcane from the farmers in their government-mandated 'command areas'. Mills have to buy the crop from the farmers at or above the Fair and Remunerative Price (FRP) set by the Union Government or the (higher) State Advised Price (SAP) fixed by the State Government.[3] This pricing mechanism helps cane farmers in getting an assured and generally higher income. Indeed, according to the Indian Sugar Mills Association Indian farmers benefit from the world's highest price paid per tonne of sugarcane. The sugar price for consumers, however, is not regulated; the result is a three to five-year production cycle which makes sugar manufacturers vulnerable to industry oscillations. Sugar by-products such as molasses and bagasse aid the sugar mills in diversifying risks and lending stability to their revenues (Solomon 2011).

[2] Recovery is the amount of sugar out produced out of sugarcane, so 10% recovery means: 10 kg of sugar out of 1000 kg sugarcane.

[3] The FRP for 2015-16 is 2300 Rp/ton at a recovery rate of 9.5% which is the same as 2014-15. The FRP for 2016-17 hasn't been announced yet as it will announced in October.

2.2 High occurrence of water-wasting irrigation practices

The tragedy of groundwater depletion

The above outlined patterns of stagnating production despite consumption increase, price regulations and the unstable sugarcane market are one side of the coin. The other side of the coin is that water scarcity is increasing, affecting sugarcane farming areas as sugarcane is high in irrigated water use. The situation is exacerbated by increased rainfall variability due to climate change which may reduce sugarcane yields (WorldBank 2008). The common method of water delivery in growing sugarcane in southern India is either by flood or furrow irrigation. However, the irrigation efficiency of these (traditional) methods is only 30-50% so there is considerable wastage of water. In addition, these practices harm soil fertility by leaching soil nutrients. To compensate for the loss of soil nutrients, high levels of unbalanced fertilisers are applied contributing to groundwater pollution (Solidaridad 2014).

Joined forces to combat production and water shortages

These challenges at farmer, mill and public-good level ask for an approach where forces are joined and are mutually beneficial to all participating actors. The intervention will be sustainable if it strengthens the sugarcane farming business case – at producer and mill level - while at the same time effectively addressing the over-extraction of groundwater. As the mills and extension staff have frequent contact with their farmers they can play a crucial role in training and convincing farmers to adopt best practices. Given the political difficulties associated with bringing about effective policy reforms to achieve the objective of water conservation, the Government of India's response to the emerging water crisis is focused on technological solutions backed by subsidies to aid and facilitate adoption of water efficient technological solutions by farmers. Local government can play an important role in transitioning from exploitation to management of the critical groundwater resource. The knowledge institutes VSI and Osmania University are crucial actors in generation and dissemination of knowledge and in influencing political decision-makers. Solidaridad as an NGO can play an important role as multi-stakeholder and independent convenor. The cooperation of these players is organised through a public-private partnership (PPP) with the objective to support, expand and sustain the intervention, long after the FDW project has ended.

2.3 The 3 mills in the FDW are very diverse

FDW mills have sufficiently large production levels, water scarcity and sound monitoring

The partnership is established with 3 mills from 2 leading companies of India, here referred to as company A and company B. All companies have several factories in operational in various states of Southern India. Company A has 5 integrated sugar factories with a crushing capacity of 27,000 tonnes of cane per day (TCD) located in 3 states in southern/western India with a total command area of 2,300 villages with 57,000 sugarcane growers. These mills differ in production capacity and are located in different states and as such vary in environment, climate, soil condition and water availability, farmer profiles and mill management.

Company A selected two mills out of the five to participate in the project: one is located in Karnataka state and the other in Telangana. Company B has four sugar mills in Tamil Nadu and Telangana with a total crushing capacity of 13,500 TCD. Also at company B, mills differ in terms of capacity, climatological circumstances, farmer characteristics and profiles. This implicates that more information and data are needed to draw conclusions on upscaling at the end of the intervention if that is upscaling is one of the aims of the partnership. The possibilities and limitations of upscaling are outside the scope of this project, but the recommendation is that results are not automatically representative for the sugarcane sector in India. The companies based their selection of the participating mills on the following criteria.

1. Farmers in the command area are consistent and loyal in cane production, as such guaranteeing a certain volume of sugarcane to be supplied and showing the relevance of cane as an income source.
2. A command area marked by water scarcity and soil conditions which can be improved by certain good agricultural practices.
3. The mills have an up to date management information system in place[4] with registration of all sugarcane farmers in their command area including their basic characteristics; as such they are able to realistic targets, approach and monitor the farmers and providing the methodological basis for a representative sampling.

[4] SAP Cane Management System.

Mills differ in terms of size, capacity, production but also *soft* parameters

Table 2.1 below shows the main characteristics of each mill. Mill 1 and 2 are of the same company and Mill 2 and 3 are located in the same state. It is important to take into account these difference when interpreting the results (e.g. high differences in temperature of rainfall influences levels of cane production and productivity). The policy or reputation of a specific mill could also explain differences observed. These more 'soft' parameters cannot be captured objectively in figures. However, these issues are topics of discussion with the implementing parties. Appendix B presents a complete overview of the main results from the data per mill.

Table 2.1 Characteristics of mills

Parameter	Mill 1	Mill 2	Mill 3
Company	--	--	--
State	South Karnataka	Telangana	Telangana
Command area (acres)	24,000	11,500	21,000
Irrigated area (acres)[5]	75,000	250,000	29,966
Number of farmers registered[6]	12,200	3,200	11,130[7]
Capacity (tonnes of cane per day)	6,000	3,500	3,500
Average yield (metric tonnes/acre)	30	28	29
Average annual rainfall (mm)[8]	650-700	600	837
Revenue / acre (INR) plant / ratoon	84,000 / 72,000	75,000 / 62,500	Unknown
Costs / acre (INR) plant / ratoon	49,500 / 33,200	42,360 / 27,200	Unknown
Gross income / acre (INR) plant & ratoon	36,650	33,970	Unknown

[5] Irrigated area and command area differ in size because the irrigated area data are for the district and include other crops apart from sugarcane, whereas the command area is the area designated for the sugarcane mills to operate in. Hence, the command area is always smaller than the irrigated area.

[6] Supplied sugarcane in the last harvest.

[7] Meaning a total number of registered farmers in the project area of 26,530.

[8] Sugarcane favours 700-1,200 mm rainfall.

The climate of the command areas of Mills differ

Figure 2.1 below shows the maximum, minimum and average temperatures of the mills per month. The temperature influences the growth of sugarcane: very high temperatures reduce moisture content and thus increase the need for water. Rainfall does not coincide with the warmest months of the year.

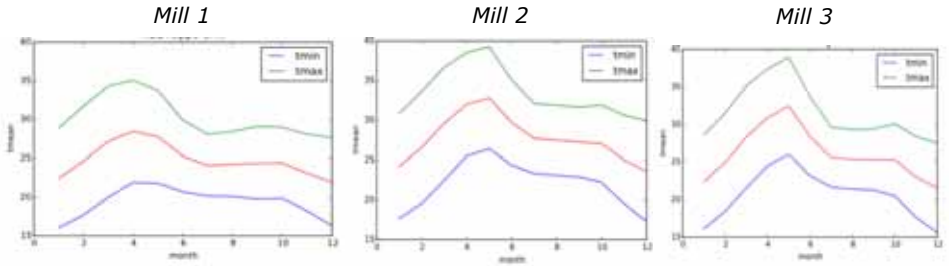


Figure 2.1 Temperatures per month in command areas mills differs

Farming areas differs in terms of soil quality and condition

As briefly indicated above, there are several contextual and climatological differences between the two states explaining some of the differences noticed between farmers in these states. The most important difference concerns soil quality and condition. In general soil of Karnataka has a better quality compared to Telangana as it is river basin soil with higher soil nutrients. Table 2.2 gives a short narrative of the main mills characteristics relevant to this project.

Table 2.2 Specific context of mill

Mills	Characteristic soil, water and irrigation
Mill 1	The command area of Mill 1 is characterised by red and black sandy loam and medium soils, which allows high water drainage. Its' fairly rich organic nutrient content makes it conducive for sugarcane cultivation and it has 75,000 acres of irrigated area. Average rainfall in the target's catchment region is in range of 650-700 mm. Yield and cane acreage exhibits very low to moderate correlation with rainfall over the past ten years owing to improved irrigation facilities in the region. The area is irrigated via a host of rivers (Hemavati, Cauvery, Lakshmana Tirtha and Shimsha), reservoirs (Krishnarajasagar, Markonahalli and Managala) and a well-branched canal system network. Main irrigation source is KRS Dam through perennial Vishweshwaraih canal system. Irrigated land in Maddur and Mandya talukas constitute nearly 80% and 60% of cultivable land respectively. Accordingly, most of the mill's catchment area is very well irrigated making it suitable for sugarcane cultivation. The primary crops in the region are paddy, ragi and sugarcane, of which paddy and ragi are used largely for domestic consumption. As a result, this is mainly a cane belt with limited competition from other crops. the closest competitor to sugarcane is paddy; Currently, sugarcane is ~1.4x more gross income able than paddy and 1.3x more gross income able than ragi.
Mill 2	The command area of Mill 2 in the southern Telangana zone is characterised by red loams (40%) and black soil (60%), both conducive for sugarcane cultivation and it has 250,000 acres of irrigated area. Average rainfall in target's catchment region is around 600 mm. It is sufficient to maintain 750-800 TMC[9] of water outflow from the Jurala reservoir which is adequate for cane cultivation. This area is irrigated via 3 rivers (Krishna, Tungabhadra and Bheema). Two significant lift-irrigation projects, to be fed by Jurala dam on river Krishna, are in progress. The Nettanpadu phase I & II, Bhima phase I & II projects on completion are expected to add over 400,000 acres of irrigated area in next 2 to 3 years. This is expected to lead to significant incremental cane availability. Paddy and groundnut are the other major crops cultivated in the irrigated area. Crop economics indicate sugarcane results in 1.2 times more gross income than paddy and groundnut each.
Mill 3	In the command area of Mill 3, the annual rainfall has been decreasing. The groundwater depth in most of the zones is already 400 to 500 feet and there is no scope for either deepening existing wells or drilling new wells. Sufficient rainfall is required every year to recharge the groundwater potential; 60% of the soil consists of red laterite, which has very poor water retention capacity and percolation. There are hardly perennial sources for irrigation such as rivers, canals or irrigation schemes. Sixty-eight per cent of the water for irrigation comes from open wells, 22% from bore wells, 3% from rivers and canals and 8% from tanks and lakes and the irrigated area is 29,966 acres.

Source: data of the mills provided during field visit, April 2016

[9] One thousand million cubic feet, commonly used in reference to volume of water in a reservoir or river flow.

Policy advice valid for individual mills

Although the mills are selected on these parameters, they differ in many perspectives. As a methodological consequence, the mills and their farmers cannot be compared one-on-one. This is further elaborated upon in the methodological chapter. The policy consequence is that it might not be very effective and relevant to roll out a one-fits-all approach and training to all 40,000 farmers to be targeted. This will be further targeted upon in the conclusion and recommendation chapter.

FDW intervention logic

3

FDW intervention logic

Enhance the social, economic and environmental sustainability of sugarcane production

The overall objective of the FDW project is:

> 'To stop and reverse the depletion of the critical groundwater resource, thereby sustaining and improving the livelihoods of smallholder sugarcane growers and securing employment at sugar mills and downstream agro-industry in India' (FDW Project Plan Solidaridad 2014).

Achieving this objective requires that less water is extracted in cultivating sugarcane. Therefore, it proposes a large-scale roll-out of irrigation techniques and farming practices that have proven to raise water productivity and gross income of sugarcane farming in smallholder settings in India. Figure 3.1 is the visualisation of the intervention logic of the FDW project by Wageningen Economic Research.

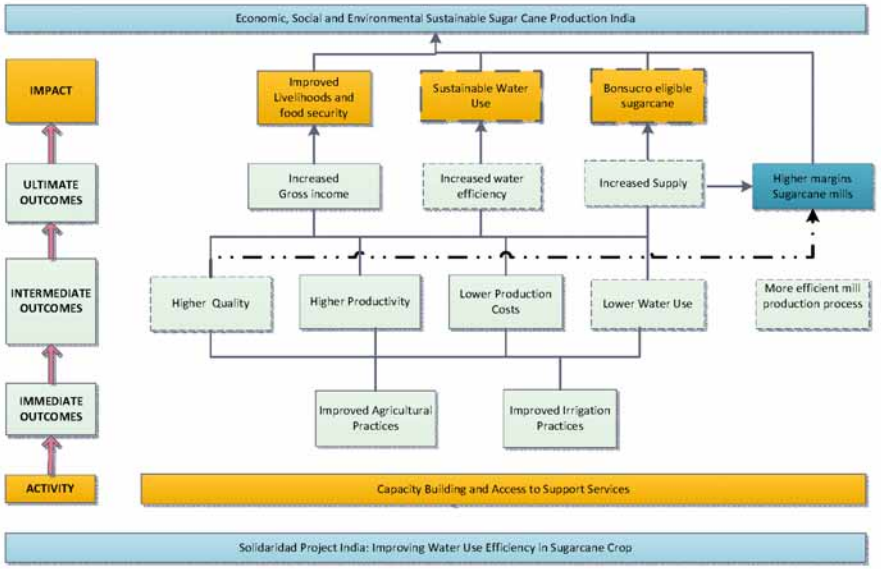


Figure 3.1 *FDW intervention logic*: from capacity building and support services to sustainable sugarcane production

Capacity building in best farming practices, financial literacy and service delivery

At activity level, 35,000 smallholder sugarcane farmers are to be trained in best farming practices by extension workers of the three selected mills and selected lead farmers. The project reaches out via the so-called training of trainers (ToT) and training of farmers (ToF) model, i.e. first 2,000 lead farmers are defined and trained (ToT) who are responsible for training and coaching of the farmers (ToF) which are organised in groups. Table 3.1 gives an overview of the main priority areas. Theory and practice are both components of the training and 100 demonstration plots are cultivated. An additional 5,000 farmers are trained in financial literacy with the aim to be linked to loans to be able to finance investment in irrigation systems. An additional

300 farmers are trained and equipped to provide trash shredding services (100 famers), produce and supply sugarcane seedlings (100 farmers) and provide drip irrigation maintenance services (100 farmers).

Table 3.1 Priority areas sugarcane producer trainings on irrigation and water conserving practices

Irrigation systems	Water conserving practices
Surface drip irrigation	Improved fertigation
Sub-surface drip irrigation	Trash mulching and shredding
Drip irrigation with fertigation	Composting and bio-fertiliser
	Intercropping and wide-spacing
	Seedlings and gap filling

Improved practices result in increased income, water use efficiency and production

Adoption and uptake by the trained farmers is assumed to lead to improved agricultural practices, improved input use and improved irrigation systems (immediate outcome level). These in turn lead to lower production costs, lower water use and higher productivity of sugarcane. The project aims to increase sugarcane yields by 12% in the project area. The improvements in farming should also lead to higher quality of sugarcane and result in higher prices[10]. Higher productivity in combination with higher prices leads to increased gross income at producer level (ultimate outcomes) and increased water efficiency/productivity: the target is that water consumption (and electricity consumption) per acre are reduced by 16% and water productivity is increased by 33%. In addition to the producer level, the mills will receive more volumes of better quality sugarcane produce, leading to increased margins. At mill level, 446,000 tonnes of sugarcane is additionally produced at the end of the project period.

Increased income and water use efficiency result in better livelihoods

At impact level, sugarcane farmers experience improved livelihoods and food security as sugarcane is the main source of income in this area. The element of food security is targeted up via two ways. First, farmers are stimulated to intercrop sugarcane with fruits and vegetables as one of the good agricultural practices instead of only cultivating sugarcane. Second, more water is available for other crops when water is used more efficiently in sugarcane production. The other impact area is that water use is more efficient leading to 60 million litres of water saved at the end of the project period.

Bonsucro ascertains transparency of sustainability in the chain

Increased water efficiency leads to sustainable water use as the water footprint decreases. As the implemented and adopted farming practices and irrigation systems are based on the Bonsucro standards, there will be an ascertained, eligible supply of sugarcane meeting the Bonsucro sustainability requirements. Certification itself is no project target as it is beyond the scope of control of the implementing parties.

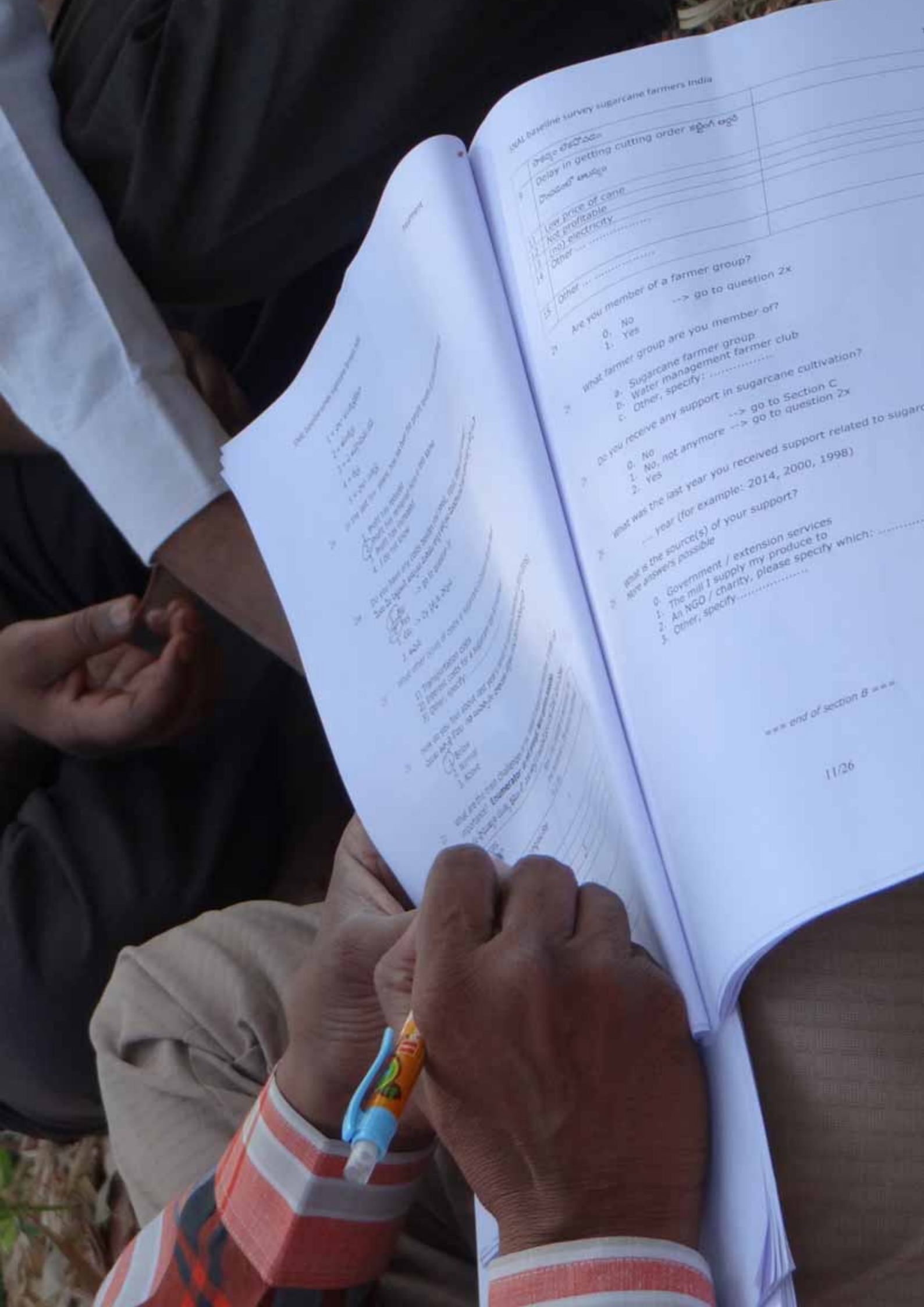
Inclusive project implementation

The project is implemented by the mills and is inclusive, i.e. all sugarcane farmers in the command area are approached to attend the different training modules. The mill sends a message to all the registered farmers via for example an announcement in the local newspaper, a text message and via the field officers. The mill informs about the upcoming training module and mentions dates, times and place. The agricultural training will be offered in modules covering good agricultural practices, water conservation techniques and suitable irrigation systems. The project target is to train 35,000 sugarcane farmers in total. This target exceeds the current number of farmers registered by the mills. Expectation is that more famers will.

Project entails more than training on good agricultural practices and financial literacy

The mills will facilitate in accessing a loan for the farmers who are interested in a drip irrigation system. A financial literacy training is therefore offered to an additional 5,000 farmers to assist them in handling their finances and paying their loan and interest. A selective group of farmers (300) will be trained on and provided with equipment on the following three other topics: 1) seed nursery, 2) trash shredding and 3) maintenance of irrigation systems. At the moment of the baseline it is not yet defined which farmers will be offered the additional trainings on financial literacy and the three topics mentioned. Training is provided by extension staff of the mills and 2,000 lead farmers. Trainings are both theoretical and practical and 100 demonstration plots are established.

[10] The fair remunerative price is the minimum price to be paid to sugarcane farmers set at 9.5% recovery. Price increases when recovery percentage increases.


SAI baseline survey sugarcane farmers India
Are you member of a farmer group?
0. No
1. Yes --> go to question 2x
What farmer group are you member of?
a. Sugarcane farmer group
b. Water management farmer club
c. Other, specify: .....
Do you receive any support in sugarcane cultivation?
0. No
1. No, not anymore --> go to Section C
2. Yes --> go to question 2x
What was the last year you received support related to sugarc
___ year (for example: 2014, 2000, 1998)
What is the source(s) of your support?
Give answers possible
0. Government / extension services
1. The mill I supply my produce to
2. An NGO / charity, please specify which: .....
3. Other, specify.....
=== end of section B ===
11/26

4

Methodology

Methodology

4.1 Demonstrating impact of improvements

Data for M&E are collected by several parties to ensure complete data and triangulation

Monitoring and Evaluation (M&E) is crucial to demonstrate the level of success of the project, i.e. the effectivity of the intervention to bring about large-scale adoption of improved techniques and best practices, and to translate learnings in a road map for sugarcane sustainability. To capture impact at the different levels and objectives and to interpret and validate pathways, M&E is conducted with several parties all with their specialism and expertise focusing on a specific target. Increased margins at mill level, Bonsucro certification and sustainable water use (i.e. lower water foot prints) are not incorporated in this study. These indicators are monitored and evaluated by the other parties involved (i.e. eLEAF, Vasantdada Sugar Institute and Osmania University). Data of the different sources are shared and combined to guarantee triangulation and to be able to report on the achievements of all targets and the intervention logic. Data will be collected on specific targets such as rainfall, temperatures, water efficiency and groundwater levels. Figure 4.1 shows the different steps in the process.

4.2 Building a counterfactual to enable impact evaluation

Impact evaluation requires a strong counterfactual design

The interest is to show the projects' impact on behavioural changes and the socio-economic development of the supported farmers. This requires a counterfactual: we need to identify what would have happened had the project not (or otherwise) been implemented. A simple comparison between baseline and end line indicators is not enough, because changes might have resulted from other issue than the project (e.g. rainfall, economic development, policy changes etc.).

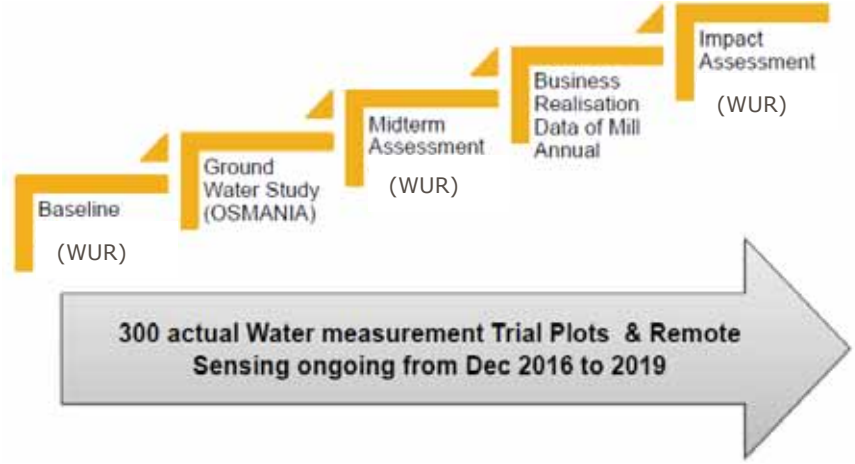


Figure 4.1 Steps and roles in evaluation process: from baseline in 2016 to impact assessment in 2018.

A strong counterfactual design requires an appropriate comparison group

A strong counterfactual is built on an adequate research design, including issues such as an appropriate sample size (large number of farmers), sampling strategy and data analysis. It is based on an appropriate identification strategy; this means we can only identify impacts (and attribute these to the projects efforts) making correct assumptions on 'what would have happened to the farmers if they would not have participated in the projects'. The choice for the identification strategy depends on the availability of a pool of (comparable) non-supported farmers, now, but also in the near future when the scope of the projects extends. In the FDW project this is a challenge because the aim is to cover all sugarcane farmers in the command area. In addition, there are no districts that are comparable to those that receive support, at least comparable

in those aspects that influence the main outcome indicators of the project (yield, water use, but also socio-economic development).

Exploiting the quasi experimental nature of the gradual phase in of the project

For the purpose of impact evaluation we exploit the fact that the project is implemented gradually over the years - the so-called 'quasi-experimental pipeline design'. This means we can compare farmers based on their different stages in the project support. This so-called pipeline design can be used to (better) control for unobserved differences, in absence of experimental designs and a control group (Khandker 2010, Stern 2012, DCED 2013). The main assumption is that support is indeed implemented gradually among the 35,000 targeted beneficiaries which are divided into years of training at the start of the programme. We will compare the average status of farmers that have already received support with the baseline status of the farmers that have not received it yet. With the pipeline approach it is possible to a) answer the questions concerning impact and attribution and b) meet the quality requirements and scientific rigour of an impact assessment.

Comparability between project cohort is crucial for impact evaluation

The quasi-experimental pipeline approach will give reliable estimates of programme net-effects only if the farmers in the different 'cohorts' are comparable. This is not likely if support is not allocated randomly; those that start receiving support might be different from beneficiaries that opt-in at a later stage – e.g. they might be more entrepreneurial or already used better practices. Before project implementation Solidaridad and Wageningen Economic Research agreed project implication will be phased in by Taluka (sub-district) spread across different mills: this addresses some of the concerns. In the impact analyses we take into account remaining differences at household level using econometric controls. Results reveal though that there are some variations between the three cohorts and as a consequence, the results of the different groups should be checked and controlled for and should be taken into account in further analyses and interpretation of data. A more extensive description including tables per cohort are presented in Appendix 5 tables A5.1 till A5.4 and figure A5.1.

To gain insight into short and long-term effects yearly data collection is needed

The pipeline method constructs a comparison group from subjects who are eligible for the program but have not yet received it. The mills will not train all their farmers in the first year, but will train approximately one-third in 2016, one-third in 2017 and one-third in 2018. As such, we can compare farmers in different stages in the project intervention. For example, on the assumption that farmers trained will apply the lessons learnt and new methodologies within one year (i.e. at the next planting round) the pipeline approach is suitable for estimating one-year effects.

4.3 Random selection of sugarcane farmers

Using power calculations to determine appropriate sample size

To measure the impact of the FDW project we need a sufficiently large sample size that allows us to capture the expected effect size with statistical significance. To determine this sample size we made ex-ante power calculations. If the sample size is too low, we might not capture the impact and if the sample size is too high, resources are wasted. In this context power calculations are informed by the variation among sugarcane farmers and the expected differences between supported and unsupported farm households. We use yield as a key outcome indicator: this is the indicator for which the lowest change is expected and this can be used as the upper limit of the minimum sample size needed, a safe point of departure. The mean values and expected change are based on the project plan. Based on previous research experience it is taken into account that the true change attributable to the project might be lower than initially estimated.

A sample size of 1,000 gives the basis for a relevant impact evaluation in 2018

Based on different scenarios and criteria we conclude that a sample size of 1,000 is sufficient to provide insights in terms of accountability as well as learning. This means approximately 1,000 farmers are interviewed in 2016, in 2017 and in 2018. Sample sizes per mill and year are determined according to the number of registered farmers per mill and the number of farmers to be trained each year. The majority of farmers will be trained in 2016 and 2017 so the sample proportion in these years is relatively large. The current databases

of the mills register 22,213 farmers in total. New farmers will be proactively approached and motivated to cultivate sugarcane and to attend the trainings. Estimation is therefore that at the end of the project period 40,000 farmers are trained and registered in the mill databases.

The sample of sugarcane farmers is selected randomly by mill and project cohort

The sample size is defined by a random selection of farmers from the mills' management information system whereby all farmers were divided into three groups based on the year they are expected to receive the training. The baseline survey is conducted among 1,008 farmers (3% of the total sugarcane population in the area) out of which 50 are lead farmers. The same 1,008 farmers will be surveyed at the mid and end-line measurements in 2017 and 2018. Drop out percentage is expected very low guaranteeing a sample size which is large enough for statistical analysis and regressions[11].

Table 4.1 Farmers to be trained per year and mill

Mill/year of training	2016	2017	2018	Total in%
Mill 1	2,495	4,427	1,127	8,049 (36%)
Mill 2	2,575	4,567	1,163	8,307 (37%)
Mill 3	1,816	3,222	820	5,859 (26%)
Total	6,887	12,216	3,110	22,213
In % of total	*31%*	*55%*	*14%*	*100%*

Sample size shares by mill and cohort year are in line with shares in total target group

Mill 1 and 2 are the largest mills in terms of registered farmers (36 and 37%). Therefore, the sample size includes more farmers of these two mills. As the majority of farmers will be trained in year 1 and 2 (respectively 31% and 55%), year 1 and 2 farmers represent the majority of the sample size. See Table 4.1 for an overview of the training schedule per year and per mill and Table 4.2 with the sample sizes per year and mill.

[11] Based on oral information of key experts of the sugarcane industry and on a trend analysis of data of the management information system of the mills.

Table 4.2 Sample size per year and mill

Sample sizes per year and mill	2016	2017	2018	Total sample size
Mill 1	201	208	128	537
Mill 2	54	58	30	142
Mill 3	132	136	61	329
Total	387	402	219	1,008
In % of total	*38%*	*40%*	*22%*	

4.4 Outcome changes for producers as indicators

Scope of this study is limited to the producer level

The impact assessment of Wageningen Economic Research focuses at producer level and evaluates the changes and effects at outcome and impact level. The project indicators at producer level are the point of departure in choosing the household survey as the tool for measuring impact. The intervention logic assumes that a certain change at producer, household level, leads to the desired outcomes and impact. A household survey gives the possibility to follow this logic. The intermediate steps are covered by measuring behavioural changes and quantitative data are collected on outcome areas concerning productivity and margins. Although the intervention is based on a clear business case (Catalyst, Business Case 2014) there are various assumptions underneath its logic. Table 4.3 below represents these assumptions per outcome level. The survey and statistical analysis makes it possible to test the underlying assumptions and as such the logic itself. Besides, information can be gathered about drivers and possible barriers for (no) adoption. The large sample size of farmers offers the possibility to verify the impact logic by checking and controlling for the assumed causal linkages.

Table 4.3 Assumptions per result area

Influence	Level	Result	Assumptions
High	Outputs	Training interventions such as information, goods and services delivered to farmers. Lead farmers are defined and trained, farmers are organised in water clubs, demonstration plots are established.	The right message. Project is relevant and people need the intervention, project is the right solution for the defined problems, enough resources are available, legal grounds for operation.
Medium	Immediate outcome	Enhanced knowledge on cultivation practices and irrigation systems due to the training received	Message is accepted. People, staff, timing, message is understandable, message is applicable, people want to be trained and willing to learn. No unforeseen events during intervention.
Low	Intermediate outcome	Changes in agricultural practices and irrigation techniques thanks to increased knowledge, awareness and access to finance	Willingness to change, people are willing to take a risk, people are willing to trust the new insights and trainers/mill extension staff and lead farmers Enabling environment allows change.
Lower	Ultimate outcomes	Increased productivity, reduced cost price, increased gross margin, decreased chemical use, increased water efficiency, thanks to adapted agricultural practices.	Proven correct technology, implementation, risks are controlled for, access to finance (loans, subsidy) no constraining unintended outcomes.
Lowest	Impact	Improved livelihoods and food security, sustainable water use, Bonsucro eligible sugarcane	Increased gross income is spent on healthy and nutritious food, water savings in sugarcane production are re-used for vegetable crop production; vegetable and fruit crops are used for intercropping.

Data collection on a wide range of personal, household and farm characteristics

Data is collected on the following 9 topics (see Table 4.4 below and see Appendix 6 for the complete survey). The sections gather data on personal and farm characteristics. Other sections include questions that give insight into the challenges sugarcane farmers face and their personal opinion to training needs to test the relevance of the programme from the farmers' perspective. Also various potential drivers (e.g. shortage of water) and barriers (e.g. no financial resources) for adoption are covered to be able to clarify and interpret (differences) in impact. Incentives for farmers to adopt GAPs differ depending on the focus of the GAP programme and the market failure it addresses. But broadly speaking, these incentives can be divided into economic incentives, regulatory/legal incentives and human-capital incentives. The disincentives for farmers to adopt GAPs include economic disincentives, institutional infrastructure constraints and human capital constraints (FAO 2003). The survey collects data on the main known incentives and disincentives to get insights into decision making and the rationale of the sugarcane farmers. Besides, based on literature (FAO 2012, Laeequddin et al., 2012; Kwon & Suh, 2005, Barham et al., 2014; Feder et al, 1985, Borgen 2004, Murphree 1993) aspects of trust, willingness to invest, risk perception and time horizon are taken into account. Previous studies have shown that these behavioural aspects are influencing decision making of an individual farmer in whether to adopt certain practices or not. The intervention logic, the project plan, literature and information gathered during the field visit are the basis of the survey and the topics covered. In the mid-term and end evaluation, additional data will be collected about the trainings received, attendance, satisfaction and relevance according to the target group.

Table 4.4 Sections and topics household survey

Section	Details / Main indicators
General characteristics	Gender, age, household size, education
Farm characteristics	Acreage, crop cultivation, plant/ratoon, own/leased land,
Sugarcane production characteristics	Production, labour, price received Challenges, farmers organisation,
Agricultural practices sugarcane	Seed and seedlings, chemical/biological inputs, trash shredding/burning, row space, intercropping, pest & disease
Irrigation practices	Irrigation systems applied/preferred, source of water, challenges
Inputs for sugarcane production	Types, volumes and costs of inputs used, share of chemical-biological fertiliser
Household income and diversification	Income composition, dependence on sugar, access to capital, subsidy (for irrigation/production)
Livelihoods	Includes progress out of poverty index
Risk, willingness to investment and time horizon	(un)Willingness to invest (in agriculture), risk attitude (aversion/taking), time horizon (short/long term)

Survey sections and details

4.5 The household survey as key tool

The household survey is customised to local context and pilot tested

A draft survey was developed based on FDWs intervention logic, the local context, and the available literature on impact of comparable interventions. This survey was discussed, refined and customised during a stakeholder meeting in April 2016. Stakeholder present were the partnering mills, the local research partner and visiting sugarcane farmers. Six local enumerators and supervisors were trained in close collaboration with Q&Q and the survey was pre-tested in the field. The surveys are translated into the two local languages (Telugu and Kannada) and conducted by the local research partner Q&Q Research Insights Pvt Ltd in the period June till August 2016.

4.6 Advanced data analysis in three steps

Descriptive data to give insight into situation of targeted sugarcane farmers

Data from the household survey were provided to Wageningen Economic Research in Excel format in August 2016. Data analysis took place with the statistical software STATA in August and September 2016. The purpose of this research is to set a clear baseline for impact measurement in 2018. A first step in the analysis is therefore to show the current situation of sugarcane farmers as defined by the indicators discussed in Section 4.4. To give an accurate and realistic representation of the situation we present mean, median, standard deviation and minimum and maximum values for each indicator.

Statistical analysis to give insight into difference between mill and project cohorts

We already showed there are significant differences between the mills, their command area and the farmers that supply them. The same is true for the difference between the project cohorts: farmers who receive support in the next year might differ from those that are scheduled to receive it in 2017 or 2018. This implies that a matching method is needed to compare the outcomes between cohorts. To show these differences, we present descriptive data by mill and project cohort, and use a t-test to verify the statistical significance of the differences between groups. The differences are however very minor and can be corrected for in the impact analysis. This confirms that the chosen pipeline approach is a very valid and suitable methodology to measure socio-economic impact in a rigorous and robust way. Appendix 5 shows the tables with cohort differences.

When estimating sample size we adhere to the international standards for significance level (α=0.05) and predictive power (1-β=0.8), with corresponding z-scores of respectively 1.96 and 0.84 significance levels are indicated as follows: *** (α = 0.01), ** (α = 0.05) and * (α = 0.1). More advanced statistical analyses (such as regression analysis) are used to test the robustness of these results when we also take into account sugarcane farmers do not only differ in term of mills they supply or cohort they are in, but also in terms of personal, household and farm characteristics. The most important regression models are presented in Appendix 4.

Statistical analysis to give insight into the determinants of envisioned project outcomes

The intervention logic in Figure 3.1 clearly shows how FDW aims to enhance the sustainability of the India sugarcane sector. In this report we validate whether the envisioned impact pathways are evident. We use regression analyses to link the different stages of the intervention logic: e.g. in estimating the determinants of productivity we include indicators of adoption. However, the FDW project will not be the only influence on the envisioned project outcome. Personal (e.g. age, education), household (e.g. household size) and farm characteristics (e.g. land size) also matter. Therefore, we use advanced statistical analysis (regression analysis) to gain insight into the relations between key personal, household and farm characteristics (as presented in Chapter 5) and key outcome and impact indicators. This means we look for determinants of how sugarcane is produced and what outcomes this has from an economic perspective (e.g. profit). Different statistical models are used to ensure robustness of results. Regression analysis focuses on specific key variables to get insights into relations, correlations and possible causal linkages. Three regression analysis are done to answer the following questions: i) what determines the presence of specific good agricultural practices including drip irrigation; ii) what determines productivity and iii) what determines farmers' gross income of sugarcane.

4.7 Validation workshop to verify result from analysis

In October 2016, the results were shared and validated with the project staff and local experts during a workshop with representatives from Solidaridad South Asia, research partner Q&Q, the participating mills and a Bonsucro expert. These discussions were used to interpret and validate the findings.

4.8 Limitations in inclusive selection

At the end of the project period, 40,000 farmers are planned to be trained and registered in the mill databases. Methodological implication is that these farmers did not have the chance to be selected to take part in the impact analysis. The same holds for the 2,000 lead farmers. There has been a random selection of the lead farmers who were already defined and the selected lead farmers participated in the baseline survey. The percentage of lead farmers in the baseline survey is 11%. The impact study focuses on the 35,000 farmer who are trained on the agricultural and irrigation practices. At the start of the project it was not known which farmers (300) would be trained on the entrepreneurial topics and who would receive the financial literacy training (5,000) to be eligible for a loan. It might be these farmers take part in the survey received more attention and specific trainings than the other farmers. The next survey design will include questions to identify these farmers and to control for results.

Profiles of a sugarcane farmer

5

Profiles of a sugarcane farmer

This chapter presents the general socio-demographic characteristics of the targeted sugarcane farmers, their views on investment, the farm and production characteristics of their sugarcane cultivation, and the perceived challenges and training needs. We find large differences between and within mills. The findings in this chapter are not only a point of departure for the impact evaluation in 2018 but also provide relevant insights for the design and roll-out of the intervention: what to further investigate, what to focus on and what to prioritise.

5.1 Socio-demographic characteristics

Necessity for area-specific farm evaluation

In order to characterise the target group, and in 2018 the impact of the project on this target group, we select the characteristics that are most relevant in explaining sugarcane production. These characteristics are related to gender, age, education, household size, income and poverty levels. Combined with the variables included in section 5.2 and 5.3, these characteristics will explain the outcomes FDW is training to influence (e.g. production, practices, profit).

Table 5.1 and 5.2 show the total values and per mill values of these personal and household characteristics. The characteristics differ significantly between sugarcane farmers supplying. There are high standard deviations of Mill 3 indicating that there are large differences between the farmers of this mill.

Sugarcane farmers are predominantly male, received education and are on average 44 years

Farmers are predominantly male (90%) and head of the household (76%); the average age is 44 years, households consist of 4 persons on average, illiterate is the small percentage of 20% of the total sample. Sugarcane is the predominant source of income and more than half of the farmers are likely to fall below the poverty line of USD2.50 a day. Results are heterogeneous among mills and between farmers.

A small number of female participants can be found in Mill 3 and the farmers which are not head of the household can particularly be found in Mill 1. The average households consists of 4 persons but Mill 3 has larger households of 5-6 persons while the Mill 1 households are relatively small with 3 persons. In total, 80% of the farmers received education, on average up to matriculation level. The 20% non-educated farmers are mainly from Mill 3: almost half of all the farmers in Mill 3 is illiterate while almost all farmers in Mill 1 received education. In Mill 3 farmers are on average 53 years while the farmers of Mill 1 and 2 are much younger. There could be a relation between the high age of the farmers in Mill 3 and the high illiteracy level in that area.

Table 5.1 Personal and household characteristics

Characteristics	Total		Mill 1		Mill 2		Mill 3	
	Mean	Mean	Mean	Mean	Mean	Std. Dv.	Mean	Std. Dv.
Farmer is male	90%		91%		93%		88%	
Farmer is head of household***	76%		69%		96%		78%	
Household size***	4.16	1.86	3.16	0.43	4.53	1.52	5.63	2.35
Illiteracy level[12]***	20%		0.4%		28%		49%	
Age***	43.6	12.8	39.2	9.27	39.0	11.2	52.7	13.6

*** (α = 0.01), ** (α = 0.05) and * (α = 0.1)

Sugarcane accounts for over two-thirds of income for 94% of the farmers

The economic relevance of sugarcane for the farmers is obvious: farmers are highly dependent on the production of sugarcane, see Figure 5.1. For almost all farmers (94%), sugarcane accounts for 75% or more of their income. Table 5.1 shows that only in Mill 1 9% of the farmers had an income share of sugarcane between 50-75%, and that sugarcane for most farmers accounts for

[12] Meaning: no education at all

over 75% of their incomes. In Mill 2, the dependence on income from sugarcane is the highest as 98% of the farmers indicated that their sugarcane income depends for more than 75% of their total incomes. In Mill 1 and 3, respectively 91% and 97% of the farmers indicated that sugarcane income accounted for 75% or more than 75% of their income. The percentage of farmers of who's incomes depend for 75% or more than 75% from sugarcane income, differs significantly between the mills at the 1% level. This is important to keep in mind as results of Section 6 reveal that the productivity, profit and satisfaction with profit are very low among Mill 2 farmers.
The data confirms earlier data of the mills and shows the relevance of sugarcane gross income increases to this farmer population.

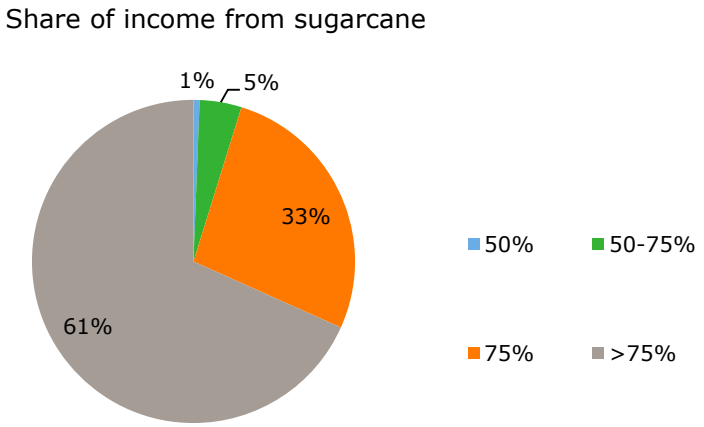


Figure 5.1 Percentage of income from sugarcane

Table 5.2 Percentage of income from sugarcane per mill

Mill	50%	50-75%	75%	>75%
Mill 1	0	9	32	59
Mill 2	2	0	0	98
Mill 3	1	2	50	48
Total	1	5	33	61

Half of the farmers are likely to fall below the USD2.50 poverty line

We use the *Progress out of Poverty Index* (PPI)[13] as a tool to measure poverty in the command areas of the three mills. The likelihood of falling below the minimum of USD2.50 per day (the Purchasing Power Parity poverty line in 2005) in the three mills is 53.2%, i.e. approximately half of the farmers is likely to fall below the poverty line, which is quite high. If we stick to the original poverty line of USD1.25 a day, only 5.8% are likely to fall below this poverty line. Figure 5.2 shows a boxplot containing PPI likelihood for all the farmers and per mill. The average likelihood of living below USD2.50 per day is highest in Mill 3 with 70.8%, this level is lowest in Mill 1 with 40% and is 61% in Mill 2. This indicates high variation in socio-economic status of farmers ranging from relatively less poor to poor.

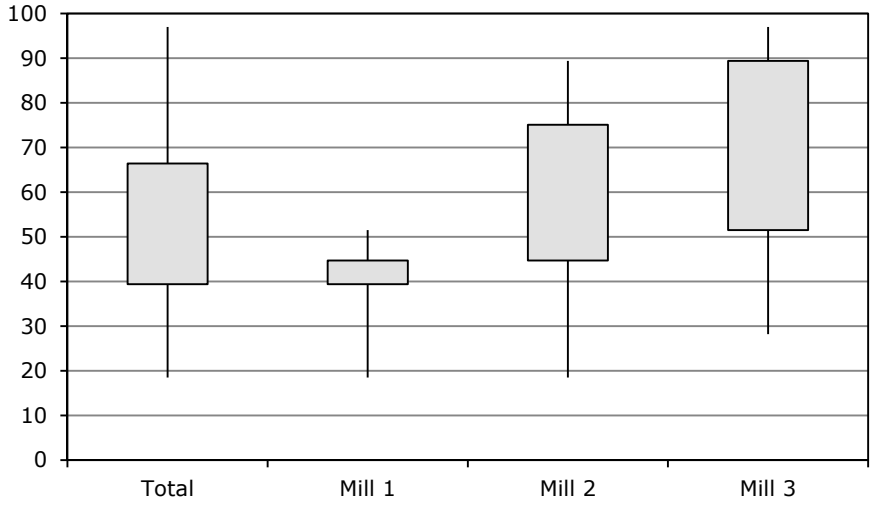


Figure 5.2 Progress out of Poverty Index (PPI)

[13] The poverty status of a household (poor or non-poor) derives from a definition of a poverty line and a definition of expenditure. It is important to consider is that the PPI could be somewhat outdated as the latest available PPI used here stems from 2010.

5.2 Willingness to invest, risk attitude and time horizon

Sugarcane farmers' perception influences adoption of practices and techniques

Aside from demographics and household characteristics, sugarcane farmers' view in terms of investment, risk, time horizon (short or long) and trust can influence adoption of certain agricultural practices and techniques (Barham et al., 2014; Laeequddin et al., 2012; Kwon & Suh, 2005; Juma, C. 2012; Nato et al, 2016) especially those requiring high investment or with uncertain, long term returns. It is important to be aware of these views in rolling out the project in the next years and in analysing why it seems effective for some farmers but not others in 2018.

More than half of the farmers are willing to invest

Willingness to invest is important in deciding whether to adopt a certain practice where investment is needed, i.e. it can be a driver for (willingness) but also a constraint to (unwillingness) changing behaviour and investing in new agricultural techniques. The statement 'I will not make any investment because you never know what will happen' is a means of illustrating the unwillingness to invest. Sixty per cent of the farmers from the full sample (strongly) disagreed on this statement and 23% was neutral. On the basis of this statement, thus, the main share of the farmers seems to be willing to invest which is an encouraging result. But, important in their willingness to invest is that they have some trust in the mill and find the mill technology reliable. As 78% agreed with the statement: 'I'm only willing to invest in new agricultural practices after I have find the mill technology reliable'. Although the differences are small, farmers who applied drip irrigation do disagree more on this statement, i.e. they are more willing to invest which could be one of the reasons why they have already drip irrigation (see Table A3.2).

More than half of the farmers is willing to take a risk when investing in agriculture

The statement 'Investing in agriculture or new agricultural practices is very risky; I rather do not do it' is perhaps the most relevant statement to measure risk attitude for the purpose of the intervention. Fifty-eight per cent (strongly) disagrees on this statement and 14% (strongly) agree. Table A3.3 shows farmers' attitude towards this statement and the application of drip irrigation. Interestingly again, the farmers who already apply drip irrigation, agree to a larger extent with this statement. To summarise, in general, farmers are willing to take risks when investing in agriculture or agricultural practices.

Sugarcane farmers have a short time horizon

The time horizon (short or long term) of farmers is relevant because it influences their willingness to invest but also their motivation to change. The time horizon is examined in Table A3.4. Farmers were asked to choose between receiving (hypothetically) INR500 right now or a higher amount in one year from now. The amount farmers would need to receive in the future to choose that option went up to INR2,000. The average amount of INR needed to choose for receiving money after 1 year is on average 929 INR, almost doubling the 500 INR. This indicates that on average farmers have a short term perspective. Certain issues, especially concerning public goods such as the environment and (ground)water challenges, might not be relevant to them today as they are struggling with today's challenges and not willing or able to change behavior to generate a positive impact in the future.

Farmers seem to generally trust in the advice the mill

The mills are key partners in the FDW project: they will provide the training on preferred practices and (irrigation) techniques. Therefore, trust in the mills is an important enabling (or constraining) condition for project success. The assumption is that farmers trust that if they change their behaviour according to what they are introduced to, it will change their life positively. Trust can be measured in various ways but focus here is the relation with the mills as they are the key persons in introducing the farmers to the new knowledge and in convincing them of its advantages. For example, the statement about willingness to invest, also reflects a trust level in the mill, i.e. 78% of the farmers indicate they are 'only willing to invest in new agricultural practices after [they] find the mill technology reliable'. Trust in and towards the mill is measured with statements concerning the attitude of the farmers towards the mill. 'I do not want to further develop a relationship with the mill because I am not sure whether it is really fair' was answered neutrally by 35% of the farmers and 58% disagreed on this statement. The farmers seem therefore not to distrust the mills.

5.3 Farm and production characteristics

Farm characteristics are presented in Table 5.2. The farmers own on average 3.3 acres of land cultivated with sugarcane and 1.3 acres of owned land is used for cultivation of other crops. The majority only uses ratoon crop (62%) with 21% cultivating plant crop only and 19% cultivating both ratoon and plant crop. The farmers are on average quite experienced with 14 years of sugarcane cultivation and 37% are member of some farmer group. In total 132 tonnes of sugarcane are supplied to the mills last harvest season and average production of cane per acre is 44 tonne. Almost half of the farmers received governmental subsidy, mainly for fertiliser and electricity. The main reported challenges for the total sample are unavailability (72%) of labour and water for irrigation (63%). There is heterogeneity between the three participating mills and among farmers. The subsequent paragraphs elaborate in depth on the results and significant differences.

Sugarcane predominantly produced on own land; on average 3.3. acres

Almost all farmers own land with approximately 3.28 acres but there are huge differences between small and big land owners. Farmers in Mill 1 have the smallest sugarcane acreage. Land is also leased (for sugarcane cultivation) but only small plots with an average of 0.24 acre and no farmer of Mill 2 leases land. Farmers of Mill 1 also cultivate rice but only on small parcels, 1.27 acre. This is possible as the farmers of Mill 1 do not have that much water shortages (as is further explained in section 5.4). It is a positive finding that the majority of farmers own land as many studies indicate that adoption of good agricultural practices and changing farming behaviour can be a constraint when it concerns leased/rented land. Especially for investment in irrigation techniques and systems, it is important that farmers can decide themselves and invest in land which is their own.

Over half of farmers cultivate both ratoon and plant crop, generally only up to 2 ratoons

Common practice in sugarcane cultivation is to cultivate cane by plant and ratoon crop. The use of ratoon crops is examined in Tables 5.3 and A3.5 and A3.6. Ratoons can increase up to 4 or 5 harvests but a good quality seed and good agricultural practices are required. Ratoon crops are more cost-efficient but there is a trade-off at a certain time when production decreases and plants might become less resistant to pest and diseases or draught. As can be seen in the table, the majority of farmers cultivate only ratoon crops (61.8%). On average a small percentage of 20.5% cultivate plant crops only but these farmers are mainly found in Mill 2 (59%). Of ratoon crops, the majority cultivate only two ratoons (46% ratoon and 42% and ratoon 2) and are mainly found among the farmers of Mill 1 and 3. Ratoon 3 and 4 hardly occur which is interesting for the Solidaridad and partnering mills as sugarcane can still have profitable ratoons up to ratoon 4 and 5, saving a lot of input and production costs for new cultivating the new plant crop.

Farmers have on average 14 years' experience in sugarcane cultivation

Farmers are quite experienced in cane farming: they cultivate sugarcane for on average 14 years. It is important to note is that the farmers of Mill 2 are relatively new sugarcane farmers: they have approximately 4-year sugarcane farming experience. This is illustrated in Figure 5.3. It can be a great opportunity for farmers who are less experienced to be trained and gain more knowledge on good agricultural practices. It might be a challenge for very experienced farmers to adopt new practices and change the way they used to farm. In general, they are used to certain practices, feel experienced and might be sceptical towards new knowledge. This is therefore an important variable in explaining adoption. Note that the years of experience vary also between farmers of one mill. It could be interesting to mix the more and less experienced farmers in one training group to stimulate mutual learning and sharing of expertise.

Studied farmers are generally not organised, except for Mill 1 farmers

It is not common in all command areas for sugarcane farmers to be organised in a farmer group: on average only 37% of the farmers are member of a farmer group and these members are mainly found in Mill 1. There is no clear explanation why membership of farmer groups differ considerably per mill. If farmers are member of a farmer group it concerns a sugarcane farmer group. This insight could be very relevant for the implementation of the project as one of the first activities is to organise farmers and to train them group wise. Especially the project roll-out in Mill 1 could benefit from the existing organisational structures. Working via farmer groups can be very effective and efficient in reaching out to thousands of farmers. From the farmer perspective, being a member of a well-functioning and organised farmer group could also stimulate adoption of practices as there is a platform of mutual learning and sharing.

Table 5.3 Farm characteristics

Characteristics	Total		Mill 1		Mill 2		Mill 3	
	Mean	Std. Dv.	Mean	Std. Dv.	Mean	Std. Dv.	Mean	Std. Dv.
Owned sugarcane area***	3.28	2.47	2.93	1.14	4.10	2.89	3.50	3.53
Leased sugarcane area***	0.24	0.65	0.37	0.61	0.00	0.00	0.12	0.79
Only plant crop***	20.5%		12.6%		59.0%		16.7%	
Only ratoon crop	61.8%		64.8%		40.8%		65.8%	
Both plant and ratoon crop	18.5%		22.6%		0.2%		17.5%	
Owned other area***	1.27	2.28	0.99	1.08	0.94	2.26	1.86	3.36
Leased other area***	0.01	0.21	0.01	0.10	0.00	0.00	0.02	0.35
Sugarcane experience*** (years)	14.1	7.25	14.6	3.57	3.83	2.43	17.8	8.87
Member of farmer group***	37%		61%		21%		5%	
of which:								
Sugarcane farmer group***	36%		59%		19%		5%	
Water management club***	2%		4.7%		0%		0%	
Credit and saving group*	1%		1.5%		2.1%		0%	

*** (α = 0.01), ** (α = 0.05) and * (α = 0.1)

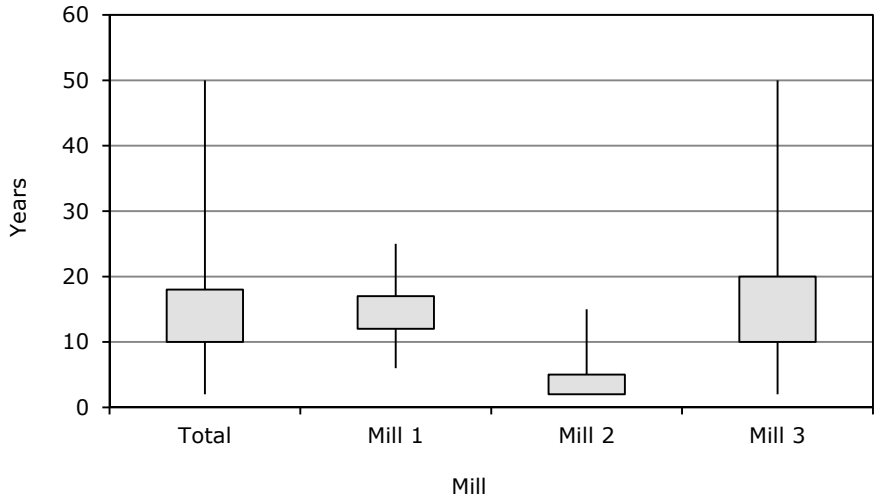


Figure 5.3 Sugarcane farming experience

High variation in production and productivity between farmers

The farmers supplied on average 132 tonnes of sugarcane to the mills at the last harvest season, as can be seen in Table 5.4. This entails the harvest of both plant and ratoon cane. As farmers usually supply the entire produce to the mill they are registered with. It could be some cane which is not supplied to the mill is used sold to cane crushers who sell fresh cane juice. However, this quantity of cane supplied to the cane crushers is minimal. We therefore perceive the supply to the mill as the actual total yield from all plots cultivated and harvested in the last season. Famers of Mill 1 supplied 156 tonnes to their mill. Supplies of Mill 1 and 2 are comparable with respectively 99.6 and 106 tonnes. Again there are considerable differences between farmers in one command area. We have seen already that there are small and large farmers in terms of acreage and this is reflected in the huge differences of the supply of cane to the mills and production per acre. Table 5.4 and Figure 5.4 show an average cane production of 43.8 tonne per acre. Highest production levels are noticed at the farmers of Mill 1 and 3: 47.9 and 45.2 respectively and Mill 2 has a remarkably relatively low production per ace of 25.5 tonne/acre. Both total production and production per acre comprise yields of owned and leased land.

Price received for cane varies by quality and costs incurred by the mill

The FRP of the 2015-2016 season was defined at INR2,300 per tonne of sugarcane. Prices received by farmers of Mill 1 and 3 are comparable but relatively high at Mill 2. Quality (moisture content) is a reason why farmers receive above the minimum FRP which could explain the higher price received by Mill 2 farmers. Reasons for averages prices below INR2,300 are that mills are deducting costs related to a credit or transportation from the field to the mill.

Table 5.4 Sugarcane production and price

Cane production and price	Total		Mill 1		Mill 2		Mill 3	
	Mean	Std. Dv.	Mean	Std. Dv.	Mean	Std. Dv.	Mean	Std. Dv.
Total supply to mill (in tonne)***	132	67.7	156	57.0	99.6	73.2	106	66.3
Production per acre (in tonne)***[14]	43.8	28.3	47.9	12.0	25.5	10.4	45.2	44.9
Price received / tonne (INR)***	2,318	220	2,271	55.3	2,554	150	2,294	235

*** (α = 0.01), ** (α = 0.05) and * (α = 0.1)

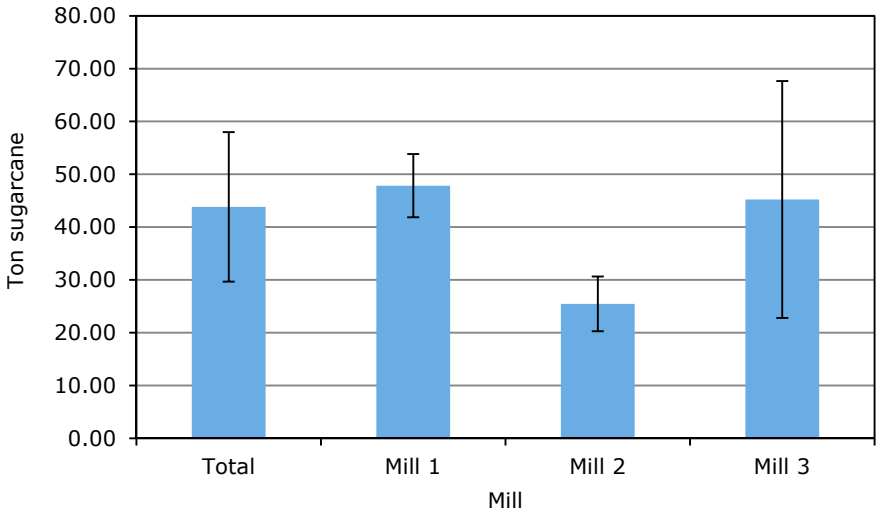


Figure 5.4 Sugarcane production per acre (in tonne)

Half of the farmers received governmental subsidy for fertiliser and electricity

The Indian government has been providing subsidies to farmers in various agricultural and development programmes [15] and almost half of the farmers (45%) indicates to have received a subsidy in 2015 and 2016. The differences between the mills are minor here. And indeed, 99% of the farmers who received subsidy, received the subsidy from the government. The majority used subsidy for purchasing fertiliser and for electricity in Mill 1, the majority of Mill 2 and 3 used subsidy for purchasing other irrigation system which is: drip irrigation with fertigation. (see Table 5.5).

Table 5.5 Subsidies (in percentages)

Characteristics	Total	Mill 1	Mill 2	Mill 3
Subsidy received*	45	48	38	43
Purpose subsidy:				
Fertiliser***	58	96	7	8
Electricity***	56	97	4	1
Drip irrigation fertigation***	35	1	67	83
Pump***	15	25	0	1
Surface drip irrigation***	5	1	20	8
Sub-surface drip irrigation	2	2	0	1

*** (α = 0.01), ** (α = 0.05) and * (α = 0.1)

5.4 Challenges in sugarcane farming

Self-reported challenges give insight into project relevance

The life of a farmer can be challenging as can be seen in Table 5.6 which summarises all the challenges farmers face now and then. These challenges give insight into what farmers consider as the main challenges; this gives insight into project relevance (though factual challenges may differ) and the desire motivation of farmers to change current practices or techniques. Not all are issues are equally challenging and there are again difference between the mills.

Unavailability of labour is the main challenge according to farmers

More than two-thirds (72%) agrees that unavailability of labour is a serious challenge. According to Solidaridad, labour shortage is a common phenomenon across the country. The government has been promoting self-employment and rural employment and the internal migration has slowed down, especially rural to rural migration. The bulk of rural poor are migrating to urban areas. The face of agriculture is changing and to address the same there is a need to provide emphasis on mechanisation and agri-entrepreneur services. The project's

[14] Note: production of both leased and owned land

[15] For example the government launched in 2005-06 and subsequently upscaled during the Eleventh Five Year Plan (2007-12) the 'National Mission on Micro Irrigation (NMMI)' as a Centrally Sponsored Scheme (CSS).

component of *drip irrigation maintenance service providers* addresses this to further enhance the provision and availability of mechanised harvesting to the farmers.

Water shortage is a serious challenge for farmers of Mill 2 and 3

The second biggest challenge faced is unavailability of water of irrigation. This issue is not new and forms the basis of the FDW project. However, its relevance is confirmed by the farmers themselves. An important nuance is that for the farmers of Mill 1 (Karnataka state), unavailability of water is only an issue according to 47% of the farmers. This is fundamental for the implementing parties and the concerning mill as the drive for adoption and implementing different irrigation systems might be not that strong.

Table 5.6 Reported challenges of the farmers (in percentages)

Characteristics	Total	Mill 1	Mill 2	Mill 3
Enabling environment				
Unavailability of labour	72	61	73	89
Unavailability of water for irrigation	63	47	85	81
Production/technique				
Attack of pest and diseases	52	67	61	25
Poor quality of soil	31	42	31	15
Contract/market/resources				
Low price of sugarcane	56	58	29	64
Delay in getting cutting order	60	67	18	67
Not profitable	23	17	4	40
No resources for agricultural inputs	39	47	71	13
No equipment for soil testing	38	34	26	50
Bad condition of drip irrigation	30	34	61	9

*** (α = 0.01), ** (α = 0.05) and * (α = 0.1)

Cutting order, pest and diseases, and low prices of sugarcane are other major challenges

Another important challenge is the delay in cutting order (for Mill 1 and 3 particularly). The mills provide the farmers with an order when to harvest based on farm data and collection of yields. It seems farmers have to wait too long which might be a risk for the (quality) of their produce. Pest and diseases are also considered an important challenge for 52% of the farmers; this is especially true for Mill 1 and 2, but less relevant for Mill 3 farmers (25%). Farmers from Mill 3 seem to be challenged more by low sugarcane prices (56%).

5.5 Support and training needs

Importance of gaining insight into support received in the past

It is important to know whether other sources of support (e.g. trainings) exists to get a clear understanding of the context and the (im)material resources of farmers. Besides, it is important to have insight in potential external influences of other actors active in the same area which could contribute (or counteract) potential impact. It also shows the relevance of an intervention when no other projects or supporting activities are present.

98% of farmers never received support on sugarcane cultivation, 100% are interested

In this area, 98% of the farmers indicate they never received any support[16] from organisations or interventions similar to Solidaridad and the FDW programme in sugarcane cultivation, and 100% of the farmers indicate they were interested in receiving training on sugarcane cultivation. The training topics that the farmers mentioned are: (i) soil testing (61%), (ii) good agricultural practices (55%), (iii) trash shredding and mulching (46%) and (iv) irrigation systems (44%). See Table 5.7 for all the results on training topics.

Table 5.7 Interest in training topics (in percentages)

Preferences for training	Total	Mill 1	Mill 2	Mill 3
Soil testing	61	47	87	74
Good agricultural practices	55	30	93	80
Trash shredding and mulching	46	82	15	0
Irrigation practices	44	24	92	55
Intercropping	13	14	38	1
Financial farm management	13	11	32	8

[16] This does not include governmental subsidies.

Unique training needs per mill

There are differences per mill. This is important for the specific mill to take into account in the design of the training modules. The percentage of farmers willing to receive a training in irrigation practices is relatively low in Mill 1 (only 24%) and relatively high in Mill 2 (92%). The percentage of farmers willing to receive training in good agricultural practices is relatively low in Mill 1 too. Farmers from Mill 2 and 3 indicated to be particularly interested in receiving training on these topics (respectively 93% and 80%). It might not be very surprising that the farmers of Mill 1 are not very enthusiastic in following a training on irrigation practices as they indicated they do not have much problems in accessing water for irrigation (section 5.5). This is an important insight for the project partners: how to approach these farmers and what is it that they would like to learn.

6

Immediate outcome

Improved agricultural practices and irrigation techniques

Improved agricultural practices are key to FDW's theory of change

Improved agricultural practices are key immediate outcomes in the Theory of Change and as such crucial in project implementation. It is assumed good' agricultural practices lead to higher production levels, higher productivity, higher gross incomes from sugarcane and increase water efficiency. While this assumption is based on solid experimental proof from an agro-economic point of view (FDW Project Plan Solidaridad 2014 and Catalyst Business Case Report 2014), it is not yet certain this will hold for all farmers targeted by FDW. This chapter presents the agricultural practices and irrigation techniques which are common and subsequently in chapter 7 the next steps in the theory of change of productivity and gross income are elaborated upon.

All farmers apply chemical fertilisers but only 20% follow the guidelines of correct application. Majority of farmers, 84% also applies biological fertiliser in addition to the chemical variants. Main biological, or organic fertiliser, is cattle manure from farmers' own farm/cattle. Majority also applies pesticides (96%) and chemical pesticides are common practice (71%). If all input costs are compared, it appears that the largest share of the money spent on inputs is on both chemical and biological fertilisers. Row spacing is 3 feet (33%) and 4 feet or more (66%). Intercropping and trash mulching hardly occurs. Furrow irrigation is the predominant technique applied by 72% of all farmers; drip irrigation is applied by 28%. The following paragraphs present all results in depth and distinguish between mills and farmers as again major differences are occur in the application of good agricultural practices.

Good practices are defined by input use, specific practices and irrigation techniques

A first step to gaining more insight into this is to get familiar with the current practices, which includes input use, specific practices and preferred irrigation systems (6.2). Combined these three areas are used to characterise the production of sugarcane. In addition to the most efficient and effective irrigation system, others good agricultural practices are, among others, a) use of seedlings and gap filling, b) better and increased composting and use of bio-fertiliser and improved fertigation, c) intercropping and wide-spacing, d) trash mulching and shredding. For a good understanding good practices are presented as follows: 6.1:Input use, 6.2 Row spacing, intercropping and trash shredding and 6.3 Irrigation practices.

6.1 Input Use

Farmers almost exclusively use traditional setts

Table A3.7 provides an overview of the planting practices applied by the farmers. Farmers use almost exclusively traditional setts for planting new crops (98%) and 41% of them plants directly single bud setts. Seedlings, seed nurseries (and thereby transplanting) are hardly applied by the farmers, only by 2% of the farmers in Mill 1 so there is high potential to introduce the farmers to this practice. One of the practices to be promoted is the use of seedlings raised from single budded cane chips in a simple nursery with transplantation at the age of 25-35 days. The use of seedlings saves one month of irrigation while also increasing productivity by minimising plant mortality and of course saves seed usage (FDW Project plan Solidaridad 2014). Besides, seedlings can be used for gap filling (replacing plants that have died) which also increases productivity and water use efficiency. As such, farmers are introduced to these activities to further enhance and sustain water and cane productivity.

The set variety is in 58% of the cases CO86032, but mainly at Mill 2 and 3. 45% The farmers at Mill 1 use whatever the mill provides them and they do

not know the name of the variety, and could indicate a relative indifference or unawareness towards the variety used by the farmers at Mill 1.

84% of farmers use chemical and biological fertilisers: application guidelines are neglected

All farmers apply chemical fertiliser and 84% use both chemical and biological fertiliser, in Mill 3 the use of biological fertiliser is relatively low. 90% Of the chemical fertiliser is applied by broadcasting and 18% via irrigation water, both organic and chemical fertiliser are applied mainly 2-3 times a year (65%). The source of biological fertiliser is in most cases (85%) the own farm or other farmers (23%) and in some cases the mill (12%). Cattle manure is the predominant biological fertiliser, compost and press mud are applied to a far lesser extent. All three types are part of biological fertiliser and as such stimulated by the programme. The choice for a specific type can be guided by a the cost perspective: compost and cattle manure stem mainly from farmers' own farm and land as long as trash is not burnt while press mud has to be purchased from the mill. Farmers are further stimulated to increase the use of biological fertiliser and diminish the application of chemical fertiliser. According to Solidaridad, composting improves the water-holding capacity of the soil while application of bio-fertilisers containing beneficial micro-organisms helps in sustaining soil fertility thereby reducing dependence of chemical fertiliser. The latter have a detrimental effect on soil structure, crop productivity and groundwater quality in the long run. Besides, it is economical to use bio-fertilisers as they are a cheap source of nutrients when compared to chemical fertilisers and can increase yields by up to 24%. It is estimated by the implementing parties that to have 5% water savings and at least 5% higher sugarcane yields due to the adoption of this practice under average farm conditions (FDW Project Plan Solidaridad 2014).

It is alarming that only 20% of the farmers follows the governments' or mills' guidelines regarding quantity and time of application of chemical fertiliser, especially the farmers of Mill 3 (3%) do not stick to the recommendations on how to apply chemical fertiliser. In Mill 2, however, this 82% of the farmers follows these guidelines, perhaps since they have less farming experience, they are in higher need for guidance regarding farming practices.

Table 6.1 Application of fertiliser (in percentages)

Fertiliser	Total	Mill 1	Mill 2	Mill 3
Chemical fertiliser	100	100	100	100
Follows recommendations fertiliser***[17]	20	12	85	3
Biological fertiliser***	84	100	82	58
Of which				
Cattle manure***	81	98	71	57
Compost	1	1	1	2
Press mud***	7	9	11	1
Of which source:				
Own farm***	85	95	71	66
Mill***	12	17	12	1
Government**	1	2	0	0
Other farmers***	23	18	15	44

*** (α = 0.01), ** (α = 0.05) and * (α = 0.1)

Share of chemical fertilisers higher for female farmers, more experienced farmers and higher share of land used for other crops

Aside from the command area (see Table 6.1 above), farm or household characteristics may also determine whether or not farmers use a higher share of chemical fertilisers. To investigate this, we run a regression analysis to explain the rate of costs for chemical fertilisers (versus biological) by the farm and household characteristics as described in chapter 5. After controlling for differences between mills we find the share of chemical fertilisers significantly higher for female farmers, farmers with more years of experience in cultivation and farmers with a higher share of land used for other crops. We also find willingness to invest is related to a higher share of chemical used (as proxied by cost). This makes sense because financial resources (i.e. investment) are spent on chemical inputs, more than biological inputs and willingness to invest usually relates to financial expenses. However, farmers who are more willing to establish long-term relationships with the mill (as measured by 'I do not want to further develop a relationship with the mill because I am not sure whether it is really fair') have a lower share of chemicals used. At this moment of

[17] Governmental/ mill guidelines on application of chemical fertiliser

measurement and with the data available, there is no further explanation for this relation.

Application of chemical pesticides is a common practice

Pesticides are applied by 96% of the farmers and predominantly chemical pesticides are applied (71%). Farmers in Mill 1 and 2 apply both while farmers of Mill 3 mainly use only chemical fertiliser (88%). Is interesting to find out how the farmers of Mill 2 were motivated and introduced to the application of both organic and chemical pesticides as 80% of all farmers uses both. This could be a relevant learning for the other mills in stimulating farmers to use more biological fertiliser. In Mill 2, pesticides are applied for 4-5 times a year. This is less among the farmers of Mill 1 and 3: pesticides are mainly applied 2-3 times a year only which is better when the volumes applied did not increase. Most pesticides are applied both curative and preventive and 91% of the farmers reported to have had pests or diseases in the last season (see Table A3.8 with occurrence of pests per mill). Red rot occurs often in Mill 1 and 2 and not so often at Mill 3. This is important information to design a customised training module per mill based on the pest and disease problems they face in their area. Farmers from Mill 1 and 2 indicated that attacks of diseases and insects are a serious challenge (see Section 5.5).

Table 6.2 Application of pesticides (in percentages)

Pesticides	Total	Mill 1	Mill 2	Mill 3
Farmers applying pesticides***	96	100	99	88
Of which:				
Only chemical***	71	74	18	88
Only organic	0.5	0.6	1.4	0
Both***	25	25	80	1
Of which:				
Preventive***	20	20	4	23
Curative***	30	23	1	58
Both***	50	57	94	16

*** (α = 0.01), ** (α = 0.05) and * (α = 0.1)

Largest share of input costs on fertiliser, both chemical and biological

To examine the absolute and relative use of different types of inputs, we use the money spent on different types of agricultural inputs per tonne of produced sugarcane per mill (Figure 6.1). The largest share of the money spent on inputs is on fertiliser, both chemical and biological. The money spent on inputs is relatively high in Mill 2 and relatively low in Mill 1 and diffeences between the mills are significant. Interestingly, the soil of Mill 1 farmers (Karnataka state) is known to be quite fertile but chemical fertilisers account for 56% of their total input costs. Table 6.3 provides the share of inputs of the total expenses and shows that in every mill, planting material (e.g. single bud sets, 2 bud setts, seedlings) accounts for more than 20% of the total money spent on inputs.

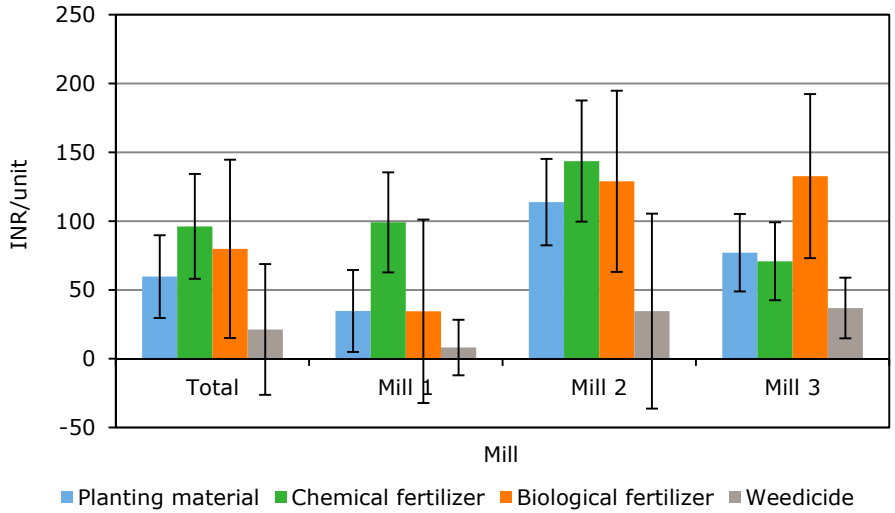


Figure 6.1 Money spent on inputs in INR

Table 6.3 Share of money spent on inputs (in percentages)

Money spent on inputs	Total	Mill 1	Mill 2	Mill 3
Planting material	23	20	27	24
Chemical fertiliser	37	56	34	22
Biological fertiliser	31	20	31	42
Weedicide	8	5	8	12
Share chemical of total fertiliser	55	74	53	35

When costs are incurred for biological fertilisers they are relatively high

Biological fertiliser is usually obtained from the own farm and in some cases from the mill. Hence, it can be obtained freely from the farm and does not take as much investment as chemical fertiliser. The majority (70%) of farmers use manure from their own farm and do not report any costs on that input. The farmers who do purchase manure or other biological fertiliser (e.g. from the mill or other farmers) report high costs influencing the total average costs for biological fertiliser.

6.2 Row spacing, intercropping and trash shredding

Farmers apply correct row-to-row spacing

To consider the correct row-to-row spacing is an important agricultural practice. 33% Of the farmers use 3 feet spacing or more of which 66% of the farmers use 4 feet spacing or more. Of the farmers who use drip irrigation (see section 6.3), which is mainly in Mill 2 and 3, 95% use 4 feet spacing or more. The standard for a as good agricultural practice according to Solidaridad is 3 feet with regular irrigation and 4 or more than 4 feet with drip irrigation and the data indicates that the farmers comply with these standards.

Intercropping hardly occurs

Wider spacing increases the opportunity to intercrop which can increase income and reduce risk. However, intercropping is hardly applied by the farmers (Table A3.9). Intercropping is an important element in the training on good agricultural practices, but farmers do not seem very interested to be trained in intercropping, as can be seen in Section 5.5. It is important to discuss with the farmers why they do not intercrop and use that knowledge in the design of the training how to stimulate this practice.

Almost all farmers burn trash after harvest; trash shredders hardly available

Burning the trash after the harvest has negative implication for the organic matter content and water conservation in the soil.[18] Burning land and trash after the harvest is applied by more than 90% of the farmers in Mill 1 and more than 40% of Mill 3, but is hardly applied in Mill 2. Only 1% of the farmers had access to a trash shredder for trash mulching. This is important information if farmers are stimulated to shred their trash: the availability of equipment to be able to adopt his practice. Interestingly, 82% of the farmers from Mill 1, where burning occurs the most, indicated to be interested in trainings concerning trash shredding and mulching.

Share of land for sugar, time preferences and risk perception are related to burning trash

Aside from the command area, farm or household characteristics may also determine whether or not farmers adopt certain agricultural practices. To investigate this, we run a regression analysis to explain use of burning (yes or no) by the farm and household characteristics as described in Chapter 5. There is not one indication or a clear pattern which points to a certain group or cluster of farmers who are more likely to burn their trash instead of re using it via trash shredding. It is important though as it is one of the training elements of the intervention. There are a few characteristics influencing the habit of burning. First of all, if farmers have more leased land, they have a higher likelihood of burning trash after harvest (see Table A.4.3 in Appendix). This can be explained by the fact that trash shredding has costs per acre and costs increase if land size is high. So to save costs big farmers may prefer to burn instead of the shred. Another relation is found between willingness to invest and burning: if farmers are more willing to invest, they are less likely to burn trash. This make senses as costs are involved in shredding trash instead of burning, so an investment should be made. However, farmers with less trust in the mill or who are risk averse, are more likely to burn trash. This can be explained by the fact that these farmers are more risk averse and less willing

[18] FDW Project Plan Solidaridad, 2014.

to invest and to spend money to a practice which they do not really trust yet. farmers are used to burn their trash where no costs are involved.

6.3 Irrigation systems

Irrigation techniques influence water use efficiency and productivity

Improving irrigation systems is another key concept in the intervention logic which should in the first place lead to increased water efficiency, but also to higher production levels as leaching of soil nutrients could be prevented with a well applied drip irrigation systems. Four types of irrigation systems are applied in the command areas of the mills. Furrow irrigation is the most applied system, which the common method of water delivery in sugarcane growing in India (FDW Project Plan Solidaridad 2014), but has low water efficiency and harms soil in the long run by leaching soil nutrients. Surface-drip irrigation is more water efficient compared to furrow as it eliminates conveyance losses and percolation losses and can boost the yield by more frequent water delivery. Sub-surface drip irrigation is installed in the root zone and drip irrigation with fertigation combines drip irrigation with fertiliser.

Furrow irrigation is the predominant technique (72%), drip irrigation is applied by 28%

Figure 6.2 provides an overview of the used irrigation systems by the farmers. Furrow irrigation is as expected the predominant irrigation method of the farmers with 72% of the farmers using this method, despite its lower water efficiency. Twenty-eight per cent of the farmers use some form of drip irrigation (in cases multiple techniques): drip irrigation with fertigation is applied by 22% of the farmers, surface drip and subsurface drip are applied to a lesser extent by respectively 8% and 1% of the farmers.[19]

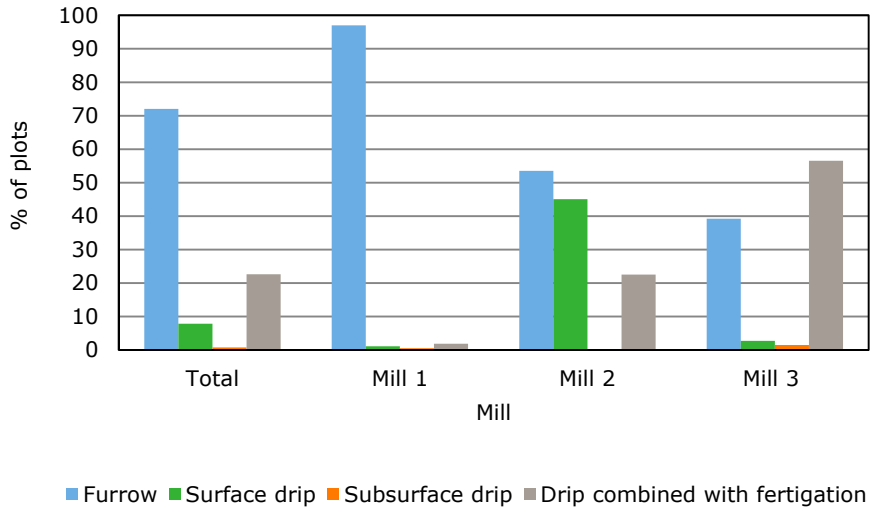


Figure 6.2 Irrigation systems applied full sample

Only 3% of farmers from Mill 1 use and prefer drip irrigation

Farmers of Mill 1 use predominantly furrow irrigation, despite its lower water efficiency. Moreover, farmers from Mill 1 do not consider unavailability of water for irrigation that much of a challenge compared to the other mills and also do not consider irrigation practices - and good agricultural practices - useful topics for training (see Table 5.6 and 5.7). These findings could indicate a relative abundance of natural water resources in the command area of Mill 1, or ignorance about the decreasing groundwater level. A well-branched network of canals, hosted by several rivers and reservoirs (as described in the context) is in place, but it is unclear if the availability of natural water resources keeps the groundwater level constant. This could be an important topic for future research and worth to further investigate by the other partners such as eLEAF or Osmania University.

For farmers in mil 1 irrigation practices is less important and relevant while almost all have furrow irrigation. So if these farmers should be convinced to adopt another irrigation practice or good agricultural practices, it is worth to explore how to convince them of the relevance of it because they are not intrinsically motivated.

[19] There are some farmers who apply several techniques adding up to >100%

Drip irrigation is more common at Mill 2 (45%) and 3 (61%)

Mill 2 and 3 use drip irrigation to a larger extent, respectively 45% and 61%; also availability of water is perceived as a larger challenge by the farmers (Table 5.6). More than two-thirds of the farmers from Mill 2 started cultivating sugarcane in the last 5 years. Perhaps these farmers decided to implement drip irrigation systems because of the government's support for drip irrigation in the 11th Five Year Plan (2007-2012), meaning they were motivated and financially capable. Also, the costs and efficiency benefits of drip irrigation may have persuaded new farmers in investing a drip irrigation system when starting a new farm. It could indicate that these farmers are more innovative. Another probable more plausible reason is that the farmers of Mill 1 have no serious water available challenges so the urgency for drip irrigation is less high in Mill 1.

Leasing land and experience in sugarcane cultivation are related to lower drip irrigation.

The regression was done on these three dependent variables as the application differed the most between the mills and the tables with the regression. Output on regression on drip irrigation can be found in Table A4.1. Indeed, difference in water unavailability between the command area may partly explanation whether or not farmers adopt drip irrigation. However, farm or household characteristics may also determine whether or not farmers adopt drip irrigation. To investigate this, we run a regression analysis to explain uptake of irrigation (yes or no) by the farm and household characteristics as described in chapter 5. We find that leased area which is not used for sugarcane cultivation is negatively and significantly related to the application of drip irrigation. Leased land could provide less incentives for farmers to implement good agricultural practices or water efficient irrigation systems, moreover when not used for sugarcane cultivation.

More education, land and membership in farmer groups and subsidies are related to higher drip irrigation

We also find that education level, size of land owned used for sugarcane cultivation and membership in a sugarcane farmer group all increase the likelihood farmers adopt drip irrigation. Education level may increase the awareness of farmers that drip irrigation is necessary in the long term; or may facilitate farmers to implement it. The more land a farmer owns, the higher the probability that the farmer uses drip irrigation. This is in line with the expectation that less land can be a constraint in the application of good agricultural practices or irrigation. Membership in sugarcane groups is positively correlated to higher uptake of drip irrigation; this does makes sense as the farmers of Mill 1 are organised in farmer groups but do not have drip irrigation techniques. This influence of the mill is confirmed by running a regression without the mill variable: the influence of being a member of the farmer group turns out to be negative towards drip irrigation (See Table A4.1). Subsidies are positively correlated to higher uptake of drip irrigation, which makes sense as the Indian government provides subsidies for the uptake of drip irrigation.

Finally, farmers who are more positive and trusting towards the mill (as measured by 'I do want to further develop a relationship with the mill')[20] have a higher likelihood of adopting drip irrigation. This may be because these farmers have positive experiences with the mail and possible longer time horizons; though the break point for time preferences does not confirm this. However, the relation between a positive attitude towards the mill and the occurrence of drip irrigation is crucial: it reveals that there is an influence of the mills reputation and probably the behaviour of the extension staff in the adoption of drip irrigation. The overall conclusion here is that risk attitude, willingness to invest and trust do play a role in adoption of an irrigation system. Farmers who are more risk averse, less willing to invest and who have lower trust, have significant less drip irrigation. Not all these behavioural aspects are in the sphere of influence of the implementing parties. Trust in the mill and farmers' perception of the mill can however be influenced by trustworthy behaviour of the mill.

Customised training on irrigation practices and unique approach of farmers is crucial

Decreasing groundwater level is a serious problem and one of the main reasons to implement the FDW project. Information provided by the mills show that particularly Mill 3 has considerable problems with groundwater levels. The annual rainfall has been decreasing and soil has poor water retention.

[20] Original statement: 'I do not want to further develop a relationship with the mill because I am not sure whether it is really fair' recoded into positive result: the higher the score, the more the respondent agrees with further developing a relationship.

Availability of water for irrigation is considered a challenge and that could be a reason why drip irrigation is already much applied. The interest for trainings in irrigation practices is also (logically) low in Mill 3 compared to Mill 2, though still only 60%. This could be because they already have sufficient knowledge.

Maintenance of irrigation systems is a challenge that may hamper uptake of drip irrigation

Maintenance of irrigation systems is crucial for its duration functionality. According to the implementing parties, good maintenance of the drip irrigation systems is a serious challenge for the farmers for three reasons: a) they do not have the knowledge and expertise for maintenance and they b) they do not see the relevance of it and/or c) they do not have the financial resources. Survey results confirm this: the majority of the farmers in Mill 2 who have drip irrigation indicates that their system is in bad condition (61%). This is an important insight for the intervention and training focus: farmers of mill with drip irrigation have serious challenges with maintaining their system while the drip irrigation farmers of Mill 3 do not report any challenges on maintenance. This can be interesting for the implementing parties to have more information on to stimulate mutual learning and sharing.

Satisfaction with current irrigation system may hamper uptake of drip irrigation

Ninety-four per cent of the farmers who use furrow irrigation indicated that it is their *preferred* irrigation method (see Table A3.10 for details). Only 5% of them would prefer drip irrigation with fertigation. While a lack of understanding the benefits of drip irrigation might explain this, more than two-thirds of the farmers are familiar with most drip irrigation technique. Moreover, the percentage of farmers who indicated to be willing to receive a training on irrigation practices is relatively low in Mill 1 (only 24%) and Mill 3 (55%), for Mill 2 it is much higher (92%). This is an important outcome considering the relevance of the intervention from the farmers' perspective. The results might be somehow surprising but especially for Mill 1 can be explained as they do not see water shortage as a big challenge. This question will though be taken care of with caution in the surveys of 2017 and 2018 to exclude any translation bias.

Drip irrigation is financed with external source: governmental subsidy

Ninety per cent of the farmers who are currently applying drip irrigation started using it since 2008. Indian governments support to drip irrigation in its 5-year plan (2007-2011) has increased, so this could have impacted this. This is confirmed with the data: subsidies are the main financial source that finance drip irrigation: for surface drip it is 57%, sub surface drip, 63%, 85% for drip irrigation with fertigation. Important to consider is that the farmers who have drip irrigation were able to because they were financially supported with a governmental subsidy. The regression was done on these three dependent variables as the application differed the most between the mills and the tables with the regression output can be found in Appendix 4.

7

Productivity and costs of sugarcane

Productivity and costs of sugarcane

Improved agricultural practices are to reduce costs and increase quality and productivity

Following the intervention logic, improved agricultural practices, input use and irrigation systems are the immediate outcomes of the intervention which would lead to the intermediate outcomes of higher crop productivity, lower production cost, lower water use and higher quality and price for the crops. This chapter examines these intermediate outcomes. Water use is outside the scope of this research.

Average crop productivity of both total land cultivated with sugarcane is 43.8 per acre for all farmers of the sample and only 45% of the farmers is satisfied with their latest harvest. Approximately 61% of the farmers reported an increase in quality of their cane produce. The average total production cost is 29,291 INR per acre and on average, farmers received INR2,318 per tonne of sugarcane produced.

7.1 Sugarcane productivity

Average crop productivity of 44 tonne per acre is higher than national average, though differences to the average are large

According to Solidaridad and the participating mills, the average crop productivity in Southern India is 27.5 tonnes per acre, but an estimated increase towards 42 tonne per acre is needed to keep up with the domestic consumption of sugarcane (FDW project plan Solidaridad 2014). The productivity per acre includes both owned and leased sugarcane area and is 43.8 tonnes per acre for the full sample, which is well above the average national crop productivity and even above the desired 42 tonnes per acre (based on prospects of the Indian Institute of Sugarcane Research India, Vision 2030, 2011). While average productivity is higher than expected, productivity differs quite extensively between the mills and between farmers in the same command area (Figure 7.1 and Table A3.11). This is especially true for farmers supplying to Mill 3 which means that there are both farmers with very high and very low productivity.

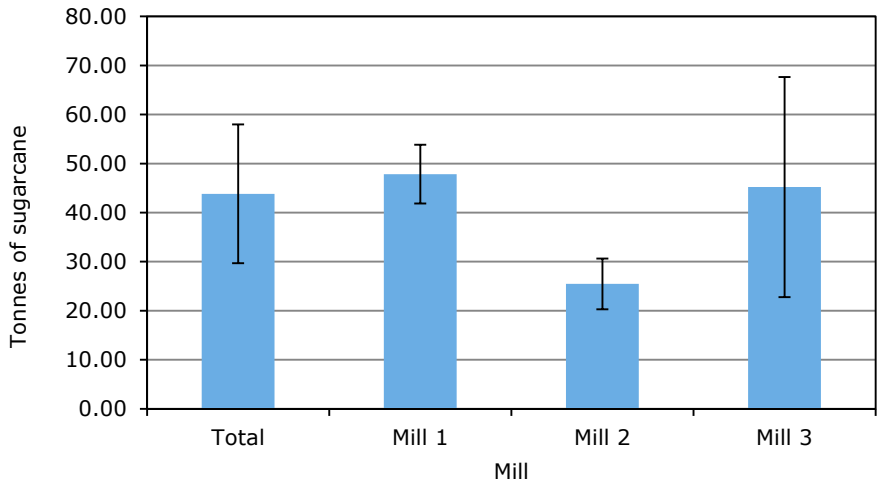


Figure 7.1 Sugarcane productivity per acre (in tonnes).

Average productivity in Mill 1 and 3 well above national average, but below for Mill 2

The average productivity per tonne of sugarcane in Mill 1 and 3 are well above the national average, with respectively 47.8 and 45.2 tonne of sugarcane per acre. The productivity in Mill 2, however, is below the national average with 25.5 tonne of sugarcane per acre and is almost half the value compared to mills 1 and 3. This difference is statistically significant, also after taking into account the differences in personal and household characteristics between mills. This is somehow alarming, especially given the high percentage of farmers (89%) from Mill 2 that indicated a decrease in production of more than

50% in recent years (Table A3.12). This means that the low productivity figures are not the standard. Reminding that the majority of Mill 2 farmers have plant crop which have in theory relatively higher yields than ratoon crops it is a question mark why productivity in Mill 2 is quite low.[21] The challenges presented in section 5.5 indicate that farmers in Mill 2 do face more production-related challenges which are worth to further investigate to be able to meet their needs and tackle the underlying causes. In Mill 1 and 3, most farmers reported an increase in productivity or no change in recent years.

Sugarcane acreage and education are related to lower productivity, subsidies to higher productivity

Aside from the command area (see Table A4.4), farm or household characteristics may also influence productivity. To investigate this, we run a regression analysis to explain the productivity by the farm and household characteristics as described in Chapter 5. We find that owned sugarcane area is negatively and significantly related to productivity, indicating that the smaller the sugarcane area, the more intense the cultivation. Education, as measured by the highest education level in the household, is also negatively related to lower productivity which could be explained by a shift of resources away from sugarcane cultivation towards other economic activities. Subsidies are positively related to productivity, this is not surprising as subsidies are provided on inputs as fertiliser, electricity and irrigation systems to stimulate productivity.

Drip irrigation is not related to productivity

We also analyse whether some of the key practices, techniques and inputs are related to production costs (see CH6). See the regression model in Appendix 4, Table A4.1.1. We do not find any significant relation with the core element of the intervention, i.e. drip irrigation. It is a striking finding that drip irrigation is not positively influencing productivity as it is an important element in the intervention logic, i.e. drip irrigation reduces water stress and as such increases yield by a more frequently and controlled water delivery. Also other important agricultural practices such as the use of chemicals and trash burning are not related to productivity. So based on the data we cannot conclude that a lower use of chemicals and leaving the habit of burning do automatically lead to higher productivity.

[21] Ask Solidaridad for further insights and possible explanations (weather, draughts, pest and disease, riots, a fox?)

Satisfaction with yields is in line with actual yield showing awareness of potential yield

Farmers are asked for their satisfaction perception towards the last harvest compared to other years. Of the farmers in the full sample, 45% report to be satisfied with their sugarcane production and 15% are neutral, i.e. neither satisfied nor dissatisfied (see A3.13). Most satisfied farmers can be found in Mill 1. In Mill 2, 91% of the farmers were (very) dissatisfied with their sugarcane productivity which is not very strange considering the low productivity as explained in the previous paragraph. In Mill 3, satisfaction towards yield varies highly. The self-reported satisfaction with sugarcane productivity is in line with the expectations based on the average productivity per mill and the self-reported change in productivity in recent years.

Most farmers reported improvement of sugarcane quality, but not in Mill 2

As the decrease in productivity, the farmers of Mill 2 reported that the quality of their sugarcane did not improve in recent years. Almost 80% of the farmers in Mill 1 and more than 60% of the farmers in Mill 3 reported that the quality of their sugarcane improved. It is a striking and important finding that farmers of Mill 2 report that both their quantity *ánd* quality of produce decreased in recent years. It is not clear which factors could have induced this decrease.

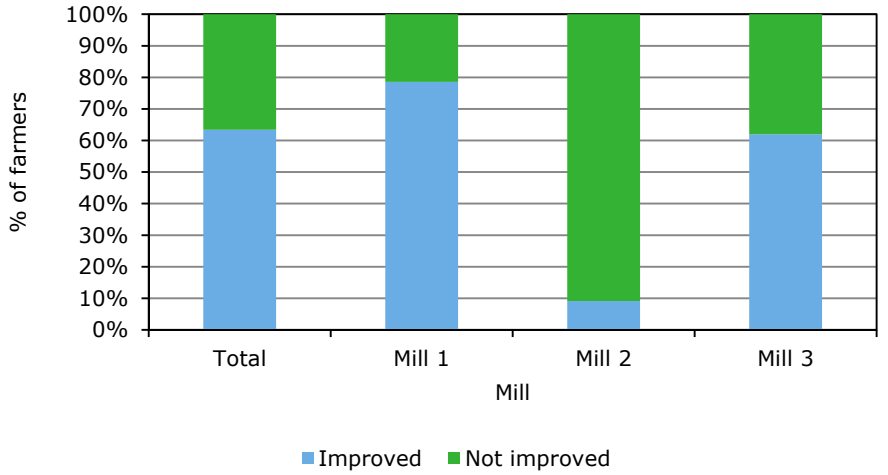


Figure 7.2 Improvement of sugarcane quality

7.2 Production costs

The average production cost per acre is 21,291 INR

For the calculation of total production costs, costs for planting material, fertilisers, pesticides and weedicides and hired labour are included. Own labour costs are not included. The average total production cost is INR29,291 per acre (see Figure 7.2 and Table A3.14) and INR209.10 per tonne (see Figure 7.3). A larger share of costs is used for labour (excluding own labour) than for inputs. This is true for costs per acre and per tonne sugarcane produced. The large standard deviations indicate that the costs per acre and per tonne vary a lot between farmers.

Large differences in production costs between command areas

Figure 7.3 (also see Table A3.14A) shows that the costs per acre are relatively low in Mill 1 (INR1,727 per acre) and relatively high in Mill 3 (INR28,323 per acre). Production costs per tonne sugarcane produced show a similar pattern for Mill 1 and 3 (Figure 7.4). However, costs per tonne produced for Mill 2 are as high as costs for Mill 3. These differences are statistically significant, also after taking into account the differences in personal and household characteristics between mills.

Differences in costs partly explained by soil quality and labour shortages

Input costs and labour cost are lower for Mill 1, especially per tonne produced. A higher use of fertilisers and weedicides is used to compensate for lower soil quality in Telangana (mills 2 and 3). And unavailability of labour is considered a lesser challenge among Mill 1 farmers (61% versus 89% and 73% - CH5, 5.5). The relatively high labour costs per tonne produced in Mill 2 and 3 could be induced by a labour shortage, which increases labour wages. The high costs for labour in Mill 2 can be also explained by the fact that they cultivate plant crops which is more labour intensive than ratoon crops.

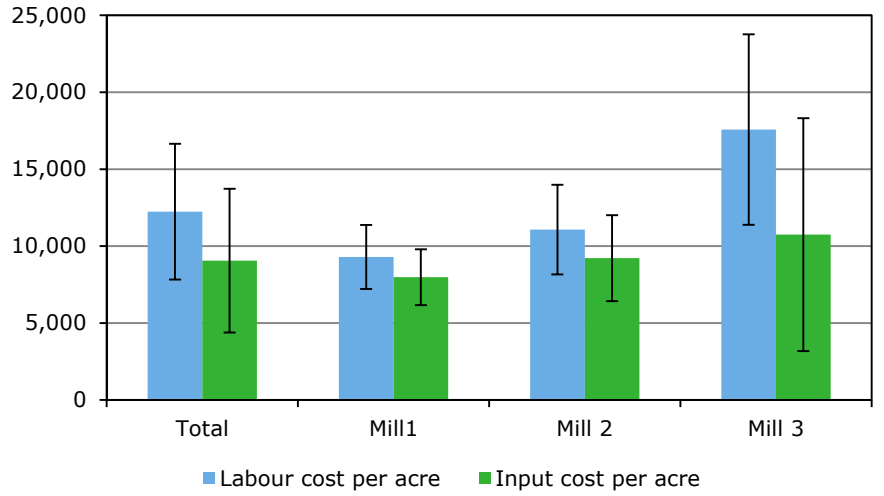


Figure 7.3 **L**abour and input costs per acre

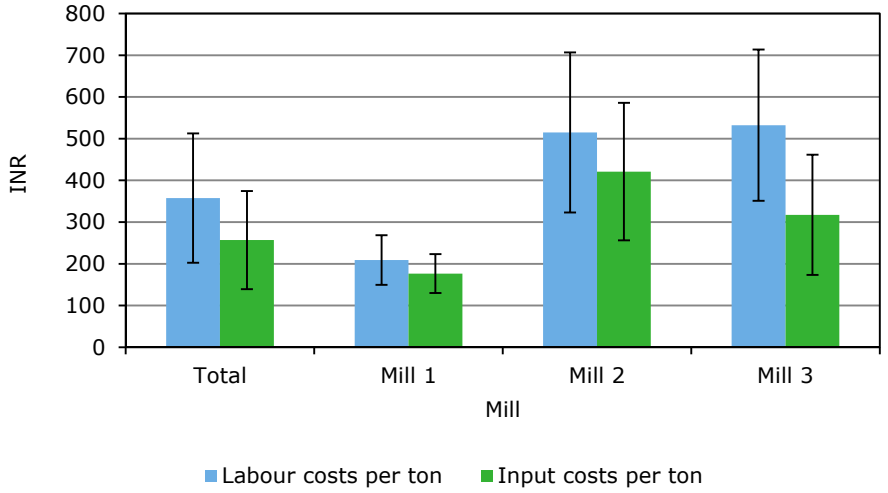


Figure 7.4 Labour and input costs per tonne sugarcane

Plant crop is related to higher production costs per tonne

Aside from the command area (see Table A4.5), farm or household characteristics may also influence cost per tonne sugar. To investigate this, we run a regression analysis to explain the height of the production costs by the farm and household characteristics as described in chapter 5. After controlling for differences between mills we find that cultivating plant crop only is positively and significantly related to higher costs. This is not surprising because more production costs and more labour are involved with plant crops, i.e. furrow and bundling, land preparation and ploughing and planting material and sowing. less cost efficient.

Large households, male farmers, sugarcane acreage and use of chemical-organic ratio are related to lower production costs

Production costs are lower for bigger households, for male farmers[22] and households with more land for sugar. A large household size may reduce gross production costs because more family labour available. Also higher costs for female farmers is to explain as female farmers do not work on the land themselves and as a consequence have higher labour costs. A large area used for sugarcane cultivation may make production costs per tonne more efficient. We also analyse whether some of the key practices, techniques and inputs are related to production costs (see CH6). We find that a higher share of input costs used for chemical fertiliser (versus organic) reduces production costs. This is not very positive as the farmers are stimulated to apply less chemical fertiliser but with the argument that the costs outweigh the benefits. This result is important for FDW given its aim to increase use of organic fertilisers. An important fact to remember is that it seems that the costs for organic fertilisers are relatively high if the source is not the farmer's own land or cattle. So if farmers should be convinced to use organic fertiliser, higher cost could be a barrier. In the current situation farmers are 'rewarded' for using chemicals – at least on the short term. Drip irrigation and the use of trash burning are not related to production costs.

7.3 Sugarcane price

Sugarcane prices below the Fair and Remunerative Price in Mill 1 and 3

On average, farmers received INR2,318 per tonne of sugarcane produced (see Figure 7.5 and Table A3.15) which is just above the Fair and Remunerative Price (FRP) of INR2,300 per tonne and well below the State Advised Price (SAP) of INR2,850 per tonne.[23] The price per tonne differed significantly between the mills. The sugarcane prices per tonne were just below the FRP in both Mill 1 and Mill 3. Farmers of Mill 1 and 3 indicated that the low price of sugarcane was a challenge for them (respectively 58% and 64%, compared to 29% in Mill 2). A reason for the difference in price can be that the mills deduct costs such as loan and credit from the price they finally pay to the farmers. Another reason is that mills 1 and 3 arrange transportation from the field to the mill. These costs are deducted from the price. This might well explain why the price mentioned in Mill 2 is relatively higher and the prices in Mill 1 and 3 is below the FRP.

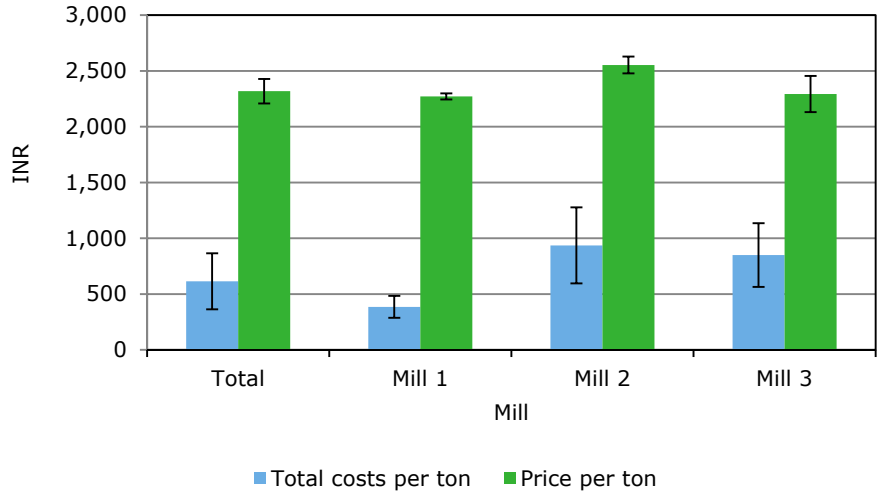
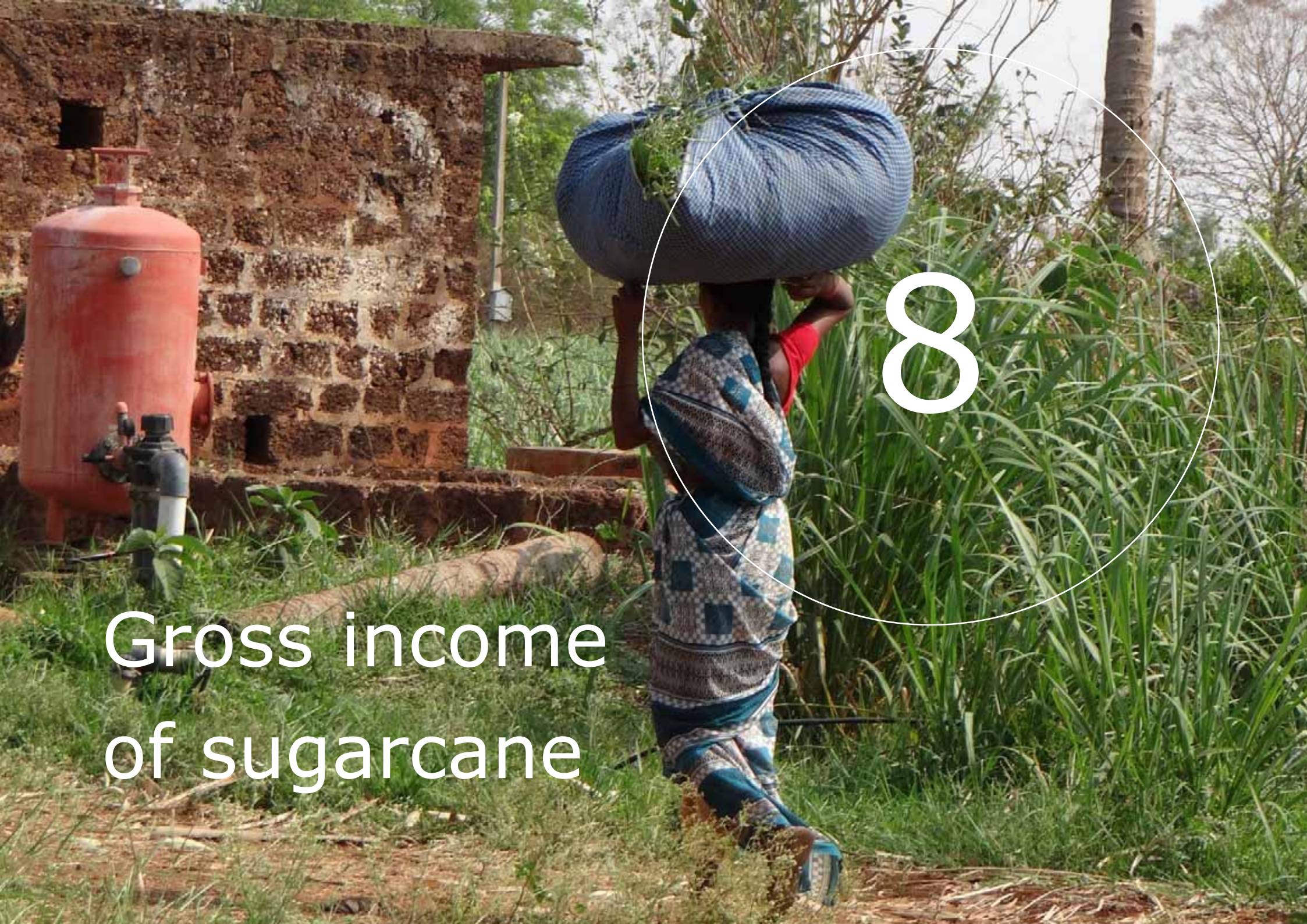


Figure 7.5 Sugarcane production costs and price per tonne

[22] Man is head of the household and main responsible for farming, although all family members might be active on the field and in farming. Male farmers here distinguishes between female farmers who are also head of the household.

[23] http://www.thehindu.com/news/cities/chennai/sugarcane-sap-fixed-at-rs-2850-per-tonne/article8094351.ece



8

Gross income of sugarcane

Gross income of sugarcane

Lower production costs, higher prices and yields are expected to increase profits

The immediate and intermediate outcomes would lead to the ultimate outcomes in the theory of change, which are increased gross incomes and water efficiency of the farmers. This chapter examines gross incomes from sugarcane, per acre and per tonne of sugarcane produced of the harvest in 2015-2016. Results show that the average gross income from total cultivated sugarcane land was INR242,000 which is not satisfactory for 40% of the farmers. Cultivating plant crop only and the use of drip irrigation is negatively related to gross profit as well as the size of sugarcane land and education.

Average gross income from sugarcane of INR242,000 is above GDP

The average gross income from owned and leased sugarcane land of the farmers in 2015/2016 was INR242,000 (also see Table A3.16). This gross income is above the GDP which is, according to the World Bank (2015) 1,681$ (INR17,206) per capita. The term gross income is used instead of profit as family labour cost is not included in the total costs. This means that the actual gross margins, profits, are lower.

Mill 1 has highest gross income

The total gross income, by acre and by tonne is by far the highest in Mill 1 compared to mills 2 and 3 (Figures 8.1 and 8.2). This makes sense as the production costs per tonne are relatively low and productivity relatively high in Mill 1. Farmers report a large decrease in sugarcane gross income in Mill 2, while in Mill 1 and 3 the majority of the farmers reported no change or an increase between 10-50% (Table A3.17). Future research should pay attention to the apparent large decrease in recent years in productivity and gross income in Mill 2.

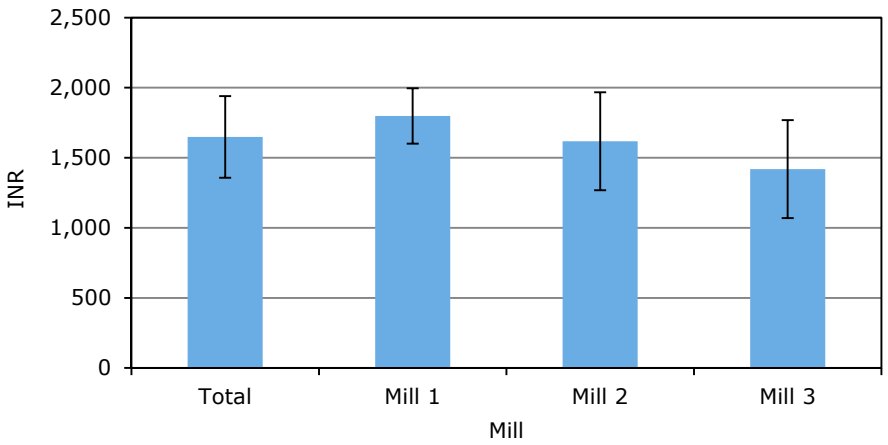


Figure 8.1 Gross income per tonne

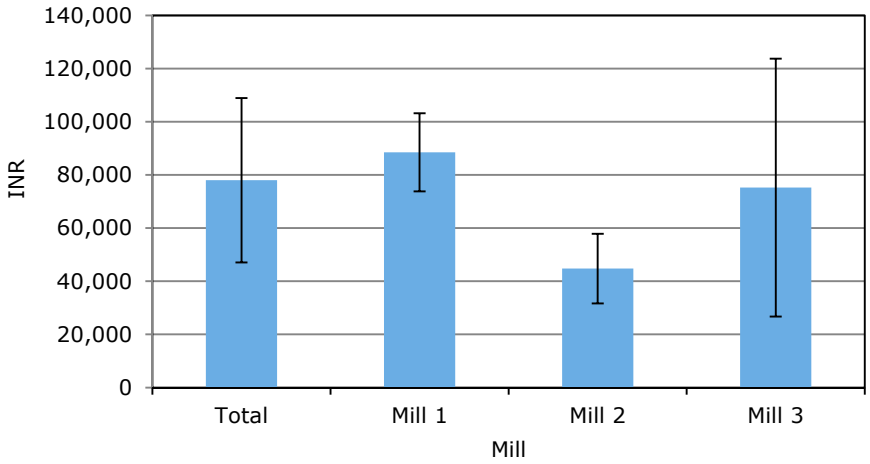


Figure 8.2 Gross income per acre

40% of farmers report to be dissatisfied with income from sugarcane

Forty per cent of the farmers reported to be dissatisfied with their sugarcane income in 2015-2016, 31% of the farmers reported to be satisfied and 22% neutral (Table A3.18). As expected, farmers from Mill 1 are most satisfied with their sugarcane gross income, Mill 2 is most dissatisfied with 67% reporting to be (very) dissatisfied and 54% of the farmers in Mill 3 reported to be dissatisfied. These data could be very helpful in the approach towards the farmers from the different mills.

Plant crop is solely related to lower gross profit than ratoon crops

Aside from the command area (see Table A4.6), farm or household characteristics may also influence gross profit. To investigate this, we run a regression analysis to explain the height of gross income by the farm and household characteristics as described in chapter 5. After controlling for differences between mills we find plant crop only is always negatively related to gross profit. This is an interesting finding. From a cost perspective it is not surprising as more costs are involved with plant crop cultivation. However, according to theory, plant crop should give higher yields compared to ratoon crops. As such, it should still be profitable. Data reveal that cultivating plant crop is not very cost efficient for sugarcane farmers. One of the aims of intervention is to increase the number of profitable ratoons from approximately ratoon 2 and 3 up to ratoon numbers 4 and 5 by good agricultural practices. This means that farmers have to start plant crop every 4 to 5 years instead of every 2 or 3 years. This results in lower costs over the years and combined with stable production and a stable sugarcane price may benefit the farmers economically. Household size is always positively related to gross profit: this can be partly explained by the fact that households with more members have more own labour. However, including production cost in the model does not entirely eliminate this relationship meaning that large households also have other characteristics that influence gross profit.

Sugarcane acreage is related to higher total profit and profit per tonne, but lower per acre

The acreage used for sugarcane, both owned and leased, have an obvious positive correlation to gross total income and per tonne: the higher, the more efficient production seems to be (see Table A4.6). However, this is not the case for profit per acre. Owned and leased sugarcane area have a strong negative correlation to gross income per acre. The more acres used for sugarcane production, the less gross income per acre. This is an interesting finding; bigger farmers in terms of land tend to have lower gross profits per acre. It could be that farmers are less capable of intensification of bigger plots but it should be discussed with the implementing parties. The present data does not give a clear explanation.

Profit per acre is higher for farmers that received a subsidy

Higher education level is negatively related to profit per acre, which can be explained by the shift toward other economic activities by these household members. However, it is not related to lower total profit or profit per tonne. Subsidies really matter to the farmers and make a positive difference in their income levels. Are these farmers already better off? It is interesting to have a better understanding of the subsidy system and criteria why certain farmers do receive subsidy and on what conditions.

Profit is lower when using a higher share of organic fertilisers and by using drip irrigation

We also analyse whether some of the key practices, techniques and inputs are related to profit (see CH6), after controlling for differences in production costs and yield. We find that a higher share of organic fertilisers is related to lower gross total profit; this has been discussed previously and was explained by the relatively high costs for organic fertiliser when it has to be purchased from an external source. An interesting and may be alarming finding is that having drip irrigation is related to lower profit per tonne sugarcane produced. This contradicts the intervention logic of the FDW programme and needs requires more research to further explain possible influencing factors.

Conclusions & Recommendations

9

Conclusions & Recommendations

Sugarcane is vital to the livelihoods of all producers, but farmers differ significantly in terms of personal and farm characteristics

The baseline results show that for all farmers sugarcane is the predominant production mode and that farmers are to a large extent dependent on sugarcane for their income. The data also show that there is plenty of room to improve the application of good agricultural practices and drip irrigation, which underlines the relevance of the intervention. Despite these similarities, there are major differences in illiteracy, experience in sugarcane farming, application of good agricultural practices and drip irrigation.

Good agricultural practices are lacking across all mills

There seems a general need for better agricultural practices. Many of the good agricultural practices as intercropping, trash shredding and the use of seedlings and nurseries, which are part of the intervention hardly occur. Therefore, the intervention can make a large difference when it concerns introduction to and training in the good agricultural practices. In the context of this project, it is promising that farmers from Mill 2 and 3 are very interested in receiving training on good agricultural practices. This is not the case in Mill 1 and it would be desirable to explain the advantages of good agricultural practices to farmers from Mill 1 in order to convince them of the benefits.

Uptake of improved irrigation practices is already evident in Mill 3

Decreasing groundwater level is a serious problem and as such one of the main reasons to implement the FDW project. Information provided by the mills show that particularly Mill 3 has considerable problems with groundwater levels. The annual rainfall has been decreasing and soil has poor water retention. Availability of water for irrigation is considered a key challenge by the farmers themselves and that could be a reason why drip irrigation is already much applied. The fact that only half of the farmers of Mill 3 are interested in receiving a training on irrigation practices (compared to Mill 2 where 92% of the farmers is interested in training on irrigation), may indicate the farmers of Mill 3 already have (or feel they have) sufficient knowledge. To collect more data of farmers who apply drip irrigation on the specific difficulties they face during implementation and maintenance of their drip irrigation could be of use in order to pursue smooth transition from furrow irrigation into drip irrigation for other farmers who still have to make this transition.

Uptake of improved irrigation is not considered key by Mill 1 farmers

Farmers of Mill 1 predominantly use furrow irrigation (97%), despite its lower water efficiency. Farmers from Mill 1 do not consider unavailability of water for irrigation that much of a challenge compared to the other mills, indicating a relative abundance of natural water resources in the command area of Mill 1, or ignorance about the decreasing groundwater level. A well branched network of canals, hosted by several rivers and reservoirs is in place, but it is unclear if the availability of natural water resources keeps the groundwater level constant. It is recommended to the specific mill and Solidaridad to further investigate this contextual situation; it would be desirable to explain the advantages of drip irrigation to farmers and the common good problem of the available water resources.

Maintenance of drip irrigations systems is an important training need

Having concluded that a relatively large portion of farmers already use drip irrigation, especially in Mill 2 (45%) and 3 (61%), gives way to a focus on other issues aside from promoting uptake as such. Farmers indicate they do not have the knowledge and resources to adequately maintain their system. This means part of the training should focus on maintenance of the system.

Financial barriers or enablers, such as subsidy, to adoption are important

There are many barriers to adoption; in this research financial barriers arise in two particular cases. First in relation to adoption of irrigation practices. Almost all farmers who have drip irrigation were able to adopt because they received governmental subsidy. This is an important fact as the absence of subsidy or external finance can be a barrier in adoption and underlines the important role

of governmental support. More insight is needed into the governmental subsidy system to understand what kind of farmers are eligible for subsidy. Second, we find that costs for organic fertilisers are relatively high although the majority of farmers have access to manure and compost of their own farm and cattle. The farmers who have to purchase biological fertiliser report very high costs. This could be a barrier in adoption of biological fertiliser.

Reputation of the mill is related to uptake of better irrigation practices

The reputation of mills and how they approach the farmers seems related to the uptake of irrigation practices. The majority of farmers complain about the delay in receiving the cutting order which can negatively affect the quality of their produce. This is a concrete recommendation to the mill to improve the relationship with their farmers and to increase trust levels.

The average productivity per acre is above the national average, but varies significantly between and within mills

The average productivity is 43.8 tonne per acre for the full sample, which is well above the average national crop productivity and even above the desired 42 tonne per acre (Vision 2030, IISR 2011). Productivity, production costs and gross income from sugarcane production show highly significant differences between the mills and large differences within the command area of the mills. This means that the profile of farmers in one command area differs considerably in terms of farm size, (cost)efficiency, yield and productivity and gross income.

Adoption of drip irrigation is not related to improved productivity or gross margins

Improved production is one of the key (short term) advantages of adopting better practices from the perspective of the farmer. Farmers can be convinced more easily to adopt better practices or techniques if this translates to higher productivity and gross profit. This research indicates that especially farmers of Mill 2 are dissatisfied in terms of both quantity and quality of their produce. However, we find drip irrigation is not automatically related to higher productivity and higher gross margins - even when taking into account differences in household and farm characteristics. This requires more attention because it is one of the key elements of the projects' theory of change.

Farmers of each mill face different challenges and have different training needs

The challenges farmers face and their priorities for training differ considerably. A one-size-fits-all approach is probably not the best approach in this context considering the differences between and within mills. Farmers of each mill face different challenges, have different training needs, different irrigation systems and different preferences for irrigation systems. Moreover, the mills are located in two different states with different climatological conditions and soil quality. These are important points of reflection and recommendation towards the program implementers.

Farmers are already partly organised in groups

The formation of farmer groups is a key building block to the project approach. This baseline research shows large differences between farmers organisation supplying to the same mill: this is especially the case for Mill 3. It is worthwhile to dive into the specific farmers profiles and characteristics when enrolling the intervention and organising farmers in training groups. Furthermore, it is also worthwhile to consider and make use of the existing organisational structures: farmers of Mill 1 are already organised in groups.

The cohorts of farmers form a good baseline to enable impact evaluation

Contrary to the large difference we find in farmers supplying to different mills, we find few differences between the cohorts. The differences that do occur might be explained by selection bias: e.g. farmers with a better network or more assets may have been selected into the first year of the program. This selection bias can be partly controlled for in the statistical analysis in 2018. However, more information is also needed from the mills on what basis they divided the farmers of their command groups into the years of training.

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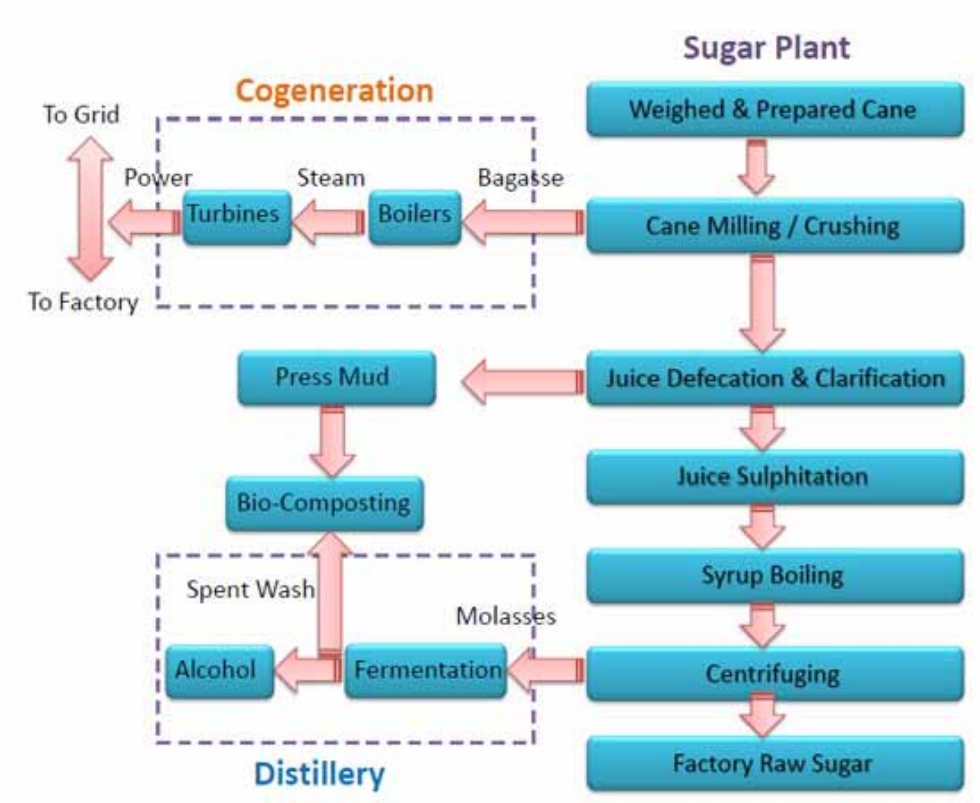
Appendix 1 Map and process of sugarcane

Figure A1.1 Sugarcane mills in India

Figure A1.2 Sugarcane processing



There are in total 642 sugar mills in India. The Southern and Northern India sugarcane industries are not comparable in terms of sowing and harvest period, yield and productivity. Source: http://www.indiansugar.com/SugarMap.aspx

Appendix 2 Farmer profiles per mill

Table A2.3 Farmer profile Mill 1

Farmers profile Mill 1		Mill 1 sugarcane farmers description
Personal characteristics		The average age of the farmers is 39.2 years, 91% of the farmers is male and 69% head of the household. The average household consists of 3.2 members, and almost all farmers received education, leading to an illiteracy level of only 0.4%. The average acreage per farm is 2.93 owned and 0.37 leased. Farmers have on average been cultivating sugarcane for 14.6 years and 59% is member of a sugarcane farmer group. 48% of the farmers received subsidies, mainly for fertiliser (96%), electricity (97%) and pumps (25%). For 91% of the farmers, sugarcane accounts for 75% or more of their incomes, indicating a high dependency on sugarcane production. Thirteen per cent of the farmers use only plant crops and exclusively sets are used for planting new crops, of which 18% directly plants single bud sets. Both chemical and biological fertilisers are used by all farmers. However, usually chemical pesticides are applied, and 25% uses organic pesticides too. Furrow irrigation is the predominant irrigation type and drip irrigation hardly occurs in Mill 1. The average productivity is almost 50 tonnes of sugarcane per acre, 58% of the farmers reported a productivity increase in the last years and 63% is satisfied with their productivity. Sugarcane is sold for INR2,272 per tonne, which is below the FRP. The profit per tonne is almost INR1,800 on average. 43% Reported no change and 53% reported an increase in profit in recent years. Forty-two per cent reported to be satisfied with sugarcane profit, 22% neutral and 35% was dissatisfied. Top 5 challenges of Mill 1 farmers: 67%: Attack of pest and diseases 67%: Delay in getting cutting order 61%: Unavailability of labour 58%: Low price of sugarcane 47%: Unavailability of water for irrigation
Age	39.2	
Male	91%	
Head of household	69%	
Household size	3.2	
Illiteracy level	0.4%	
Farm characteristics		
Owned sugarcane area	2.93	
Leased sugarcane area	0.37	
Experience	14.6	
Sugarcane farmer group member	59%	
Income		
Subsidy	48%	
% 75 or more income sugarcane	91%	
Good Agricultural Practices		
Only plant crop	13%	
Setts	100%	
Single bud sets	18%	
Chemical fertiliser	100%	
Biological fertiliser	100%	
Chemical pesticides	100%	
Chemical and organic pesticides	25%	
Intercropping	1%	
Burning	89%	
Irrigation systems		
Furrow	97%	
Surface drip	1%	
Sub-surface drip	1%	
Drip fertigation	2%	
Production & Gross income		
Productivity (ton per acre)	47.8	
Labour costs/tonne (INR)	209	
Input costs/tonne (INR)	176	
Price/tonne	2,272	
Total Gross income (INR)	293,390	
Gross income/acre (INR)	88,513	
Gross income/ton (INR)	1,798	

Table A2.2 Farmer profile Mill 2

Farmers profile Mill 2		Mill 2 sugarcane farmers description
Personal characteristics		The average age of the farmers is 39 years, 93% is male and 96% head of the household. The household size is 4.5 on average and the illiteracy rate is 28%. The average owned acreage used for sugarcane production is 4.1 and no area is leased for sugarcane cultivation. Farmers have only 3.8 years of sugarcane cultivation experience and 19% is member of a sugarcane farmer group. Thirty-eight per cent received subsidies which were mainly used for other irrigation systems than surface or sub-surface drip. Ninety-eight per cent of the farmers were for 75% or more dependent on sugarcane production.
Age	39.0	
Male	93%	
Head of household	96%	
Household size	4.5	
Illiteracy level	28%	
Farm characteristics		Fifty-nine per cent of the farmers uses only plant crops, 88% uses sets to plant new crops and 46% single bud sets. Chemical fertiliser is applied by 100% of the farmers and biological fertiliser by 82%. Chemical pesticides are applied by 99% of the farmers and 82% use also organic pesticides. Intercropping and burning are applied to a lesser extent.
Owned sugarcane area	4.10	
Leased sugarcane area	0.00	
Experience	3.83	
Sugarcane farmer group member	19%	
Income		Drip irrigation is applied by ways of surface drip (45%) and drip irrigation combined with fertigation (23%). Furrow irrigation is applied the most by 54% of the farmers.
Subsidy	38%	
% 75 or more income sugarcane	98%	
Good agricultural practices		The average productivity acre is just above 25 tonnes of sugarcane, 89% of the farmers indicated a large decrease in productivity in the last years and most indicated to be (very) dissatisfied with their productivity. The price per ton was with INR2,554 well above the FRP and the profit per tonne was INR1,618. As with productivity, a large part of the farmers (87%) indicated a large decrease in profit and many farmers were dissatisfied with their profit.
Only plant crop	59%	
Sets	88%	
Single bud sets	46%	
Chemical fertiliser	100%	
Biological fertiliser	82%	
Chemical pesticides	99%	Top 5 challenges for Mill 2 farmers are: 85%: Unavailability of water for irrigation 73%: Unavailability of labour 71%: No resources for agricultural inputs 61%: Bad condition of drip irrigation 61%: Attack of pest and diseases
Chemical and organic pesticides	80%	
Intercropping	3%	
Burning	8%	
Irrigation systems		
Furrow	54%	
Surface drip	45%	
Sub-surface drip	0%	
Drip fertigation	23%	
Production & gross income		
Productivity (tonne per acre)	25.5	
Labour costs/tonne (INR)	515	
Input costs/tonne (INR)	421	
Price/tonne	2,554	
Total Gross income (INR)	193,983	
Gross income/acre (INR)	44,757	
Gross income/tonne (INR)	1,618	

Table A2.3 Farmer profile Mill 3

Farmers profile Mill 3		Mill 3 sugarcane farmers description
Farm characteristics		The average age in Mill 3 is 52.7 years, 88% of the farmers is male and 78% head of household. Education is less common as 49% of the farmers is illiterate. The household size is on average 5.6 members. Farmers have on average almost 18 years farming experience, and the owned sugarcane area is on average 3.5 acres. The leased sugarcane area only 0.12 acres on average and only 5% is member of a sugarcane farmer group.
Age	52.7	
Male	88%	
Head of household	78%	
Household size	5.6	
Illiteracy level	49%	For 98% of the farmers, sugarcane accounts for 75% or more of their incomes, and 43% received subsidy, mainly for other irrigation system than surface drip or sub-surface drip irrigation.
Farm characteristics		
Owned sugarcane area	3.50	
Leased sugarcane area	0.12	
Experience	17.8	
Sugarcane farmer group member	5%	
Income		
Subsidy	43%	
% 75 or more income sugarcane	98%	
Good agricultural practices		Seventeen per cent use only plant crops and 98% use sets for planting new crops, 92% use single bud sets. All farmers apply chemical fertiliser and 58% also use biological fertiliser. 88% use chemical pesticides and organic pesticides are hardly applied. Intercropping hardly occurs and burning by 42% of the farmers.
Only plant crop	17%	
Sets	98%	
Single bud sets	92%	
Chemical fertiliser	100%	
Biological fertiliser	58%	
Chemical pesticides	88%	
Chemical and organic pesticides	1%	
Intercropping	1%	
Burning	42%	
Irrigation systems		Drip irrigation with fertigation is the predominant irrigation system (57%) followed by furrow irrigation (39%), surface and sub-surface drip irrigation are applied to a far lesser extent.
Furrow	39%	
Surface drip	3%	
Sub-surface drip	2%	
Drip fertigation	57%	
Production & Gross income		Average productivity per acre is just above 45 tonnes of sugarcane. At INR2,293, the price per tonne of sugarcane is just below the FRP and the profit per tonne is INR1,419. High percentages of farmers are satisfied and dissatisfied with production and profit, indicating differences in this.
Productivity (tonne per acre)	45.2	
Labour costs/tonne (INR)	532	
Input costs/tonne (INR)	317	
Price/tonne	2,293	
Total Gross income (INR)	176,953	
Gross income/acre (INR)	75,218	
Gross income/tonne (INR)	1,419	Top 5 challenges for Mill 3 farmers: 1) 89%: Unavailability of labour 2) 81%: Unavailability of water of irrigation 3) 67%: Delay in getting cutting order mill 4) 64% Low price of sugarcane 50%: No equipment for soil testing

Appendix 3 Descriptives tables

Tables Chapter 5 Personal and Household Characteristics

Table A3.1 Share of income from sugarcane production (in %)

Mill	50%	50-75%	75%	>75%
Mill 1 ***	0	9	32	59
Mill 2 ***	2	0	0	98
Mill 3 ***	1	2	50	48
Total	1	5	33	61

*** (α = 0.01), ** (α = 0.05) and * (α = 0.1)

Table A3.2 Willingness to invest

I will not make any investment because you never know what will happen (in %).

tatement investment	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Does not apply drip irrigation	10	45	27	19	0
Applies drip irrigation	6	66	14	12	1
Total	9	51	23	17	0

*** (α = 0.01), ** (α = 0.05) and * (α = 0.1)

Table A3.3 Risk attitude

Investing in agriculture or new agricultural practices is very risky; I would rather not do it (in %).

Statement risk	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Does not apply drip irrigation	19	43	28	9	1
Applies drip irrigation	5	44	29	17	5
Total	15	43	28	11	3

*** (α = 0.01), ** (α = 0.05) and * (α = 0.1)

Table A3.4 Time horizon

I chose INR500 today or INRX next year

Time horizon choice	Total		Mill 1		Mill 2		Mill 3	
	Mean	Std. Dv.	Mean	Std. Dv.	Mean	Std. Dv.	Mean	Std. Dv.
INR needed to choose to receive in 1 year or INR500 now***	929	236	903	236	1,063	388	914	79

*** (α = 0.01), ** (α = 0.05) and * (α = 0.1)

Table A3.5 Ratoon numbers per plot

Ratoon	Number of plots	In %
Ratoon 1	498	46%
Ratoon 2	449	42%
Ratoon 3	122	11%
Ratoon 4	4	0%
Total	1073	1

*** (α = 0.01), ** (α = 0.05) and * (α = 0.1)

Table A3.6 Ratoon numbers per mill (in %)

Ratoons	Mill 1	Mill 2	Mill 3	Total
ratoon 1	49	10	41	100
ratoon 2	56	2	42	100
ratoon 3	48	1	51	100
ratoon 4	0	0	100	100

Tables Chapter 6 Cultivation practices

Table A3.7 Planting practices (in %)

Inputs	Total	Mill 1	Mill 2	Mill 3
Setts used for planting***	98	100	88	99
Of which				
CO86032	58	28	73	99
What the mill provides me with	24	45	0	0
COM0265	13	44	0	0
2003V646	2	0	15	0
Directly plant single bud sets***	41	18	46	92
Seed nurseries***	1	2	0	0
Of which				
Shade house	0	0	0	0

*** (α = 0.01), ** (α = 0.05) and * (α = 0.1)

Table A3.8 Pest and diseases occurrence (in %)

Pest and diseases	Total	Mill 1	Mill 2	Mill 3
Reported pest or disease***	91	96	87	84
Occurrence:				
Red rot***	53	68	67	22
Top borer***	25	26	39	18
Early shoot borer***	24	12	3	50
Pyrilla	6	5	6	7

*** (α = 0.01), ** (α = 0.05) and * (α = 0.1)

Table A3.9 Intercropping (in %)

Intercropping	Total	Mill 1	Mill 2	Mill 3
Rice***	1	1	3	0
Ginger	0	0	0	0
Fruits	0	0	0	0
Vegetables	0	0	0	1
Pulses	1	0	1	1

Table A3.10 Preferred irrigation systems (in %)

Preferred irrigation system	Total	Mill 1	Mill 2	Mill 3
Furrow***	70	96	52	34
Surface drip***	4	1	17	3
Subsurface drip**	0	0	0	1
Drip irrigation with fertigation***	25	2	31	61

*** (α = 0.01), ** (α = 0.05) and * (α = 0.1)

Tables Chapter 7 Production and productivity tables

Table A3.11 Sugarcance production

Production	Total		Mill 1		Mill 2		Mill 3	
	Mean	Std. Dv.	Mean	Std. Dv.	Mean	Std. Dv.	Mean	Std. Dv.
Sugarcane production per acre (in tonne)***	43.8	28.3	47.8	12.0	25.5	10.4	45.2	44.9

*** (α = 0.01), ** (α = 0.05) and * (α = 0.1)

Table A3.12 Sugarcane productivity change (in %)

Change	Total	Mill 1	Mill 2	Mill 3
Large decrease (-<50%)	22	3	89	23
No change	31	39	6	30
Increase (10-50%)	47	58	5	47
Large increase (>50%)	0	0	0	0

*** (α = 0.01), ** (α = 0.05) and * (α = 0.1)

Table A3.13 Sugarcane productivity satisfaction (in %)

Satisfaction	Total	Mill 1	Mill 2	Mill 3
Very dissatisfied	20	0	49	40
Dissatisfied	19	19	42	9
Not satisfied nor dissatisfied	15	17	3	18
Satisfied	45	63	6	33
Very much satisfied	1	1	0	2

*** (α = 0.01), ** (α = 0.05) and * (α = 0.1)

Table A3.14 A Sugarcane production costs per acre

Production costs/acre (INR)	Total		Mill 1		Mill 2		Mill 3	
	Mean	Std. Dv.	Mean	Std. Dv.	Mean	Std. Dv.	Mean	Std.Dv.
Labour cost24 per acre produced	12,238	8,818	9,294	4,154	11,076	5,827	17,577	12,378
Input cost per acre produced	9,053	9,344	7,979	3,639	9,217	5,581	10,746	15,138
Total production cost per acre produced	21,291	15,386	1,728	6,914	20,292	10,713	28,323	22,910
Total margin per acre	79,715	61,305	91,421	26,508	44,757	26,181	75,673	96,747

Table A3.14B Sugarcane production costs per tonne

Production costs/tonne (INR)	Total		Mill 1		Mill 2		Mill 3	
	Mean	Std. Dv.	Mean	Std. Dv.	Mean	Std. Dv.	Mean	Std.Dv.
Labour cost25 per tonne produced***	358	310	209	119	515	384	532	363
*Average hours of labour hired****	*590*	*206*	*497*	*140*	*612*	*130*	*733*	*236*
*Average hours of hired labour per tonne****	*6.47*	*5.71*	*3.75*	*2.16*	*9.38*	*7.18*	*9.64*	*6.66*
Input cost per tonne produced***	257	235	177	93.3	421	330	317	288
Total production cost per tonne produced***	615	503	386	197	936	681	850	571

*** (α = 0.01), ** (α = 0.05) and * (α = 0.1)

Table A3.15 Sugarcane price

Price	Total		Mill 1		Mill 2		Mill 3	
	Mean	Std. Dv.	Mean	Std. Dv.	Mean	Std. Dv.	Mean	Std. Dv.
Price per tonne sugarcane (INR)***	2,318	220	2,272	55.3	2,554	150	2,293	325

*** (α = 0.01), ** (α = 0.05) and * (α = 0.1)

[24] Only hired labour

[25] Only hired labour

Tables chapter 8

Table A3.16 Gross sugarcane income

Gross Income (INR)	Total		Mill 1		Mill 2		Mill 3	
	Mean	Std. Dv.	Mean	Std. Dv.	Mean	Std. Dv.	Mean	Std. Dv.
Gross income***	242,000	159,000	293,000	130,000	194,000	183,000	177,000	160,000
Gross income per acre***	78,015	61,846	88,513	29,362	44,757	26,181	75,218	96,987
Gross income per tonne sugarcane***	1,649	583	1,798	395	1,618	699	1,419	699

*** (α = 0.01), ** (α = 0.05) and * (α = 0.1)

Table A3.17 Gross sugarcane income change (in %)

Change	Total	Mill 1	Mill 2	Mill 3
Large decrease (-<50%)	19	4	87	14
No change	40	43	13	46
Increase (10-50%)	41	53	0	39
Large increase (>50%)	1	0	0	2

Table A3.18 Gross sugarcane income satisfaction (in %)

Satisfaction	Total	Mill 1	Mill 2	Mill 3
Very dissatisfied	6	0	37	2
Dissatisfied	40	35	30	54
Not satisfied nor dissatisfied	22	22	6	29
Satisfied	31	42	25	14
Very much satisfied	0	1	1	0

Appendix 4 Regression tables and models

Regression tables chapter 6

*** (α = 0.01), ** (α = 0.05) and * (α = 0.1)

Table A4.1 Regression results drip irrigation

Drip irrigation	Impact (+)	Drip irrigation	Impact (-)
Owned sugarcane area	+***	Experience	-***
Education	+**	Leased other area	-**
Sugarcane farmer group	+*		
Subsidy	+*		
Statements			**Impact (+/-)**
I do not want to further develop a relationship with the mill because I am not sure whether it is really fair.			+***

Table A4.1.1 Regression model drip irrigation

Variables in equation	B
1.mill	0.000
2.mill	0.397***
3.mill	0.608***
Plant crop only	-0.044
Years of cultivation experience	-0.005***
Gender	-0.012
Head of household	-0.026
Household size	0.005
Education	0.024**
Owned sugarcane area	0.022***
Leased sugarcane area	-0.003
Owned other area	0.005
Leased other area	-0.106**
Income % from sugarcane	-0.066
Subsidy	0.043*
Sugarcane farmer group	0.054*
'I will not make any investment because you never know what will happen'	0.008
'I'm only willing to invest in new agricultural practices after I find the mill technology reliable'	0.003
'I do not want to further develop a relationship with the mill because I am not sure whether it is really fair'	0.039***
'Investing in agriculture/new agricultural practices is very risky; I rather do not do it'	-0.006
Time horizon	0.000
Constant	-0.062
Observations	1002

*** (α = 0.01), ** (α = 0.05) and * (α = 0.1)

Table A4.2 Regression results share of chemical fertiliser in total fertiliser costs

Share of chemical fertiliser	Impact (+)	Share of chemical fertiliser	Impact (-)
Sugarcane farmer group	+***	Time horizon (risk aversion)	-***
Household head	+**	Household size	-**
Gender	+*	Owned sugarcane area	-**
Experience	+*	Plant crop only	-*
Statements			**Impact (+/-)**
I will not make any investment because you never know what will happen			+***
I do not want to further develop a relationship with the mill because I am not sure whether it is really fair.			+*
Investing in agriculture/new agricultural practices is very risky; I rather not do it			-***

Table A4.3 Regression results burning

Burning	Impact (+)	Burning	Impact (-)
Experience	+***	Plant crop only	-***
Sugarcane farmer group	+***	Owned other area	-***
Leased sugarcane area	+**	Household head	-***
Education	+**	Household size	-***
		Time horizon (risk aversion)	-**
		Gender	-*
Statements			**Impact (+/-)**
Investing in agriculture/new agricultural practices is very risky; I rather not do it			-***

Table A4.4 Regression results productivity

Productivity	Impact (+)	Productivity	Impact (-)
Head of household	+**	Owned sugarcane area	-***
Subsidy	+*	Leased sugarcane area	-***
		Education	-**

Table A4.4.1 Regression model productivity

Productivity	$B^{model\ A}$	$B^{model\ B}$
1.mill	0.000	0.000
2.mill	-21.778***	-20.717***
3.mill	-4.889*	-5.519
Drip irrigation		5.129
Share chemical in total fertiliser costs		-3.842
Intercropping		-4.775
Burning		1.587
Plant crop only	-2.792	-1.934
Years of cultivation experience	0.011	0.336*
Gender	3.554	10.333***
Head of household	5.206**	11.105***
Household size	0.938	0.496
Education	-1.435**	-0.664
Owned sugarcane area	-3.279***	-5.472***
Leased sugarcane area	-5.201***	-5.093***
Owned other area	0.388	0.742
Leased other area	-4.061	-3.900
Income % from sugarcane	2.410	3.430
Subsidy	3.009*	1.049
Sugarcane farmer group	0.202	1.779
Constant	56.267***	49.962***
Observations	1006	607

*** (α = 0.01), ** (α = 0.05) and * (α = 0.1)

Table A4.5 Regression results production costs per tonne

Production costs	Impact (+)	Production costs	Impact (-)
Plant crop only	+***	Owned sugarcane area	-***
		Share of chemical fertiliser	-***
		Gender	-**
		Head of household	-**
		Household size	-*

Table A4.5.1 Regression model production costs per tonne

Costs per tonne	B model A	B model B
1.mill	0.000	0.000
2.mill	552.601***	492.889***
3.mill	508.412***	479.970***
Drip irrigation		-9.208
Share chemical in total fertiliser costs		-190.593***
Intercropping		116.101
Burning		13.460
Plant crop only	100.113***	71.595*
Years of cultivation experience	-0.769	-2.344
Gender	-107.035**	-145.200**
Head of household	-89.468**	-101.232**
Household size	-17.481*	-18.191*
Education	-10.119	-19.977
Owned sugarcane area	-34.895***	-52.253***
Leased sugarcane area	-18.542	-2.622
Owned other area	-3.316	3.655
Leased other area	17.139	4.955
Income % from sugarcane	-45.855	-19.062
Subsidy	-34.917	9.328
Sugarcane farmer group	-51.719	-48.963
Constant	766.469***	987.179***
Observations	1008	608

*** (α = 0.01), ** (α = 0.05) and * (α = 0.1)

Table A4.6 Regression results gross income

Gross income	Impact (+)	Gross income	Impact (-)
Head of household	+***	Plant crop only	-***
Owned sugarcane area	+***	Household size	-***
Household size	+**	Drip irrigation	-**
Share of income from sugarcane	+**	Share of chemical fertiliser	-**

Table A4.6 Regression results gross income per acre

Gross income per acre	Impact (+)	Gross income per acre	Impact (-)
Head of household	+***	Owned sugarcane area	-***
Gender	+*	Leased sugarcane area	-***
Subsidy	+*	Plant crop only	-**
Household size	+*	Education	-*

Table A4.7 Regression results gross income per tonne

Gross income per tonne	Impact (+)	Gross income per tonne	Impact (-)
Head of household	+***	Leased sugarcane area	-***
Owned sugarcane area	+***	Plant crop only	-***
Gender	+**	Drip irrigation	-*
Household size	+*		

Table A4.7.1 Regression model gross income per tonne

Profit per tonne	B model A	B model B
1.mill	0.000	0.000
2.mill	-266.577***	82.192*
3.mill	-493.911***	52.438
Price		0.977***
Productivity		1.126***
Total costs per tonne		-1.062***
Plant crop only	-180.061***	-45.233**
Years of cultivation experience	-0.309	-0.445
Gender	144.271**	38.965
Head of household	175.311***	13.335
Household size	22.907*	5.013
Education	8.136	-4.866
Owned sugarcane area	38.786***	33.817***
Leased sugarcane area	-181.844***	-204.151***
Owned other area	7.526	-8.753**
Leased other area	21.599	-0.927
Income % from sugarcane	121.462	36.476
Subsidy	23.941	16.313
Sugarcane farmer group	66.185	-28.054
Drip irrigation		-44.518*
Share chemical in total fertiliser costs		23.010
Intercropping		71.588

*** (α = 0.01), ** (α = 0.05) and * (α = 0.1)

Appendix 5 Differences per cohort

Table A5.1 Personal characteristics

Characterstics	Cohort 1		Cohort 2		Cohort 3		Total	
	Mean	Std. Dv.	Mean	Std. Dv.	Mean	Std. Dv.	Mean	Std. Dv.
Household size**	4.17	1.72	4.29	2.03	3.89	1.76	4.16	1.86
Owned other area (acre)***	1.10	1.54	1.58	3.05	0.97	1.53	1.27	2.28
Member credit/saving group*	1%		0%		2%		1%	
Subsidy received***	32%		48%		62%		45%	
Years cane experience**	14.0	6.88	15.0	8.05	12.6	6.03	14.1	7.25
Lead farmer***	10%		14%		6%		11%	
PPI**	55.5%		53.1%		49.2%		53.2%	

*** (α = 0.01), ** (α = 0.05) and * (α = 0.1)

Table A5.2 Farm characteristics

Production cost (INR)	Cohort 1		Cohort 2		Cohort 3		Total	
	Mean	Std Dv.	Mean	Std. Dv.	Mean	Std. Dv.	Mean	Std. Dv.
Productivity per acre (tonne sugarcane)	45.1	29.3	42.5	26.9	44.1	29.0	43.8	28.3
Input cost per tonne sugarcane (INR)	258	221	259	269	251	192	257	235
Labour cost per tonne sugarcane (INR)	356	287	366	345	344	283	358	310
Total cost per tonne sugarcane (INR)	614	477	626	560	595	433	615	503
Price per tonne sugarcane (INR)	2,331	219	2,301	235	2,327	189	2,318	220

*** (α = 0.01), ** (α = 0.05) and * (α = 0.1)

Table A5.3 Production characteristics

Sugarcane gross income (INR)	Cohort 1		Cohort 2		Cohort 3		Total	
	Mean	Std. Dv.	Mean	Std. Dv.	Mean	Std. Dv.	Mean	Std. Dv.
Total gross income	234,000	150,000	250,000	172,000	239,000	146,000	242,000	159,000
Gross income/ acre	80,622	68,334	73,974	50,686	80,820	67,988	78,015	61,846
Gross income/ tonne	1,652	570	1,625	642	1,689	482	1,649	583

*** (α = 0.01), ** (α = 0.05) and * (α = 0.1)

Table A5.4 Good agricultural practices ((in %)

Practices	Cohort 1	Cohort 2	Cohort 3	Total
Seed nurseries*	1	2	0	1
Pesticides**	95	95	100	96
Burning***	69	57	63	63
Sets***	99	96	99	98
Single bud setts	41	40	47	42
Pesticides	95	95	100	96
Intercropping***	3	2	2	2.4

*** (α = 0.01), ** (α = 0.05) and * (α = 0.1)

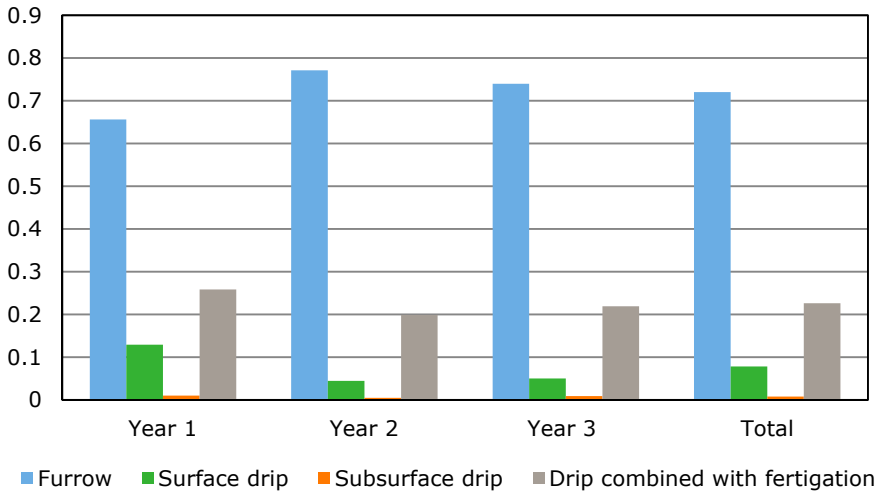


Figure A5.1 Irrigation system per year/cohort **

Appendix 6 SNAL 2016 survey sugarcane farmers India

April 16, 2016

Sections

A General characteristics
B Farm characteristics
C Sugarcane production characteristics
D Agricultural practices sugarcane
E Irrigation practices
F Inputs for sugarcane production
G Household income and diversification
H Livelihoods
I Trainings, Farmer Field Schools
J Risk and investment

Instructions for enumerators (do not read)

1. All questions need to be answered. Please check before you leave the place.
2. If a respondent does not know the answer, write down -999.
3. If a respondent does not want to answer, write -888.
4. If the question does not apply to the respondent, write NA.
5. And if an answer is '0', put '0', for example at the 'costs questions'.
6. Make sure the respondent feels free to talk and diminish any noise and interference.
7. If we ask a question about 'last harvest' this means the last cultivation and harvest season of 2015-2016. Questions relate to both) plant crop and ratoon.

For enumerator to answer – check supervisor

A Date of interview (dd-mm-yyyy):..... Start time:.....

B Name of enumerator.....

C Respondent will receive training in:
1. Year 1 (2016)
2. Year 2 (2017)
3. Year 3 (2018)

D Command area of mill:
1. Koppa Unit mill (Karnataka, Mandya and Tumkur districts)
2. Kirshnaveni Mill (Telangana, Mehaboobnagar district)
3. Trident Sugar Mill

E Division, please circle the correct code:

xxxx

-000-

Introduction to respondent

My name is .....

I am here on behalf of the India research institute Q&Q and Wageningen University in the Netherlands. We are carrying out a research on the livelihoods and agricultural practices of sugarcane farmers in Telangana and Karnataka. You have been selected to be part of this survey because the international NGO Solidaridad will work here in partnership with the mill you supply your produce to.

Your selection to take part in this survey was done at random, that means based on coincidence, If you agree to participate, the survey will take approximately 60 to 90 minutes. We hope that the research will give important insights to improve the livelihoods of sugarcane farmers in these states and in an increased water use efficiency. And we hope it will provide insights and learnings to improve future work of similar initiatives.

The researchers will keep your responses confidential. Your name will never be used anywhere to ensure confidentiality.

You are not obliged to answer questions if you do not want to. We hope we will go through the entire survey but you are free to stop to interrupt the interview at all times. You will not receive any direct benefit if you join this study; your participation is voluntary which we highly appreciate. We hope that the research outcomes and your perspective will benefit the sugarcane producers in the Telangana and Karnataka states.

Do you have any questions for me? You may ask question about this study any time.

Are you willing to participate?

1=yes
2=no

Thank you.

SECTION A HOUSEHOLD AND RESPONDENT IDENTIFICATION

This section is about some personal and household characteristics of you and your household.

1a Name of the farmer.....pre-filled
1b Fathers name: .....pre-filled

Enumerator: this should be the person on your list, if he/she is not available check whether someone of the household is available and who is actively involved in sugarcane production with knowledge on the cultivation process, production costs of the last year (2015-2016) (e.g. a caretaker, employee, or knowledgeable family member). Check with your supervisor if you doubt.

1c Is the name of the respondent in front of you different than the name mentioned at 1a and 1b?

0. No **--> go to question 1f**
1. Yes

1c What is the name of the respondent in front of you: .....

1d What is his/her fathers' name: .....

1e If there is a name under 1c and 1b, why is the farmer different from 1a?
1. The original respondent is no longer alive, or no longer farming
2. The original respondent is available, but not really actively involved
3. The new respondent is a different member of the same household with thorough knowledge on sugarcane production and its costs
4. Other, specify:.....

1f District: .....

1g Village: .....

1h Taluka.....(Q&Q: better to use a predefined list with codes, can the mill provide such a list? Or based on the sampling)..

1i Mandal: .....(Q&Q: better to use a predefined list with codes, can the mill provide such a list? Or based on the sampling)..

1j Phone number .....

1k Gender of the respondent
0. Male
1. Female

1l What is your position in the household

1. Household head
2. Spouse
3. Other adult (e.g. grandparents, brother, etc)
4. Child

1m Did you cultivate sugarcane in the last year (2015-2016)?

0. No
1. Yes

If the answer to question 5 is NO, then stop the interview and go to another farmer on your list.

1n For how many years do you cultivate sugarcane? .... number of years

1o How many people are part of your household, including you?

Enumerator: household = lives under one roof / eat from the same kitchen (include the respondent and his/her spouse)

	Person first name	**Age**	**Male / Female** *0 = male 1 = female*	**Education** *0= illiterate 1 = literate NA if <5 years*	**Education level *** *See below NA if <5 years*	**If yes, private or government school?** *0 = government 1 = private*
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

**Codes for education:*

1. Did not go to school
2. Started primary school but could not complete and stopped at level .....
3. Primary school (upto 5th standard)
4. Middle school (Upto 8th standard)
5. Matriculation (Upto class 10th)
6. Intermediate (upto Class 12th)
7. College, please specify the level.....
8. Other education..... (please specify)

=== end of section A ===

SECTION B FARM CHARACTERISTICS

We want to get to know your farm and different sugarcane plots better. Therefore we will ask you questions about what you do on the farm and on your plots where you grow sugarcane. We want to ask information on your sugarcane production about the last year combined for all sugarcane plots.

The questions relate to the last cultivation and harvest season (2015-2016).

Enumerators: check: they may have several subplots, so ask for the total sugarcane acreage

	2a. Crops cultivated	2b. Area (in acre)		2c. Intercropping with sugarcane *0.No* *1. Yes*	2d. What is the type of soil? *0. Black* *1. Red* *2. Both*	2e. Did you conduct a soil test? *0.No* *1. Yes*
		Own	*Leased*			
1	Sugarcane (all plots)			NA		
2	Rice / paddy					
3	Ginger					
4	Fruits					
6	Potatoes					
6	Vegetables					
7	Pulses					
8	unirrigated farm land					
9	Other, specify:					
10	Other, specify:					

<u>Sugarcane</u> production and sales

Enumerator 1: the following questions refer to the sugar plot <u>owned</u> only.

2b In which month was your last harvest?

1. January
2. February
3. March
4. April
5. May
6. June
7. July
8. August
9. September
10. October
11. November
12. December

2c. We now ask you per sugarcane plot whether you cultivated plant or ratoon crop and what your harvest was.

Enumerator: some farmers have several plots with sugarcane, we would like to know which type of crops (plant or ratoon) respondent cultivated and the harvest per plot.

	Sugar plot (owned only)	Type *0)* ***Plant*** *1)* ***Ratoon 1*** *2)* ***Ratoon 2*** *3)* ***Ratoon 3*** *4)* ***Ratoon 4*** 5) ***Ratoon 5***	Plot size	Harvest in metric tonnes per acre per plot
1	Sugarcane Plot one			
2	Sugarcane Plot two			
3	Sugarcane Plot three			
4	Sugarcane Plot four			
5	Sugarcane Plot five			
6	Sugarcane Plot six			
7	...			
8	...			

2d How much did you supply in total to the mill? (NOT PER ACRE, BUT TOTAL)

_____metric tonnes

2e What was the price that you received per tonne of your sugarcane crop?
Rs_____per tonne

2f How satisfied are you with your the last sugarcane production of 2016?

1. Very dissatisfied
2. Dissatisfied
3. Not satisfied nor dissatisfied
4. Satisfied
5. Very much satisfied

2g Do you believe the quality of your sugarcane produce improved in the last years?

0. No
1. Yes

2h In the recent years, have you seen an increase or decrease in production of sugarcane?

0. Large decrease (< 50%)
1. Decrease (-10-50%)
2. No change (0%)
3. Increase (10-50%)
4. Large increase (>50%)

2i Is your sugarcane production certified?
Enumerator: the mill is no certification!

0. No **--> please go to question 2**
1. Yes
2. Other, specify:.....

2j What certification does your produce have?

1. Bonsucro
2. Other, specify: .....

2k What was the age of your sugarcane crop when you harvested it?

1. Less than 10 months
2. 11 months
3. 12 months
4. 13 months
5. More than 13 months

2l Were you satisfied with the **profit** you made from sugarcane last year?
Enumerator: profit = gains, so revenue minus costs (i.e. not the total price received for yields)

1. Very dissatisfied
2. Dissatisfied
3. Not satisfied nor dissatisfied
4. Satisfied
5. Very satisfied

2m In the last few years, have you seen an increase or decrease in the profit levels of your sugarcane?

Enumerator: profit = gains, so revenue minus costs (i.e. not the total price received for yields)

0. Large decrease (< 50%)
1. Decrease (-10-50%)
2. No change (0%)
3. Increase (10-50%)
4. Large increase (>50%)

2n Do you have any costs besides your seed, input, labour and harvest (e.g. transportation, irrigation, bank?

0. No **--> please go to question 2p**
1. Yes

2o What other types of costs in sugarcane cultivation do you have? More answers possible

1. Transportation cost
2. Interest costs for a sugarcane loan & investment
3. Other, specify: .....

2p How do you feel about last year's rainfall for sugarcane production? (2015-2016)

1.Below average of expectation
2.Normal
3.Above average of expectation

2q What are the main challenges for you related to sugarcane production, in order of importance? **Enumerator: you may prompt. More options possible.**

	Challenges
1	Unavailability of labour
2	Unavailability of agri inputs
3	No resources to buy agri inputs
4	Delay in payment from the mill
5	Transportation issues of produce to the mill
6	Unavailability of water for irrigation
7	My drip irrigation is in bad condition
8	Attack of diseases and insects / pest
9	Poor quality of soil
10	No facility for soil testing
11	Delay in getting cutting order
12	Low price of cane
13	(no) electricity / blackouts
14	Other ... .
15	Other ... .

2r Are you member of a farmer group?

0. No **--> please go to question 2x**
1. Yes

2s What farmer group are you member of?

a. Sugarcane farmer group
b. Water management farmer club
c. Credit and savings group
d. Other, specify: .....

2t Do you receive any support in sugarcane cultivation? *Such as trainings, financial assistance, input provision, advisory services*

0. No **--> go to Section C**
1. No, not anymore **--> go to question 2u**
2. Yes **--> go to question 2v**

2u What was the last year you received support related to sugarcane production?

.... year *(for example: 2014, 2000, 1998)*

2v What is the source(s) of your support? *More answers possible*

0. Government / extension services
1. The mill I supply my produce to
2. An NGO / charity
    a. If yes, please specify which: .....
3. Other, specify.....

=== end of section B ===

SECTION C LABOUR IN SUGARCANE PRODUCTION

3a The following questions are about how much time is spent on sugarcane growing and harvesting activities of the last cultivation season 2015-2016. We ask you about how much time you spent per activity in the production process and for both own labour (farmer and family members) and hired labour.

Enumerator:

- Fill out -999 when the farmer does not know
- Fill out NA when not applicable
- Fill out '0' when 0

Enumerator 1: the question concern total owned land, so the number of labour for all sugarcane plots

Enumerator 2: the work of farmer himself counts as labour

Enumerator 3: if the farmer has only ratoon, don't fill in the activities applicable to plant crop

#	Activity	Total days required	*Of which:* farmer labour days (respondent) (number of days)	*Of which:* Family days (number of days)	*Of which:* Hired labour days (number of days)
1	Ploughing (plant crop)				
2	Land preparation (plant crop)				
3	Furrows & bunding (plant crop)				
4	Fertilisation/manure (both)				
5	Sowing (plant crop)				
6	Hoeing (both)				
7	Weeding (both) *Manual, Pre-emergent & post-emergent*				
8	Irrigating (both)				
9	Trash shredding/mulching (ratoon)				
10	Carrying / transport (to mill (both)				
11	Other (e.g. tying, propping) Specify:				
12	Harvest labour costs (per tonne) in INR				

3b How much hours is a regular and typical labour day (including breaks, travelling)?
.... hours

=== end of section C ===

SECTION D AGRICULTURAL PRACTICES SUGARCANE

4a How do you plough?

0. I do not plough
1. I use a rented tractor
2. I use my own tractor
3. I use my own livestock
4. I use rented livestock

4b What do you use for planting fresh crops?

1. Setts
2. Seedlings

4c What is the name of the variety?

1. CO8632 --> check mill
2. CO8603 --> check mill
3. 93V29

4. Xxxx * ask list of varieties from mill
5. Xxxx
6. Xxxx
7. Xxxx

8. What the mill provides me with
9. Other, specify: .....
10. I do not know

4d Do you use seed nurseries?

0. No **--> please go to question 4g**
1. Yes

4e When do you transplant?

0. I do not know
1. 05-10 days
2. 10-20 days
3. 25-30 days
4. 30-40 days
5. 40-50 days
6. Other, specify: .....
7. I do not know

4f Do you use shade houses (green house) for raising seedling nursery?

0. No
1. Yes my own shade house
2. Yes, I rent a shade house

4g If you use sets, do you directly plant single bud setts?

0. No
1. Yes

4h What is the row-to-row spacing?

1. 2 feet
2. 3 feet
3. 4 feet
4. More than 4 feet

4i Do you tie your sugarcane when gaining height (not yet harvested)?

0. No
1. Yes

4j Do you apply chemical fertilisers at your sugarcane crop?

0. No
1. Yes --> **please go to question 4n**

4k Why don't you apply chemical fertilisers? *Multiple answers possible*

1. I don't have financial resources to buy the fertilisers
2. I don't have access / no availability
3. I prefer to use organic fertilise
4. I do not see the benefits of it
5. I am not used to of doing so
6. I do not know

4l How do you apply chemical fertiliser at your sugarcane crop? *Multiple answers possible*

1. Broadcasting
2. Spray
3. With irrigation water
4. Other_____

4m How often do you apply chemical fertiliser? *Multiple answers possible*

1. Once in a season
2. Twice in a season
3. 3 times in a season
4. 4 times in a season
5. 5 times in a season
6. More than 5 times in a season

4n Do you follow the guidelines of the government/mill or sugar institute regarding quantity and time of application?

0. No
1. Yes
2. I do not know these guidelines

4o Do you apply any organic fertiliser at your sugarcane crop?

0. No **--> please go to question 4s**
1. Yes

4p What kind of organic fertiliser do you use? *Multiple answers possible*

1. Cattle manure
2. Compost
3. Press mud

4q What is the source of your organic fertiliser? *Multiple answers possible*

1. My own farm
2. The mill supplies me
3. The government supplies me
4. Other farmers
5. Other: .....

.

4r How often do you apply organic fertiliser per cultivation season?

1. 0-1 times per season
2. 2-3 times in a season
3. 4-5 times in a season
4. I do not know

4s Why don't you apply organic fertiliser? *More answers possible*

0. I did not know it was possible to use as an agri-input
1. I am not convinced of the benefits of it for my crop
2. I prefer chemical fertiliser
3. I do not have access to organic fertiliser
4. I do not have the resources to purchase organic fertiliser
5. Other, specify: .....

4t Do you have access to a trash shredder?

0. No **--> go to question 4x**
1. Yes

4u Do you own a trash shredder?

0. No, I make use of someone else's services
1. Yes I own a trash shredder

4v Do you apply pesticides at your sugarcane crop?
Enumerator: pesticides include weedicides, fungicides and pesticides.

0. No **--> go to question 4z**
1. Yes

4w What kind of pesticides do you apply?

1. Chemical pesticides
2. Organic pesticides
3. Both chemical and organic pesticides

4x How often do you apply pesticides per cultivation season?

1 0-1 times per season
2 2-3 times per season
3 4-5 times per season
4 6-7 times per season
5 8-10 times per season
6 I do not know

4y Do you apply pesticides preventive or curative?

1 Preventive
2 Curative
3 Both

4z Why don't you apply pesticides at your sugarcane crop?

1 I do not have the financial resources to buy pesticides
2 I do not have access / no availability
3 I do not believe in the benefits of it
4 I am not used to do so
5 I learned that it is not healthy for my crop and for my health
6 Other, specify: .....

4aa Did you have any pests or diseases at your crop last season?

0. No **--> go to question 4ad**
1. Yes

4ab What kind of diseases/pests did occur?
Enumerator: show card

1 Red rot
2 Top borer
3 Pyrilla
4 Early Shoot borer
5 White fly
6 Other specify: .....

4ac What did you do when you noticed your crop was affected?
Enumerator:. Multiple answers possible

1 I uprooted and burnt the affected clumps immediately
2 I sprayed pesticides
3 I harvested my crop as soon as possible
4 I kept the field free from standing water
5 I did not ratoon
6 I did not collect seed setts from the affected plants
7 Other: ..... (specify)

4ad Do you burn your land after harvest?

0. No
1. Yes

== end of section D ==

SECTION E IRRIGATION PRACTICES

The following questions are about irrigation practices. It concerns only the water and water source used for watering the crops. So not for domestic use.

5a. What kind of irrigation systems do you know, use and would like to use?

	System	Known to farmer? *0=unknown* *1=known*	Used irrigation system (for most/all plots) *0=no* *1=yes*	For which crop *Multiple answers* *1=sugarcane* *2=paddy* *3=ginger* *4=fruits* *5=potato* *6=vegetables* *7=pulses* 8=other	Preferred irrigation system ** Circle which is applicable
1	Furrow irrigation				1
2	Surface drip irrigation				2
3	Sub-surface drip irrigation (15-30 cm depth in root zone)				3
4	Drip irrigation combined with fertigation				4
5	Other, specify:				5

**** Enumerators: if used and preferred systems are different, ask:**

5b If your preferred system is different than your adopted irrigation system, why is that?

1 The investment is too costly
2 I cannot access a loan
3 I do not have the technical knowledge
4 I have other priorities

Ask ONLY to those who use Furrow irrigation

5c Please let us know what is your source of water, method of transportation, frequency, amount spent and water quality.

	In case of:	Source of water *1.Bore wells* *2.Canal* *3.Directly from river* *4.Other*	Method *1.Electric pump* *2.Diesel pump* *3.Any other...*	Do you rent water? *0. No* *1.Yes*	If you use rented water, how much do you pay per hour? (INR)	If you have an electricity pump, do you have easily access to electricity ? *0. No, not very easy* *1. More or less easy* *2. Yes, very easy* *If no diesel pump: put NA*
1	*furrow* irrigation					

Ask ONLY to those who use <u>drip irrigation</u>:

5d Please let us know some information about the method of irrigation.

#	In case of:	Since when *(mention which year, e.g. 2012)*	How were you able to invest in this system? *0. A loan* *1. A subsidy* *2. I saved* *3. A gift*	How do you maintain and repair the system? *0.I do not maintain* *1.I hire labour* *2.I know how to do it myself*	Do you have access to electricity for your irrigation system? *0.No* *1.Yes* *NA in case of fuel*	For how many hours in a day do you have electricity for agricultural use? *Average in a year*	What is the condition of your irrigation system? *0.Bad* *1.Average* *2.Good*
1	surface drip irrigation based on electricity						
2	sub-surface drip irrigation based on electricity						
3	Drip irrigation with fertigation						

5e How do you know when to irrigate your sugarcane plots? More answers possible

1) From my own experience.
2) I look at the condition of the soil
3) The mill taught me when to irrigate
4) The government/extension mill taught me when to irrigate
5) An NGO/charity taught me when to irrigate
6) I just guess
7) I do not know
8) Other, specify: .....

5f What challenges do you face in your current irrigation system?

Enumerator: you may prompt

	Possible challenges	Applicable *0=no - 1=yes*
1	I do not see any challenges	
2	There are water shortages	
3	It is too labour intensive	
4	It is too costly (the price of the water)	
5	There is not enough availability of electricity	
6	Fuel is too costly *(if not applicable, put NA)*	
7	I do not know how to maintain my irrigation system	
8	I do not have resources to maintain my irrigation system	
	Other:	
	Other:	

== end of section E ==

SECTION F INPUTS FOR SUGARCANE PRODUCTION

2015-2016 season

Enumerator: only for: own land & Sugarcane only

		Used at the last cultivation last season 2015-2016	Quantity used per acre *(number of bottles, bags, etc)*	Unit *(Bottles, bags, etc)*	Content *(e.g. (50 kg, 100 kg, 100 ml, etc)*	Price per item last season
		Type names	*Total quantities (e.g. 1, 2, 3 etc)*	*Bag/bottle/....*		*Price per unit in INR*
6a. Type of planting material	6a.1	Single bud Setts				
	6a.2	2 bud setts				
	6a.3	Seedlings				
	6a.4	Others, ...				
6b. Type of Chemical fertiliser	6b.1	Urea				
	6b.2	DAP				
	6b.3	SSP (single super phosphor)				
	6b.4	MOP				
	6b.5	Other, ...				
6c. Type of Biological fertiliser	6c.1	Manure				
	6c.2	Compost				
	6c.3	Press mud				
	6c.4	Other ,.....				
	6c.5	Other ,.....				
6d. Type of Weedicide	6d.1	Pre-emergent				
	6d.2	Post emergent				
a) pre-emergent spray before the weeds emerges, so preventive	6d.3	Other, ...				
	6d.4	Other, ...				
b)Or after: post emergent: you spray when the weedicides occur						

== end of section E ==

SECTION G HOUSEHOLD INCOME AND DIVERSIFICATION

7. Please estimate the percent of your household income that

a) came from sugarcane last year (versus the total that include other cash crops, dairy, animal husbandry and off-farm incomes) and

b) came from other activities on your farm (include other cash crops, dairy and animal husbandry)

c) came from non-farm activities

Enumerator 1: the total should be 100%! Check.

Enumerator 2: if this question is too difficult, explain with e.g. stones/ candies/wood or something alike.

7a	Income % from sugarcane production 2015-2016 *Circle the right answer* *If >75%: go to question 7f*	7b	Income % from other farm related activities 2015-2016: *Circle right answer*	7c	Income % from non-farm activities *Circle right answer*
1	< 25%	1	< 25%	1	< 25%
2	25%	2	25%	2	25%
3	25%-50%	3	25%-50%	3	25-50%
4	50%	4	50%	4	50%
5	50-75%	5	50-75%	5	50-75%
6	75%	6	75%	6	75%
7	> 75%	7	> 75%	7	> 75%

Enumerator: this question should only be answered if respondent has farm income next to sugarcane

7d You mentioned to have other farm-income sources next to sugarcane (see Table 7b).
Please indicate what other income sources you have. Multiple answers possible

1. Other cash crops, specify: .....
2. Dairy
3. Animal husbandry
4. Seedling production / nursery for sales
5. Trash shredding services for other farmers
6. Drip irrigation maintenance services for other farmers
7. Provision of labour to other farmers

8. Provision of farm equipment to other farmers
9. Other, specify: ....

Enumerator: this question should only be answered if respondent has non-farm income

7e You mentioned to have other non-farm income sources next to farm income (see Table 7c). What other non-farm income sources do you have?

1. I do not have non-farm income
2. I have a shop
3. I work for government
4. A family member works for the government
5. I work as an employee
6. A family member works as an employee
7. Remittances
8. Others, specify: .....

7f Where did you spend the profit of your entire last sugarcane harvest on?

1. I did not have any profit
2. I bought agri-inputs (seed, fertiliser, etc) for cultivating the next crop
3. I invested in a drip irrigation
4. I invested in maintenance of my irrigation system
5. I bought a tractor
6. I purchased new land
7. I gave a party
8. Other, specify: .....
9. Other, specify: .....

Loans/credit

7g Have you taken any credit/loan in the last year?
Enumerators: credit is defined as a loan of cash– does not include in-kind gifts

0. No → **Please go to question 7j**
1. Yes

7h Who provided you with this credit?
1. Bank
2. Post office

3. Micro finance institute
4. Cooperatives
5. Sugar mill
6. Local money lender
7. Family
8. Government
9. Others_____

7i Was the loan a production loan or investment loan (term loan)?

1. Crop loan (e.g. inputs, seeds, pesticides, etc) **--> go to question 7j**
2. Investment loan (e.g. tractor, irrigation system)
3. Both
4. Other, specify:....

7j For what agricultural purpose did you use the credit?
(Instruction to the enumerator: multiple answers are possible)

1. Drip irrigation surface
2. Drip irrigation subsurface
3. Other irrigation system, specify: .....
4. Maintenance of drip irrigation system
5. Water pump
6. Electricity
7. Fertiliser
8. Farm machinery (such as tractors)
9. Other, specify_____

Savings

7k Do you and your household maintain any savings (including bank savings accounts, such as, micro-banking)

0. No --> Please go to question 7m
1. Yes

7l What are you saving for?
Enumerator: Do not limit here. Multiple options possible. Circle applicable answer(s).

1=Pension

2=Emergencies
3=Education
4=Buy assets
5=Invest in irrigation system for my land
6=Invest in my farm, specify:.....
7=Build a house
8=Purchase land
9=Travel
10=Marriage of family member/children
11= Other, specify: .....

Subsidies

7m Do you and your household receive any subsidies?

0. No --> **Please go to t Section H**
1. Yes

7n Where do you receive subsidy from?

1. Government
2. NGO
3. Others_____

7o What did you receive subsidy for? Please go through the following options:

	Subsidy received for	0=no 1=yes
1	surface drip irrigation	
2	sub-surface drip irrigation	
3	Other irrigation system, specify:	
5	Electricity	
6	Water Pump	

== end of section G ==

SECTION H LIVELIHOODS

8a How do you feel about your overall economic situation compared to last year?

1. Much worse
2. Worse
3. Same
4. Better
5. Much better

8b What is the primary source of drinking water for your household? (1 answer)

1	Interior plumbing	8	Private outside tap/spigot
2	Hand pump	9	Public tap
3	Water merchant	10	Well with pump
4	Water truck	11	Well without pump (artesian well)
5	Rainwater	12	River, lake, spring, pond, stream, dam
6	Neighbour's tap/spigot	13	Bottled water
7	Neighbour's well	14	Other, specify: .....

8c Do you have access to electricity?

0. No
1. Yes

8d What is your main source of energy for cooking? (1 answer)

1. No cooking arrangements
2. Firewood and chips
3. Dung cake
4. Kerosene
5. Charcoal
6. Coke or coal
7. Gobar gas
8. LPG
9. Electricity
10. Other, specify: .....

8e Does your household possess any casseroles, thermos, or thermoware?

0. No
1. Yes

8f Does your household possess a television and a VCR/VCD/DVD player?

1. No, neither one
2. Yes, only one
3. Yes, both

8g Does your household possess a mobile handset and a telephone instrument (landline)?

1. No, neither one
2. Yes, only a mobile
3. Yes, a landline, regardless of mobile

8h Does your household possess a sewing machine?

0. No
1. Yes

8i Does your household possess an almirah/dressing table?

0. No
1. Yes

8j Does your household possess a bicycle, motorcycle/scooter, or motor car/jeep?

1. No, none
2. Yes, bicycle only, no motorcycle/scooter or car
3. Yes, a motorcycle/scooter but no car (regardless of bicycle)
4. Yes, a motor car/jeep (regardless of others)

8k Did you face any difficulties the last year in procuring food for you and your family?

0. No
1. Yes

== end of section H ==

SECTION I TRAININGS RECEIVED RELATED TO SUGARCANE

At baseline:

9a Did you ever receive a training related to sugarcane production on good agricultural practices, including inputs services and irrigation techniques?

0.No **--> go to question 9e**
1.Yes

Name training *-999 = I forgot*	When received *Month + year* *in numbers: e.g. January 2016 = 01 2016)*	How many days in total?	Average duration of a training per session *(e.g. 1 day, 0.5 day, 2 hours)*	Source of training *0.The sugarcane mill I supply to* *1.The government* *2.An NGO* *3.Other, specify: ...*	Topic training *0. Agricultural practices* *1. Input services* *2. Irrigation techniques **
1					
2					
3					
4					
5					
6					

**Irrigation Techniques are:*

- *Drip irrigation*
- *Drip irrigation with fertigation*
- *Trash mulching*
- *Intercropping*
- *Maintenance of irrigation system*

***Enumerator: only in case a training on irrigation was received:**

9b If you have received a training on irrigation, what kind of topics were covered?

0. Frequency of irrigation
1. Surface drip irrigation
2. Sub-surface drip irrigation
3. Other: .....

9c On what kind of topics in sugarcane *would you like* to be trained on?
More answers possible.

1. I do not want a training
2. Mechanisation of my farm
3. Irrigation systems
4. Good agricultural practices
5. Intercropping
6. Trash shredding and mulching
7. Soil testing
8. Financial Farm management
9. Other, specify: .....
10. I do not know

== end of section I ==

SECTION J RISK, TRUST AND INVESTMENTS

We now ask you your opinion on some statements. There is no good or wrong. You may answer whatever you want to. Feel free to indicate whether you agree or disagree. This is the last section.

10a Do you agree or disagree with the following towards investments?
Enumerators: please put an 'X' in the box

#	Statements	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
1	I will not make any investment because you never know what will happen.					
2	It's better to use and enjoy what you have right now.					
3	Whatever happens, I should invest first in my family.					
4	I only invest when I am certain that I have a good investment.					
5	I would borrow money if I was convinced that investing in a business would give me good profits.					
6	I'm only willing to invest in new agricultural practices after I have find the mill technology reliable					

10b. Do you agree or disagree with the following statements towards risk?
Enumerators: please put an 'X' in the box

Enumerator: these questions relate also to the mill you are supplying to. Your answers will not reach them and will be treated anonymously.

#	Statements	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
1	Every day I get more convinced that who does not risk, does not earn.					
2	I do not want to further develop a relationship with the mill because I am not sure whether it is really fair.					
3	Investing in agriculture/new agricultural practices is very risky; I rather do not do it.					
4	In order to make some money, I am willing to risk and lose.					

10c. This question is about your preference for receiving money today or in one year.
Please remember that it is just a question. Would you prefer to receive today or would you prefer to receive in one year:

Enumerator: when a farmer choses the next year, so if he shifts, you can stop

	Would you prefer to receive today	*Or*	Would you prefer to receive in one year:
1	INR500		INR500
2	INR500		INR550
3	INR500		INR600
4	INR500		INR650
5	INR500		INR700
6	INR500		INR750
7	INR500		INR800
8	INR500		INR850
9	INR500		INR900
10	INR500		INR950

If only chosen INR 500 for today, which amount would you choose to receive in one year? ....INR

== end of section J ==

That was the last question in this questionnaire. Thank you very much for your time and effort to help us understand more about sugarcane production and producers. Is there anything else you would like to tell us or ask us?

Do you have any questions or comments?

……

……

……

……

……

……

……

Enumerator: please read through questionnaire to make sure no questions were left unanswered before leaving your farmer! Thank you!

End time of the interview:……

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