

BENEFIT-COST ANALYSIS

FARMER DISTRESS

Analysis of interventions
addressing farmer distress in
RAJASTHAN

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Analysis of interventions addressing farmer distress in Rajasthan

Rajasthan Priorities An India Consensus Prioritization Project

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ABSTRACT

The Problem

During the fiscal year 2016-2017, the contribution of the agricultural and related sectors was 14% of Gross Domestic Product (GDP), even though 58% of the population is dependent on the sectors for their livelihood. India has around 260 million people living in poverty and 80% of them live in the countryside. The median annual wage for a farmer in India is INR 18,850 (including the implied value of the food they consume). This is equivalent to two months' minimum wage in Mumbai – the commercial capital of India. It is therefore unsurprising that there was a spike in farmer protests during 2017-18 in various parts of the country.

There is wide recognition that the agricultural sector in India is in a state of distress. There are several factors which have contributed to this distress. Agriculture is characterized by instability due to a variety of risks associated with production, prices and markets. An additional factor which aggravates the situation, is that about 72% of land holdings are small and marginal (less than 2 hectares) and farmers cannot reap benefits from economies of scale.¹ Since 1960, the real agriculture growth rate in India has been an average of 2.8 percent. Before the Green Revolution the average growth rate was less than 2 percent; the period following the Green Revolution, until 2004, witnessed agriculture growth of 3 percent; in the subsequent years after the global agriculture commodity surge, growth in the sector increased to 3.6 percent.² The volatility in agriculture continues, although it has declined substantially from a standard deviation of 6.3 percent between 1960 and 2004, to 2.9 percent since 2004.³ Furthermore, approximately 52% (73.2 million hectares out of 141.4 million hectares) of the net sown area is still rainfed and not yet irrigated.⁴ The most striking impact of such levels of distress on Indian farmers is the increasing number of farmer suicides. Between 1995 and 2012, a total of 28,4673 farmers committed suicide in India.

It is in this context that it becomes important to research the reasons for the unviability of small and marginal farmers in India and the reasons for farmer suicides. Some of the common factors cited are crop failures, low farm productivity, an inability to achieve market prices, inefficient cold chain management resulting in wastage of agricultural produce from inadequate storage, lack of irrigation facilities, and insurmountable debt. However, the increasing numbers of farmer protests and suicides call for reconsideration of the policy interventions in the agricultural sector. There have

¹<http://www.thehindu.com/news/national/why-are-farmers-distressed-across-india/article22267501.ece>

²[Economic Survey 2017-18, Department of Economic Affairs, Ministry of Finance, Government of India.](#)

³ibid

⁴<http://www.thehindu.com/opinion/op-ed/stemming-the-tide-of-agrarian-distress/article22859916.ece>

been various initiatives undertaken by the Government, including – farm loan waiver schemes, higher minimum support price (MSP), reforms in the Agriculture Produce Market Committee (APMC) Act so that farmers can sell directly to end users, fertilizer subsidies, tax free agricultural income, and spending on rural infrastructure such as electrification and building canals. While each one of these interventions is expected to yield some benefits to the farmers, there are costs involved in undertaking them.

This paper seeks to research the reasons for farmer distress in the state of Rajasthan. It analyses several interventions for alleviating the distress. The three interventions which this paper analyses are - farm loan waivers, expanding end-to-end cold chain infrastructure, and expanding the scale of electronic agricultural markets.

Intervention 1: Farm Loan Waivers

Overview

This intervention assumes a hypothetical farmer loan waiver scheme that waives all formal sector loans taken out by individuals with land holding sizes of less than 2ha. This intervention is similar to the other relief schemes implemented and announced across India in the past, for example:

- a) The 2008, Agricultural Debt Waiver and Debt Relief Scheme - INR 600 billion (approximately, \$12 billion) loan waiver package for 30 million small and marginal farmers and a one-time settlement for another 10 million farmers. The amount of loans waived was equivalent to 1% of India's GDP in 2007-08.
- b) Large-scale farm debt waivers enacted during 2017 by three major states – Uttar Pradesh, Maharashtra and Punjab. The total amount of debt relief announced by these three states amount to INR 77,000 crore (approximately \$12 billion) or 0.5% of India's GDP in 2016-17.
- c) A loan waiver scheme announced in February 2018 by Rajasthan Government. It is planned to be a one-time loan waiver of up to INR 50,000 for small (between 1 and 2 ha land size) and marginal farmers (with less than 1 ha land size) in the state. This is estimated to cost Rs. 8000 crores to the state exchequer⁵.

It is important to note that the loan waiver scheme analysed in this paper is most similar to the 2008 Agricultural Debt Waiver and Debt Relief Scheme, since the effects of that scheme have been well

⁵ <https://timesofindia.indiatimes.com/india/rajasthan-announces-loan-waiver-for-farmers-to-cost-rs-8000-crore/articleshow/62887502.cms>

studied by academia. Nevertheless it is likely that schemes with slightly different parameters will have similar effects, benefits and costs.

Costs and Benefits

Costs

- The most significant cost is the loan waiver itself. Using latest data on farm size and formal debt holdings by size, we estimate a cost of 8117 crore for the loan waiver.
- Academic evidence regarding the effects of the 2008 Agricultural Debt Waiver and Debt Relief Scheme shows a reduction in lending to small farmers for up to four years after bailout (Gine and Kanz, 2017). In Rajasthan, the estimated impact on livelihoods following the farm loan waiver and subsequent reduced lending, is a loss of INR 1616 per year for *marginal* farmers (< 1ha) and INR 5156 per year for *small* farmers (1-2ha).
- Reduced formal loan lending to small and marginal farmers would result in a drop in production. Small and marginal farmers would lose INR 1185 crore annually.
- The anticipation of a loan waiver causes smallholder farmers to reduce their credit discipline, and academic evidence (Gine and Kanz, 2017) suggests that bailouts lead to an increase in non-performing loans and greater sensitivity of defaults to the electoral cycle. The welfare impact of this moral hazard is not straightforward to calculate, and is probably partially reflected in the credit restriction experienced by small and marginal farmers after a bailout. Any additional costs, for example to the wider credit environment, are not included in the calculations and this suggests the benefit-cost ratio would be even smaller than the one reported.

Benefits

- There is an immediate, one-time benefit to small and marginal farmers. They will not have to pay back outstanding loans (principal plus interest) which they owe to the banks. This value is INR 8117, exactly equivalent to the cost of the loan waiver.
- In the medium-run, large farmers (those with more than 2ha) experience an expansion of available formal credit. This allows them to pay down informal credit and increase production. It may also increase the efficiency of credit allocated in the state, since fewer funds are given to riskier small holder farmers, rather higher proportion of funds are allocated to large farm households. Estimates suggest that farmers with larger land holdings will gain INR 535 crore, annually.

Intervention 2: Managing cold supply chain logistics

Overview

- This intervention assumes the cold chain infrastructure requirements as estimated by The National Centre for Cold Chain Development (NCCD) are built within the state of Rajasthan, as well as all supporting requirements like manpower, maintenance and transportation. The intervention time horizon is 10 years.
- Fruits, vegetables, and milk command a higher market price in comparison to staple crops such as rice, wheat and pulses. One thing that differentiates fruits, vegetables, and milk from staple crops is that they are perishable by nature, and without proper storage and refrigeration wastage is high.
- Milk and horticulture items command a high price in international markets, and are in demand by corporate buyers in the food processing industry. However, the majority of small farmers do not risk growing these crops, partly because of inadequate post-harvest management.
- The absence of cold chain, an environment-controlled logistics chain that preserves essential characteristics of the products handled, leads to several challenges for farmers and the agricultural sector in general. First, it leads to wastage of fruits, vegetables, and milk. Second, as there is no mechanism for farmers to store their produce until they can optimise the price they obtain on the market, farmers will often resort to quick selling of the products. This reduces their potential earnings and affects their livelihoods. Finally, the absence of cold chain, discourages farmers from further growing these higher value commodities.

Costs and Benefits

Costs

- The National Centre for Cold Chain Development (NCCD) has estimated the cold storage and warehouse related infrastructure requirements for India, including Rajasthan. Based on NCCD data and our analysis, the current total storage requirement for storing milk, fruits and vegetables stands at 74,889 MT. The total number of pack houses required is 4,412. The total number of ripening chambers required is 5,748. The total number of specialised trucks required for transporting fruits, vegetables and milk is 132. About 90% of the storage requirement already exists within the state, but the remaining infrastructure needs are almost non-existent. To fill this gap requires a one-off investment of INR 1883 crore, plus additional investments over the following 9 years averaging approximately 11% of this value per year to meet expected growth in the horticulture and dairy sectors.
 - Additionally, at the outset an additional 127 employees would be required to run the storage facilities, 9633 employees to run pack houses and ripening chambers, and 344 workers

(including drivers and helpers) to operate the trucks. This requirement increases over the years to meet growth. The average annual workforce costs is INR 95 crore over the 10 years. Lastly, we include operations and maintenance cost of 10% of invested capital which averages INR 276 crore per year.

Benefits

- The benefit from a better post-harvest management is that fruits, vegetable items, and milk will not be wasted. Wastage of vegetables and fruit items because of lack of storage has been estimated at between 5% to 30%.
- For milk, data shows the amount of loss can be as high 40% and two-third of this loss happens during storage.
- In the first year of this intervention, the total benefit from putting cold chain logistics in place is estimated at INR 931,265 lakh. The amount of milk that can be saved by using cold storage is approx. 95% of the total, and the amount of fruit and vegetables that can be saved is 5% of total. The annual benefit increases by 6% per year in line with the expected rate of growth in the horticulture and dairy sectors.
- In India, 83% of the farmers are small and marginal farmers. The majority of these farmers cultivate mainly low value, subsistence crops. This intervention will have implications particularly on the livelihoods of small and marginal farmers who would then be able to undertake the cultivation of high return crops which are in demand in global markets. Overall, the implications are that there would be an increase in agricultural productivity and it could liberate small and marginal farmers from a cycle of poverty and distress. The option value of this benefit is not included in the calculations, though we note that to take advantage of the option to grow higher value produce, would itself require more costs at the farm-level.

Intervention 3: Introduction of e-Mandi

Overview

The Government of India plans to double farm income by 2022, as set out in the Union Budget of 2018. An important way for this to happen is to ensure better price realization for farmers. However, because of inefficient supply chain logistics farmers seldom realize true market prices.

The cost for e-mandi interventions include factors such as the costs of setting up and running e-markets, the costs of training farmers to participate in e-mandis. Similarly, the benefits refer to the increase in price realization by the farmers resulting from a reduction in information asymmetry and

being connected directly to the final market. Small and marginal farmers gain an additional 6.5% price realization from the introduction of electronic markets.

Costs and Benefits

Costs

- The costs for e-mandi interventions include factors such as the cost of setting up and running e-markets, and the costs of training farmers to participate in e-mandis.
- The fixed cost of setting up one e-market is INR 3.4 lakhs. There are 114 agricultural markets in Rajasthan that are yet to be e-enabled. The one-time total cost (fixed cost) of introducing e-mandi is INR 39 crore.

Once these e-mandis are set up there are ongoing operational costs. We assume that the operational costs will increase linearly with the growth of crop output. In the first year of the intervention, the annual cost of running the e-mandis across the state is 4.7 crore.

Benefits

The benefit refers to the increase in price realization by the farmers resulting from a reduction in information asymmetry and being connected directly to the final market.

Analysis estimates the price premium as 13%. Farmers are likely to realize a 13% increase in prices resulting from their ability to connect directly with buyers from a variety geographical areas. However, because the increase in price premium is a transfer of monetary resources from middlemen to the farmers, we assume that the social benefit is only 50% of this 13% increment in price realization for the farmers when undertaking the cost-benefit analysis.

Our estimates suggest that farmers will gain INR 8,523 crore over the next 20 years from the complete roll out of e-mandi in Rajasthan.

Conclusion

The paper suggests that for the first intervention i.e. farm loan waiver, the economic cost is higher than the total benefit. If the objective of the loan waiver is to help small farmers, then the farm loan waiver scheme does not fulfil that objective. This is because only 15% of the smallest farmers have access to institutional credit (formal credit), and loan waiver necessarily caters to farmers who have been able to access formal loans. Even for those with 2.0 ha or less, roughly 50% of them access formal credit. Moreover, studies have shown that the long-term impact of loan waiver programmes results in a fall in agricultural output and a reduction in the availability of formal loans to small and marginal farmers subsequent to the loan bailout. Also, it is a significant cost to the national exchequer which would result in a higher deficit, or a curtailing of development programs.

Regarding the second intervention i.e. building more cold-storages and investing in reefer vehicles, the analysis show that it is a beneficial policy. Investing in cold chain infrastructure with the aim of improving post-harvest management results in socio-economic benefits that far outweigh the economic costs. Improper post-harvest management not only leads to huge wastage of crops, but also discourages small and marginal farmers from growing these high-value items. These items are in high demand in international markets and by the corporations with a large presence in the food processing industry. However, small farmers often do not want to venture into growing these perishable items as the lack of cold chain management either leads to crops being wasted, or degraded to a standard which is not internationally accepted. The third Intervention analyses the introduction of e-markets. Results indicate that this intervention has the greatest benefit compared to the costs involved. E-markets are about removing the role of intermediaries in the supply chain. With e-markets in place farmers also have the option of selling their produce to retailers/processors outside their immediate geographical area. E-markets will ensure better price realization for the farmers as they will have the option of directly trading without relying on intermediaries. There is also evidence about increased competition among the traders weakening their bargaining power. There is some uncertainty about the likely uptake of e-mandis and implementation success, given that it is a new program, which in turn generates into uncertainty about the benefit-cost ratio. Nevertheless, what evidence exists suggests a highly cost-effective intervention.

Summary of costs and benefits of interventions. Note all benefits and costs assume 5% discount rate

Intervention	BCR @ 5% Discount Rates	Benefit (INR Crore)	Costs (INR Crore)	Time Horizon of analysis	Quality of Evidence
Farm Loan Waiver	0.81	9,537	11,731	5 years	Strong
Cold chain infrastructure	15.5	92,788	5,985	10 years	Medium
E-Mandis	65	8,523	131	20 years	Limited to Medium

Introduction

During the fiscal year 2016-2017, the contribution of the agricultural and allied sectors was 14% of Gross Domestic Product (GDP), despite 58% of the Indian population relying on this sector for livelihood (Central Statistics Office, Government of India, 2016).⁶ Although there has been a steep reduction in terms of its contribution to the GDP, still roughly half of the workforce depends on agriculture as a source of livelihood.⁷ India has around 260 million people living in poverty and 80% of them live in the countryside (World Bank, 2016). The median annual wage for a farmer in India is INR 18,850 (or \$ 290)⁸ (including the implied value of the food they consume) which is equal to two months' minimum wage in Mumbai – the commercial capital of India (The Economist, 2016).

There is wide recognition that the agricultural sector in India is in a state of distress. There are several factors which have contributed to this distress. Agriculture is characterized by instability due to a variety of risks associated with production, prices and markets. An additional factor which aggravates the situation, is that about 72% of land holdings are small and marginal (less than 2 hectares) and farmers cannot reap benefits from economies of scale.⁹ Since 1960, the real agriculture growth rate in India has been an average of 2.8 percent. Before the Green Revolution the average growth rate was less than 2 percent; the period following the Green Revolution, until 2004, witnessed agriculture growth of 3 percent; in the subsequent years after the global agriculture commodity surge, growth in the sector increased to 3.6 percent.¹⁰ The volatility in agriculture continues, although it has declined substantially from a standard deviation of 6.3 percent between 1960 and 2004, to 2.9 percent since 2004.¹¹ Furthermore, approximately 52% (73.2 million hectares out of 141.4 million hectares) of the net sown area is still rainfed and not yet irrigated.¹² The most striking impact of such levels of distress on Indian farmers is the increasing number of farmer suicides.

Between 1995 and 2012, a total of 28,4673 farmers committed suicides in India (Mishra, 2014).¹³ Reddy and Mishra (2010) argue that the liberalization of the agricultural sector in the early-1990s led to an agrarian crisis, and consequently farmers with certain socioeconomic characteristics, such as

⁶Year refers to the fiscal year, starting from April for any particular year and ending on March, next year.

⁷

http://niti.gov.in/writereaddata/files/document_publication/Raising%20Agricultural%20Productivity%20and%20Making%20Farming%20R emunerative%20for%20Farmers.pdf

⁸Henceforth, for the dollar-indian rupee conversion rate we use INR 65 = \$1.

⁹<http://www.thehindu.com/news/national/why-are-farmers-distressed-across-india/article22267501.ece>

¹⁰Economic Survey 2017-18, Department of Economic Affairs, Ministry of Finance, Government of India.

¹¹ibid

¹²<http://www.thehindu.com/opinion/op-ed/stemming-the-tide-of-agrarian-distress/article22859916.ece>

¹³Between 1995 and 2012, farm suicides as a percent of all suicides in India was 14%.

cash crops cultivators and small farmers with debts, are at risk of committing suicide. World Bank data shows only 35% of India's agricultural land is irrigated (artificial application of water to land or soil).¹⁴ Banik and Stevens (2016) find that uncertain weather conditions, leading to volatile agricultural output, is a primary cause of farmer suicides. According to Chand et al., (2015) growth in farm income has fallen to around 1% and this is an important reason for the sudden rise in agrarian distress in recent years. The study reported that in 2013 small farmers (with landholding size less than 1 hectare¹⁵) had a higher monthly consumption than their monthly income.¹⁶ Some of the most common contributing factors are crop failures, low farm productivity, an inability to achieve market price, inefficient cold chain management resulting in wastage of agricultural produce, lack of irrigation facilities, and insurmountable debt.

Among all the states in India, Rajasthan has one of the lowest farmer suicide rates. Between 2010 and 2012, there were 3.6 farmer suicides per 100,000 population. The corresponding figure for all India during the same period was 15 per 1000 population (Mishra, 2014). Nevertheless, this does not mean that farmers in Rajasthan have been immune to increasing levels of agrarian distress.

Indeed, there have been various initiatives undertaken by the Government in the agricultural sector designed to help farmers, including farm loan waiver schemes, higher minimum support price (MSP),¹⁷ reforms in the Agriculture Produce Market Committee (APMC) Act so that farmers can sell directly to the end users, fertilizer subsidies, tax free agricultural income, and spending on rural infrastructure such as electrification and building canals. While each one of these interventions is expected to yield some benefits to the farmers, there are costs involved in undertaking them. All governments operate within budgetary constraints, and assessing which policies for alleviating farm distress have the greatest benefit for the amount spent can help improve policy making on this critical issue.

¹⁴Available at: <http://data.worldbank.org/indicator/AG.LND.IRIG.AG.ZS/countries>. Accessed on 09/12/2017.

¹⁵A hectare is roughly equal to 2.47 acres.

¹⁶National Sample Survey Organization (NSSO), Government of India, defines an agricultural household as a household receiving some value of produce more than INR 3000 from agricultural activities (e.g. cultivation of field crops, horticulture crops, fodder crops, plantation, animal husbandry, poultry, fishery, piggery, bee-keeping, vermiculture, sericulture, etc.) and have at least one member self-employed in agriculture in the principle status during last 365 days.

¹⁷MSP is the minimum price for a product established by the government and supported by payments to producers in the event of the market price falling below the specified minimum. The Cabinet Committee of Economic Affairs announces MSP for various crops at the beginning of each sowing season based on the recommendations of the Commission for Agricultural Costs and Prices (CACP). The CACP takes into account demand and supply, the cost of production and price trends in the market among other things when fixing MSPs.

Rajasthan is the largest state in India with 342 thousand square kilometre of total land area.¹⁸ An important issue within the agricultural sector in Rajasthan is the lack of irrigation facilities. Rainfall patterns are also erratic. There is wide variation in the topography and agro-climatic zones within the state. The eastern part of state has comparatively better rainfall than the western part. The southern part is hilly and is inhabited by tribal population. The Aravalli hill range runs from south-west to north-east part of the state. The Thar desert covers 60% of the land on the western part of Rajasthan and is among the driest parts of the country. The average annual rainfall of the state is 530 mm. Although the state has 10% of the total geographical area of India, it has only 1% of the total water resources. 61% of the area lies in arid and semi-arid tract. A large tract of land is saline and the soil is alkaline. The south-east and eastern parts of Aravalli range are more suitable for agriculture cultivation.

Despite these challenges, Rajasthan is the largest producer of coarse grains such as bajra, jowar, maize and oilseeds in India. Coarse cereals are grown on about 58.4 lakh hectares in the state. Between 2005 and 2013, the state's annual growth in agricultural and allied activities was 7%, which is higher than the national average of 4% (Indian Economic Survey, 2013-2014). This above average performance of the state's agricultural and allied activities is explained by the strong presence of animal husbandry in the state.

In terms of land-holding size, small and marginal farmers in the state constitute 58.4% share in total area. Big farmers - with farm sizes of more than 10 ha – make up 33.3% of the total area. Given that the majority of the farmers are small holders, it seems an obvious argument in favour of farm loan-waiver schemes (as they are the most common beneficiaries of loan waivers) and of improved post-harvest management processes. In fact, during the 2018 Union Budget, the Government fixed the minimum support price (MSP) at 1.5 times for coarse grains, to help small and marginal farmers in the region.¹⁹ Loan waiver programmes were also announced in the Budget.

The three interventions discussed in this paper will have an impact on the livelihood of the farmers, especially small farmers. The sections below analyse the costs and benefits of three interventions -

¹⁸For more about agriculture statistics on Rajasthan, visit Department of Agriculture, Government of Rajasthan's website at: <https://www.rajasthandirect.com/government-departments/rajasthan-agriculture-department>.

¹⁹ See, Sally, (2018).

farm loan waivers, expanding end-to-end cold chain infrastructure, and the expansion of electronic agricultural markets.²⁰

Intervention 1: Farm Loan Waiver

This intervention assumes a hypothetical farmer loan waiver scheme that waives all formal sector loans taken out by individuals with land holding sizes of less than 2ha. This intervention is similar to the other relief schemes implemented and announced across India in the past, for example:

- a) The 2008, Agricultural Debt Waiver and Debt Relief Scheme - INR 600 billion (approximately, \$12 billion) loan waiver package for 30 million small and marginal farmers and a one-time settlement for another 10 million farmers. The amount of loans waived was equivalent to 1% of India's GDP in 2007-08.
- b) Large-scale farm debt waivers enacted during 2017 by three major states – Uttar Pradesh, Maharashtra and Punjab. The total amount of debt relief announced by these three states amount to INR 77,000 crore (approximately \$12 billion) or 0.5% of India's GDP in 2016-17.
- c) A loan waiver scheme announced in February 2018 by Rajasthan Government. It is planned to be a one-time loan waiver of up to INR 50,000 for small (between 1 and 2 ha land size) and marginal farmers (with less than 1 ha land size) in the state. This is estimated to cost Rs. 8000 crores to the state exchequer.

It is important to note that the loan waiver scheme analysed in this paper is most similar to the 2008 Agricultural Debt Waiver and Debt Relief Scheme, since the effects of that scheme have been well studied by academia. Nevertheless it is likely that schemes with slightly different parameters will have similar effects, benefits and costs.

Costs and Benefits of Farm Loan Waiver Scheme

Benefit cost analysis estimates the total equivalent monetary value of the benefits and costs to society when implementing this intervention. If the Benefit Cost Ratio (BCR) for a specific intervention is greater than one, then society gains from the intervention²¹. At a policy level, it is therefore rational to at least consider implementing the intervention. In this paper we consider three rates of discount - 3%, 5%, and 8%, when computing BCRs.

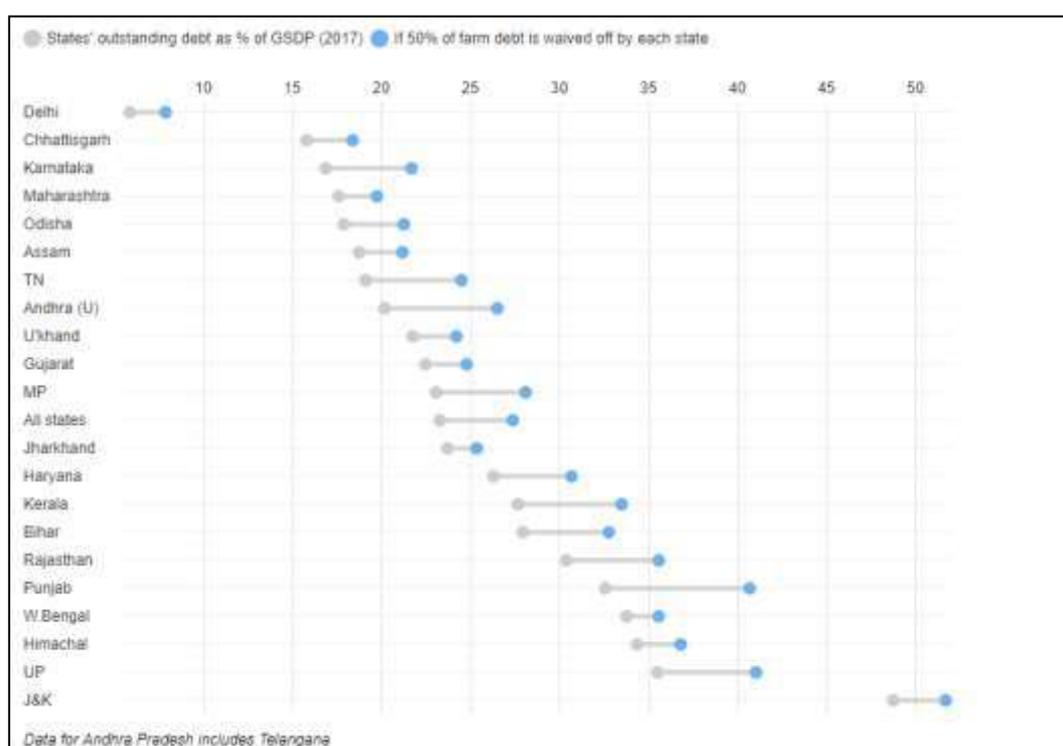
²⁰Based on focus group discussion with farmers, government officials, and NGOs working in the area

²¹From the perspective of private return, any investment decision is viable if the Internal Rate of Return (IRR) is higher than the bank's rate of interest.

Costs

Typically, the debt loan waivers packages are aimed at fulfilling election promises made by the political parties. For instance, in 2017, three major states - Uttar Pradesh, Maharashtra and Punjab - undertook large-scale farm debt waivers. The total amount of debt relief announced by these three states amounted to INR 77,000 crore (roughly, \$ 12,000 million) or 0.5% of India's GDP in 2016-17 (Kundu, 2017). If all the states in India were to waive 50% of their farm debt, it would cost 1% of India's GDP. Therefore, the farm loan waiver programme has a potentially huge cost on the national exchequer (See, Figure 1).

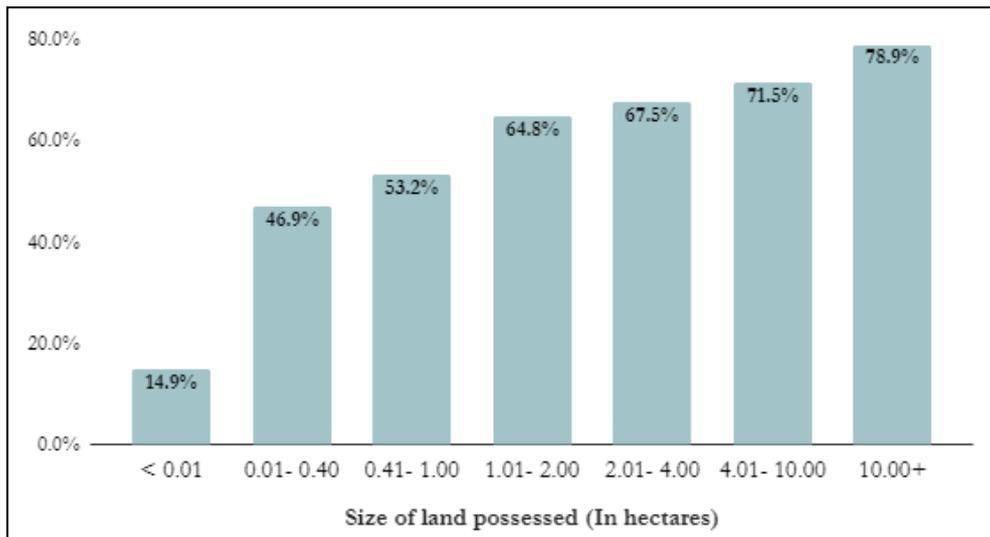
Figure 1: States' debt to GDP ratio will worsen by 4%, if 50% of farm debt is waived off by each state



Source: Rajya Sabha (Upper House of Indian Parliament) and RBI Handbook of Statistics, Reserve Bank of India

In fact, from the perspective of enhancing the livelihood of small and marginal farmers, loan waiver programmes do not make much economic sense. If the objective of the loan waiver is to help small and marginal farmers, the objective is achieved in a limited way. This is because only 15% of smallest farmers have access to institutional credit (formal credit), and loan waiver schemes typically cater to farmers who have taken out formal loans. (See, Figure 2).

Figure 2: Farmers with access to institutional credit (in %)



Source: National Sample Survey Office's 2013 situation assessment survey of farm households, Government of India.

On the contrary, loan waivers may create to a problem of moral hazard, whereby more productive farmers who can pay-off their loan, deliberately default, thereby resulting in lower loan availability during the next cycle. Analysing the loan waiver program announced by Uttar Pradesh government in 2011, Chakraborti and Gupta (2017) find that eligible households in districts that received the waiver had higher consumption expenditure, by approximately Rs. 8,000 per year, compared to non-eligible households. What is of greater concern is that eligible households also tend to spend significantly more on social events such as weddings, family occasions, and so on. This study also points out that within the same district, households who received a loan waiver had no significant productivity difference when compared with households who were not eligible for the waiver. Specifically, debt forgiveness is likely to disincentivize households from using loans for productive investments, which would be required for repayment. Households expect governments to intervene so that credit institutions do not seize their collateral in case of default. The expectation that they can avoid any penalty for non-repayment of a loan is likely to affect household decisions regarding the utilization of loans.

At a macro level, loan waiver programs can be so costly, that they can impinge upon other development activities. For example, after the Maharashtra government announced the INR 34,000 crore loan waiver program in 2017, finance officials indicated that a paucity of funds in the state exchequer was making it difficult to honor tax refunds intended for industry (Thevar, 2018).

Similarly, because of the Uttar Pradesh loan waiver program, the state's budget deficit shot up to 4.45% of the gross state domestic product (GSDP). This was significantly higher than the average level of fiscal deficit for all states, which stood at 2.5% of GSDP. It also left less money available to undertake the capital expenditure allocated for infrastructure (Kumar, 2017).

Analysis of the loan waiver intervention

The intervention provides all farmers with less than 2ha unconditional relief on outstanding formal credit. To undertake a cost-benefit analysis, we rely on two papers, Giné and Kanz (2017) and Kanz (2016) which estimate the effects of a 2008 farmer loan waiver enacted by the Union government in response to the global financial crisis. Results indicate that the benefit to cost ratio is below 1 i.e. the intervention does not create value for society in Rajasthan.

1. Data

Using data from the Agricultural Census 2011-2012 as well as the National Sample Survey (NSS) 70th round, 2013-2014 information was gathered relating to: the total number of land holdings by district, the average formal and informal credit at the level of farm, and the average farm level revenue and costs. These fields are presented as totals for each state as well as stratified by farm size: marginal (0-1 ha), small (1-2 ha), semi-medium (2-4 ha), medium (4-10ha) and large (10+ha). Based on these categorizations, the intervention is therefore targeted at *marginal* and *small* farmers.

Table 1 - Summary statistics

		MARGINAL	SMALL	SEMIMEDIUM	MEDIUM	LARGE	ALL SIZES
		(0-1 Hectare)	(1-2 Hectare)	(2-4 Hectare)	(4-10 Hectare)	(10 & more Hectare)	
RAJASTHAN	Number of land holdings	2,511,512	1,511,068	1,335,144	1,127,122	403,590	6,888,436
	Total outstanding credit per household (INR)	45,171	67,800	103,100	154,800	152,800	123,400
	Total outstanding formal credit per HH (INR)	12,329	33,222	54,849	77,090	123,157	53,679
	Total outstanding informal credit per HH (INR)	32,842	34,578	48,251	77,710	29,643	69,721
	Total farm level costs per month (INR)	616	1841	2401	4359	9275	1730
	Total farm level revenue per month (INR)	1274	5228	7276	14265	37566	5192

Source: Agricultural Census 2011-2012, NSSO 2013-2014

This data is used to calculate the amount of formal and informal credit held by farmers with different size holdings for each district. We then calculate a hypothetical exposure to bailout in each district similar in concept to the one calculated in Giné and Kanz (2017)²².

Exposure to bailout in district i = Formal credit outstanding to farmers < 2ha in district i / total formal credit in district i

²²The exposure variable in Giné and Kanz, differs in that it accounts for borrowers in default and also partial waiving of loans for those with landholdings greater than 2ha. This reflects the specifications of the 2008 loan waiver studied in that paper which only granted relief to farmers in default, and provided for relief for 25% of loans for those with landholdings greater than 2ha. Because we assume an intervention that waives loans regardless of default status (as seems to be the case for loan waivers in India since 2008), and is confined to farmers with holdings less than 2ha, we require a simplified version of the exposure variable.

Table 2: Exposure to bailout

	<i>Rajasthan districts (n=33)</i>	<i>All India districts, Giné and Kanz (n=489)</i>
<i>Mean</i>	0.318	0.326
<i>Median</i>	0.361	0.284
<i>Standard Deviation</i>	0.173	0.224
<i>Min</i>	0.020	0.002
<i>Max</i>	0.610	0.991

Source: Calculation by the authors

Note: Rajasthan represents a hypothetical bailout exposure based on data from NSSO 70. Giné and Kanz represent actual bailout exposure from 2008 government bailout.

2. Method

Estimating the cost of the bailout

To estimate the cost of the bailout we simply identify the average amount of all formal credit held by marginal and small farmers, and multiply by the number of households (see Table 1). This amounts to INR 8,117 crore.

2a. Estimating the post-bailout distribution of formal credit

Using the exposure to bailout variable, we estimate the amount of formal credit expansion or contraction following Giné and Kanz. That papers suggests a one standard deviation increase (decrease) in bailout exposure leads to a 25% reduction (increase) in formal credit allocated to that district, post-bailout.

We then assess how this credit contraction or expansion is distributed across different farm sizes within a district. In doing so we attempt to reconcile the findings of Giné and Kanz, which suggests overall formal lending increases after the bailout, and Kanz (2016), which suggests that farmers below the 2ha cut-off experience an 8-percentage point reduction in formal lending post-bailout. The implication of these two findings is that farmers with more than 2ha receive more credit after the bailout.

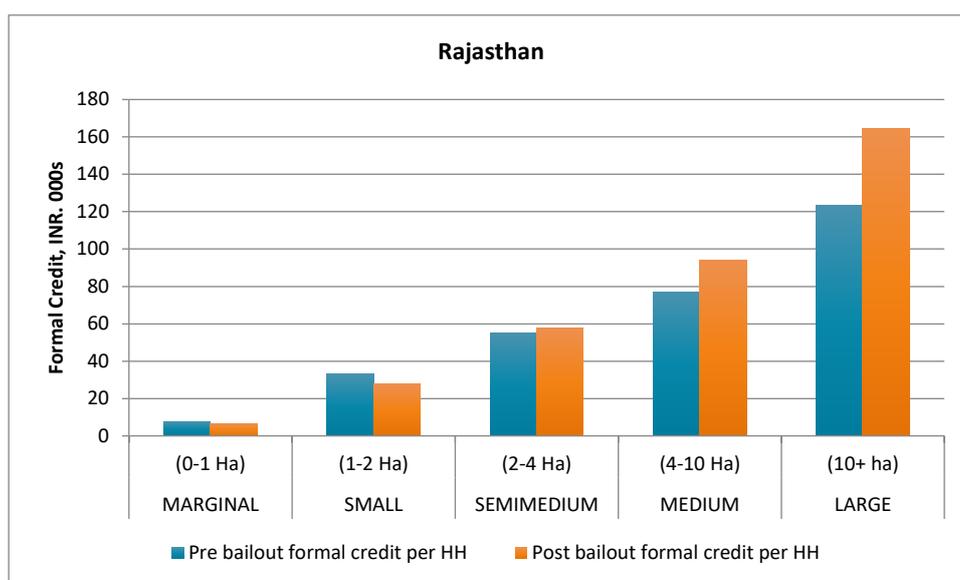
We apply Kanz (2016) 8-percentage point effect to *small* farmers (i.e. 1-2ha) to estimate their post-waiver formal credit allocation. However, we do not apply the same percentage point reduction for *marginal* farmers since they hold a lower share in formal credit than *small* farmers, and an 8-percentage point reduction would represent a very significant percentage reduction in their share. Instead of that it is assumed that *marginal* farmers experience the same percentage reduction in

their share of formal credit as *small* farmers do and calculate this effect size by dividing the estimate percentage point reduction 7.95 from Kanz (2016) by the average share of formal credit held by *small* farmers in the entire state (49% for Rajasthan). This implies a 16% reduction in formal credit for *small and marginal* farmers in Rajasthan. The above calculations are initially done at a district level and then summed up to identify the total contraction for *small* and *marginal* farmers across the state.

For farmers with greater than 2ha, the assumption is that they attract a quantum of formal credit that satisfies the formal credit contraction or expansion at the district level that was calculated using the Giné and Kanz finding. Sometimes this quantum is negative, i.e. farmers with land greater than 2ha receive less formal credit in a given district.²³ However, when summed across the state, farmers with greater than 2ha receive more formal lending *overall*, while farmers with less than 2ha attract less formal lending *overall*. Results of this reallocation are presented in Figure 3, below.

²³ The findings of the two papers do not indicate whether the rule that overall lending to farmers with greater than 2ha needs to hold at the district level, or merely overall at the state level. As such, we also test the effects of a distribution formula that assumes farmers with land greater than 2ha always receive more formal credit or zero, whichever is higher, and that the necessary contraction that would make the Giné and Kanz relationship hold for a given district is attributed to small and marginal farmers instead. The results are similar to the ones presented.

Figure 3: Average formal credit allocation before and after bailout per Household - Rajasthan



2b. Estimating the post-bailout effects of redistribution

We estimate two effects of the credit redistribution: i) credit contraction for small and marginal farmers and ii) credit expansion for larger farmers

The effect of credit contraction on small and marginal farmers

Kanz (2016) shows that smallholder farmers reduce investment in agricultural inputs by 15% relative to a control group. This leads to a 13.5% reduction in farm revenue. These effects are applied to the cost and revenue data for marginal and small farmers. Since all classes of farmers are profitable, an almost equal percentage reduction in revenue and costs leads to a reduction in profits. For Rajasthan this is INR 1616 per year for *marginal* farmers and INR 5,156 per year for *small* farmers. The total cost per year in reduced farm profit for these classes of farmers is therefore INR 1185 crore.

Another potential effect is an increase in interest payments for marginal and small farmers resulting from debt substitution. Kanz (2016) indicates that farmers are able to substitute 75% of the formal credit gap with informal sources of debt. If this were to come from costly moneylenders the extra interest expense would be significant. However, Kanz suggests that the credit gap is mostly filled with loans from friends and relatives. We assume the cost of capital of this source of credit is the same as the cost of capital from bank lending (which is plausible if the money would otherwise be placed into a savings account), hence the net interest expense is zero.

The effect of credit expansion on farmers with large land holdings

Table 1 indicates that large farmers still require some form of informal credit, though the percentage share is much lower than for *small* and *marginal* farmers. It is assumed that farmers use the expansion of formal credit to reduce their reliance on informal credit, thereby reaping a savings in interest payments. Tripathi (2017) shows that the average rate of interest on formal credit is 11.67%, while for informal credit it is 25.20%. Both of these represent the weighted average of diverse sources of credit, including banks and government (formal) as well as moneylenders, shopkeepers, friends, family, and landlords (informal). The benefit to larger farmers is simply the total formal credit increase multiplied by the interest rate differential, 13.53%. This amounts to INR 535 crore per year.

One could also argue that larger farmers, instead of substituting to informal credit, rather use the windfall credit to increase agricultural investment. Assuming these farmers are freely able to access informal credit in the pre-bailout period, the marginal return on investment should equal the marginal cost of informal credit in equilibrium. The net return of expanding investment would therefore be the return of investment, 25.20%, less the formal interest rate, 11.67%, leading to a benefit calculation identical to the substitution of informal credit.

3. Cost benefit analysis

In Year 1 the Government pays the loan waiver, and that exact same amount is received as a benefit for small and marginal farmers. In subsequent years beneficiary farmers face a production loss, while non-beneficiary farmers receive a net gain through credit expansion. We assume the effects last for four years as per Giné and Kanz (forthcoming).

Both of the papers examining the effects of the 2008 loan waiver scheme, indicate a costly moral hazard arising from the intervention. Giné and Kanz (2017) show an increase in default in districts with greater exposure to bailout, while Kanz (2016) shows that beneficiary farmers appear less concerned about the reputational effects of defaulting on their loans. The costs of this significant effect is not included fully, though is partially captured by credit restriction to farmers with less than 2ha. Therefore, the results can be considered a conservative commentary on the inefficiency of farmer loan waivers.

For simplicity, this paper ignores the effects of natural credit growth, inflation and growth in the agricultural sector. These would unlikely affect the final result significantly since they impact the intervention scenario and the counterfactual scenario in a similar way.

Table 3: Profile of costs and benefits in Rajasthan (all figures in INR crore)

COSTS	Year 1	Year 2	Year 3	Year 4	Year 5
Cost of bailout	8,117				
Reduction in farm profits for beneficiary farmers		1,185	1,185	1,185	1,185
Total Costs	8,117	1,185	1,185	1,185	1,185
BENEFITS					
Receipt of waiver	8,117				
Benefits of credit expansion for non-beneficiary farmers			535	535	535
Total Benefits	8,117	535	535	535	535

Results indicate that for Rajasthan the the net benefits of the farmer loan waiver is less than 0, and the benefit-to-cost ratio is less than 1. In fact, the BCR would have been even lower, if data showcasing district-wise non-performing assets (NPAs) could have been accounted for. As of June 2017, the total amount of NPAs in Indian banks stood at INR 829,338 crore. As state-wise/district-wise NPA data are not available, it was not possible to account for this when calculating the BCR. However, Gine and Kanz (2017) suggests that a one standard deviation to bailout exposure increases the probability that a given district has a higher share of non-performing loans by 52%.

Table 4: Summary of cost benefit results (all figures in INR crore)

Rajasthan

Discount	Benefits	Costs	BCR	Net benefits
3%	9,811	12,156	0.81	(2,345)
5%	9,537	11,731	0.81	(2,195)
8%	9,156	11,149	0.82	(1,993)

Intervention 2: Building more Storage Facilities

In India, usually farmers have two ways to sell their produce. The first is to sell directly to the Government at Minimum Support Price (MSP). The Union Government procures 25 essential food items directly from the farmers via agencies such as the National Agricultural Cooperative Marketing Federation of India Limited (NAFED) and the Food Corporation of India (FCI).²⁴ Typically, the MSP is higher than the market price, and one would assume that farmers would necessarily sell their produce to the Government and profit every time the government announces the value of the MSP.²⁵ However, in practice, farmers are seldom sell their produce at the MSP. There are multiple reasons for this. Not every village has NAFED or FCI outlets. The FCI currently procures a major portion of paddy and wheat from a few select states; 70% of paddy procurement comes from the states of Punjab, Andhra Pradesh, Chhattisgarh and Uttar Pradesh, while 80% of wheat procurement comes from Punjab, Haryana and Madhya Pradesh. In fact, three states – Punjab, Haryana and Uttar Pradesh – accounted for more than half of the total procurement during 2012-13 (Kishore, 2018).²⁶ Further to that, even if there is an NAFED or FCI outlet, the Government may not purchase the crops if the farmers bring their produce before or after the allotted dates of procurement.

The second option for the farmers is to take their produce to the nearby Government designated mandis (Hindi word for market) where, in front of the state government officers, they can auction their produce to the brokers.²⁷ In this situation, farmers have limited options other than to sell to the middlemen who charge a hefty commission. In a Supply Chain examination study involving trade in potatoes, it was found that middlemen can charge a commission of up to a staggering 70% (Singh 2017). For instance, during June 2017 in the Azadpur and Ghazipur mandis of Delhi, the middlemen were selling common variety of potatoes at INR 5-7 per kilo. If these rates were being offered to farmers they should have realized between INR 250 and 350 for a 50 kilogram sack. However, in

²⁴In 2017-18, these items were paddy, jowar, bajra, maize, ragi, tur, moong, urad, cotton, groundnut, sunflower seed, soyabean black, sesamum, nigerseed, wheat, barley, gram, masur, mustard, safflower, toria, copra, de-husked coconut, jute, and sugarcane. Some of these items such as safflower, sunflower, etc. are more perishable in nature than others.

²⁵ MSP is determined by Commission for Agricultural Costs and Prices (CACP), Ministry of Agriculture and Farmers Welfare, Government of India. CACP gives three definitions of production costs: A2, A2+FL, and C2. A2 costs cover actual paid-out expenses incurred by farmers – both in cash and in kind – on seeds, fertilizers pesticides, hired labor, fuel, irrigation, etc. A2+FL includes A2 plus an imputed value of unpaid family labor. C2 costs are more comprehensive, accounting for the rentals or interest foregone on owned land and fixed capital assets, on top of A2+FL. Farmers complain if the government were to fix MSP on the basis of first two definitions of production cost, they actually make a loss.

²⁶India's farmers need a new deal beyond cliched MSP Politics, Hindustan Times (15th February 2018).

²⁷ Mandis refer to markets in smaller towns and cities to which farmers from nearby villages bring their agricultural produce to sell. There are around 7700 government designated mandis spread across India.

reality, the maximum price the farmers were offered was INR 100 for a 50 kilogram sack. Hence, most often farmers do not know the actual market prices of the commodities and it is the middlemen who siphon off most of the profits.

Inefficient supply chain management affects the small and marginal farmers (land holding of less than 2 ha). In India, the majority of farmers can be categorised in this way. They do not have access to cold storage and warehouse facilities. To store their items in cold storage and warehouses, a farmer need to book a minimum capacity of 50,000 quintals for their produce.²⁸ However these small farmers do not have the ability to grow 50,000 quintals of good quality produce,²⁹ nor do they have access to the finance needed to keep these items in storage. The only option for them is to sell their produce to middlemen or traders at a price cheaper than the MSP and/or the market price.

In fact, the importance of access to cold storage and warehousing become more pronounced for perishable produce such as fruits, vegetables, and milk. Although returns from growing fruits and vegetables are higher, the majority of small farmers do not grow these crops. Birthal et al., (2015) point out that only 22.22% of marginal famers (with less than 1 ha of landholding size) and 23.61% of small farmers (between 1 and 2 ha of landholding size) grow any high value crops, such as fruits, vegetables, spices, flowers, plantation and medicinal plants. Analysing data from the National Sample Survey Organization (2005), this study finds small and marginal farmers are likely to gain from shifting to high value crops: the likelihood of a farmer being poor is 3–7% less, if he grows high value crops. However, partly because of the lack of storage and warehouse facilities, the majority of small and marginal farmers shy away from growing these high value crops.

Apart from its ability to reduce poverty (as is evident from the the example of growing high value crops), the absence of cold chain and warehouses also lead to wastage of fruits, vegetables, and milk. A reduction in food wastage also improves food security by increasing the real income for all the consumers. Wasting crops does not only reduce the food available for human consumption, but also causes negative externalities to society through the costs of waste management, greenhouse gas production, and the loss of scarce resources used in their production (Gustavsson, et al., 2011). Moreover, quality (nutrient contents) of fresh foods continue to deteriorate throughout their shelf life, from harvest or slaughter, through packing, distribution, marketing and sale (Kitinoja, 2013).

²⁸ See, Project Report on Cool Chamber, National Informatic Centre, Government of India. Available at:<http://odihort.nic.in/sites/default/files/10MT-Cold-Room.pdf>.

²⁹ A sizeable portion of the crop gets lost because of weeds and pest insects.

Table 5: Importance of Cold Storage

Variable	Global	Developed Countries	Developing Countries
Population in 2009 (in billions of inhabitants)	6.83	1.23	5.60
Population in 2050 (forecast, in billions of inhabitants)	9.15	1.28	7.87
Refrigerated storage capacity (m ³ /1000 inhabitants)	52	200	19
Food losses (all products)	25%	10%	28%
Losses of fruits and vegetables	35%	15%	40%
Losses of perishable foodstuffs due to lack of refrigeration	20%	9%	23%

Source: Lisa Kitinoja (2013), pp. 2.

According to an estimate prepared by ICAR-CIPHET study, the harvest and post-harvest losses for major food commodities covering crops, livestock and fish was INR 92,651 crore during the year 2013-2014. For the entire food sector this loss comes to INR 107,994 crore. These estimates reveal that 5.8% of food output is lost during harvest and transit. Around 18% of the country's food and vegetables are wasted annually because of lack of proper storage (ICAR-CIPHET, 2015).³⁰

There are several constituent elements in cold chain logistics (an environment-controlled logistics chain aimed at preserving the essential characteristics of the products handled):

- (i) Pack-house - Pack-house are equipped with conveyer belt systems for sorting, grading, washing, drying, weighing, and packaging fruits and vegetables.
- (ii) Storage - Static infrastructure designed with insulated and refrigerated chambers for long term or transient storage of whole fresh, ready-to-retail, or processed forms of perishable products.
- (iii) Cold Storage (Bulk) - Environment controlled warehousing space with multiple chambers intended for the bulk storage of perishable produce. Designed for extended duration storage of produce so as to build an inventory buffer.

³⁰ Also see, Bhosale (2013).

(iv) Cold Storage (Hubs): Environment controlled warehousing space with multiple temperature zones which functions as a distribution hub. Designed for short term handling of products so as to serve as a distribution logistics platform for market ready packaged produce and ready to retail products.

(v) Ripening Chambers: As the name suggests, these chambers are used for organically ripening fruits and vegetables.

And, (vi) Reefer Vehicles: These are refrigerated transport vehicles, with an insulated carrier and equipped with active refrigeration, designed for temperature-controlled carriage of perishable products.

In cold chain logistics, cold storage (bulk and hubs) make up about 30%. The remaining 70% comprise pack-houses, storage, ripening chambers and reefer vehicles. According to estimates by the National Centre for Cold Chain Development (NCCD), the Ministry of Agriculture and Farmers Welfare, Government of India, during 2012, there was an additional requirement for cold chain logistics that can accommodate about 40 million metric tonnes of perishable items.

Costs and Benefit Analysis

The intervention

Data

State-wide data relating to the value of fruits and vegetables produced are sourced from the Ministry of Statistics and Programme Implementation, Government of India.³¹Data on storage capacity and reefer vehicles are sourced from the NCCD report (2015). Data on the cost of building storage is also sourced from the NCCD report. As per estimates, on a per ton basis, the average cost for building multiproduct storage along with land and other infrastructure is INR 8,255. Further investment would be needed to upgrade technology of existing cold storage facilities, which is estimated at INR 1,755 per ton capacity. To build specialized storage systems, such as controlled atmosphere cold stores, would involve a higher investment cost of INR 31,000 per ton capacity. The estimate for building this specialized storage with land and other ancillary infrastructure would be INR 8255 + INR 1755 = INR 10,010 per ton capacity. These figures are for the year 2012. For subsequent years, we inflate the numbers by 30% which is the total rate of inflation between 2012 and 2017. The cost of ripening chambers is estimated at INR 0.5 million per piece. This data is

³¹ For more on this see, "Statewise and item-wise estimates of value of output from agricultural and allied sectors with new base year 2011-2012," Ministry of Statistics and Programme Implementation, Government of India, 2016, page 301.

sourced from India Mart.³² Agricultural output data and milk production data are sourced from the Agricultural Census 2011-2012 and the National Sample Survey 70th Round, 2013-2014. Costs relating to minimum wage rates are sourced from the Ministry of Finance, the Government of Rajasthan. Macro-level data such as inflation and exchange rates are sourced from World Bank Indicators, World Bank.

Table 6 - Summary statistics

Parameters	Value
Inflation 2013	10.98%
Inflation 2014	6.65%
Inflation 2015	4.90%
Inflation 2016	4.90%
Inflations 2012 to 2017	1.302
Exchange rate INR USD 2012	53.43
Growth rate in Fruits and Vegetables	7%
Growth rate in milk	6%
Cost per ton storage, (INR in 2017 price)	49,200
Land and other infrastructure per ton (INR in 2017 price)	8,838
Upgrade requirement for existing storage facilities (INR in 2017 price)	1,879
Upgrade requirement cost for non-operational facilities (INR in 2017 price)	5,358
Cost per vehicle 30 tons (INR in 2017 price)	3,061,924
Cost per packhouse for 15 MT (INR in 2017 price)	3,479,459
Cost per ripening chamber (INR in 2017 price)	500,000
Cost per employee - Rajasthan (INR in 2017 price)	64,584

Source: Agricultural Census 2011-2012, NSSO 2013-2014, World Bank, and Governments of Rajasthan.

Method

The benefit from having more storage facilities is that fruit and vegetable items will not be wasted. Studies show that the proportion of wastage of vegetables and fruits due to lack of storage is between 5% and 30%. Government data put it at 5%. According to the NCCD study, the extent of loss is 9%. For this study we take an estimate of 18% which is the average of 5 and 30%.³³ If 18% of the amount produced can now be saved, we assume this is the benefit from having a proper cold chain management. For milk, data shows the loss can be as high 40% and two-thirds of this loss happens

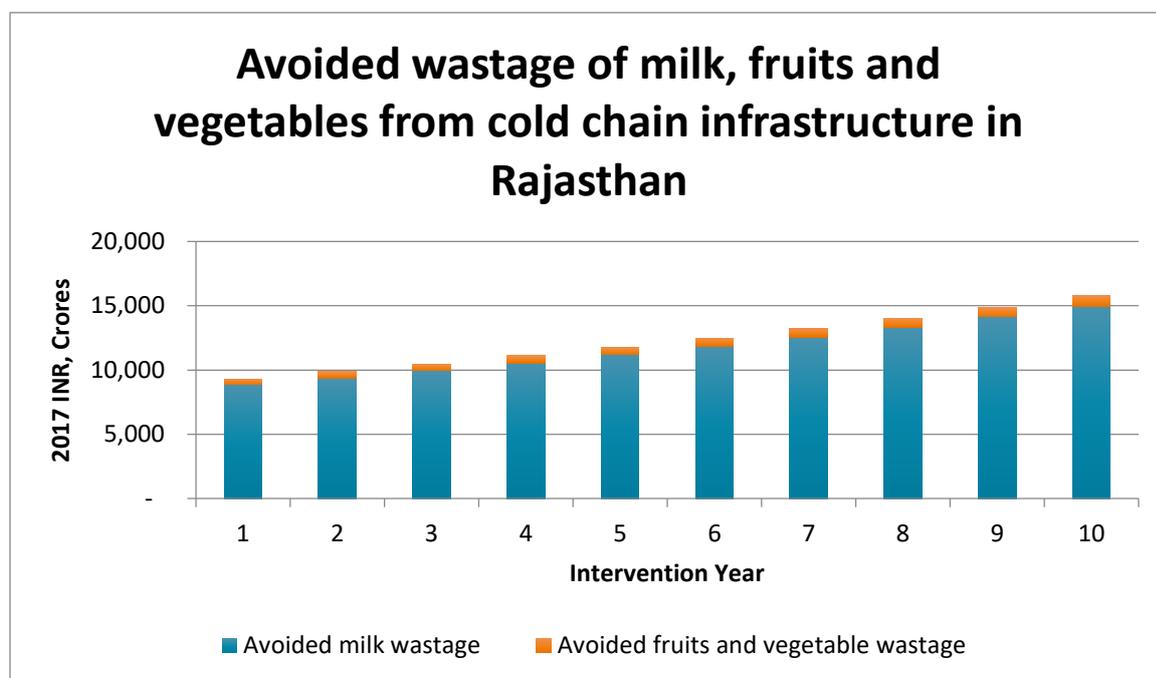
³² For more on this see: <https://www.indiamart.com/proddetail/banana-ripening-chambers-7901429155.html>.

³³This estimate about 18% wastage of fruits and vegetables annually resulting from lack of proper cold storage and warehouse facilities is same as what has been reported by the CIPHET study.

during storage (ASSOCHAM, 2017).³⁴ Hence, the net benefit for the farmers from accessing cold storage is one-third of 40%, that is 13%. This paper has analysed storage calculations for milk because Rajasthan is one of the biggest suppliers of milk in India. Data shows that milk production is growing annually at 7%, whereas for fruits and vegetables the annual growth rate is 6%.

In the first year of this intervention, the total benefit from putting cold chain logistics in place is estimated at INR 931,265 lakh. The amount of milk that can be saved by using cold storage is approx. 95% of the total, and the amount of fruit and vegetables that can be saved is 5% of total. The annual benefit increases by 6% per year in line with the expected rate of growth in the horticulture and dairy sectors. The year wise benefits are depicted in Figure 4 below.

Figure 4



For calculating the costs, we assume that there are capital costs associated with building the storage units and that once built they will require some additional costs for maintenance and upgrades. We also include the costs of variable inputs, such as labour, and other running cost, such as electricity and gasoline, which are required to run storage facilities, pack-houses, ripening chambers, and all other constituent elements of cold chain logistics. Similarly, the cost of running reefer vehicles and other fixed investment are also included. Once we have these numbers relating to the costs and benefit, we can compute the benefit-cost ratio.

³⁴ASSOCHAM-MRSS India study noted up to 50% of milk, fruits, veggies, produced in India go waste.

Based on NCCD data and our analysis, the current total storage requirement for storing milk, fruits and vegetables stands at 74,889 MT. The total number of pack houses required is 4,412. The total number of ripening chambers required is 5,748. The total number of specialised trucks required for transporting fruits, vegetables and milk is 132. About 90% of the storage requirement already exists within the state, but the remaining infrastructure needs are almost non-existent. To fill this gap requires a one-off investment of INR 1883 crore, plus additional investments over the following 9 years averaging approximately 11% of this value per year to meet expected growth in the horticulture and dairy sectors.

Additionally, at the outset an additional 127 employees would be required to run the storage facilities, 9633 employees to run pack houses and ripening chambers, and 344 workers (including drivers and helpers) to operate the trucks. This requirement increases over the years to meet growth. The average annual workforce costs is INR 95 crore over the 10 years. Lastly, we include operations and maintenance cost of 10% of invested capital which averages INR 276 crore per year. The year-wise cost breakdown is depicted in Figure 5 below

FIGURE 5

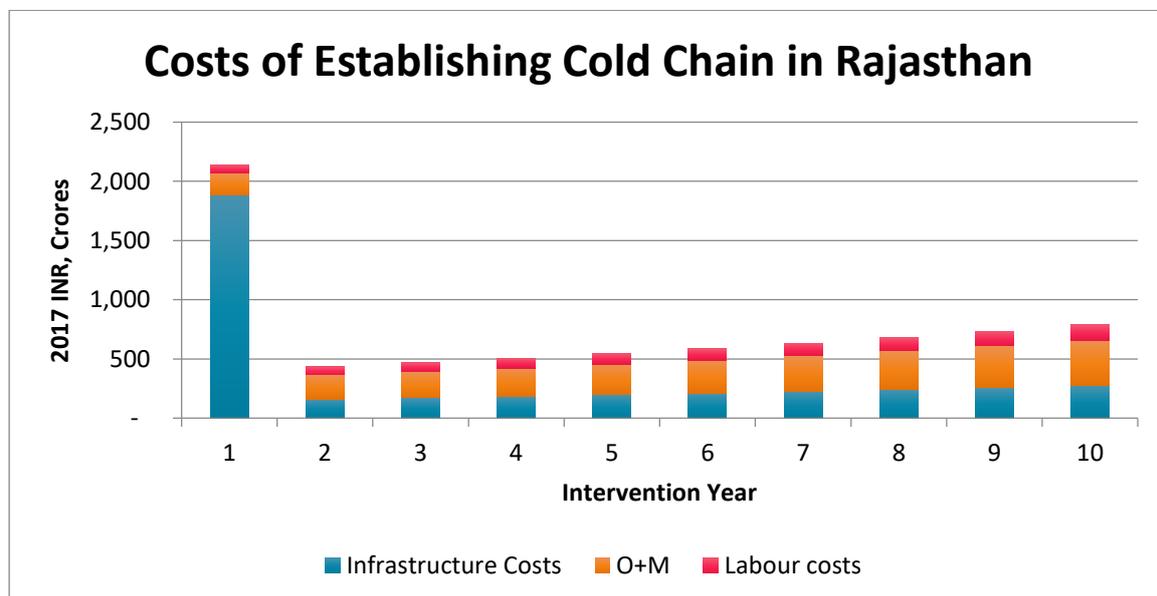


Table 7: Summary of cost benefit results (all figures in INR crore)

Cold chain infrastructure

Discount	Benefits	Costs	BCR	Net Benefit	Quality of Evidence
3%	103,460	6,527	15.9	96,933	Medium
5%	92,788	5,985	15.5	86,803	Medium
8%	79,546	5,307	15.0	74,239	Medium

Intervention 3: Impact of e-mandi (market) on farm income in Rajasthan

The Government of India has indicated that it aims to double farm income by 2022 (NITI Aayog, 2017). An important step for this to happen is to ensure better price realization for the farmers. However, as discussed in the previous section, because of inefficient supply chain logistics farmers seldom realize the true market price. According to Chand (2012), the transfer of farm produce to end-consumers involves at least four different intermediaries, without adding any value to the produce.³⁵ There are various steps involved in supply chain management in India. Small farmers typically sell their produce to local traders as they do not have access to cold storage and warehouses on an individual basis, nor are they able to sell directly to the government.³⁶ This is especially true for perishable products. These farmers have limited alternatives but to sell their produce to the local aggregator. In cases where they do not sell to the local aggregator, their other option is to take their produce to the nearby government designated mandi. Once inside the mandi, a commission agent (known as *Arthia*) buys it off from the farmers. An *Arthia* is an aggregator who buys produce from different farmers and then sells them on to sub-wholesalers within the same mandi. These sub-wholesalers then sell their produce to big wholesalers who in turn sell them to retail vendors to be finally sold to the consumers. Each time the produce changes hands, each party adds their mark-ups and the items become dearer. A farmer fails to realize the *true* market price, and the mark-ups are accrued by the multiple layers of middlemen. If the farmers were to sell directly to the wholesale buyers they would double their margins when compared to going through middlemen (Mitra, et al., 2013). However it is not legally possible to bypass the middlemen as, farmers are obliged to sell their produce only to licensed middlemen (read, *Arthias*) in government

³⁵ This has been corroborated in the earlier section on cold storage as well.

³⁶ *Ibid*

designated mandis. According to the APMC Act, which dates back to the 1960s, the state governments notify the commodities and designate market areas where regulated trade will take place. Once an area is declared as a market area it falls under the jurisdiction of a market committee, and no person or agency is allowed to trade elsewhere. It is clear that mandis located within a state are often not well integrated and there are substantial transaction costs for moving agriculture produce from one mandi to another.

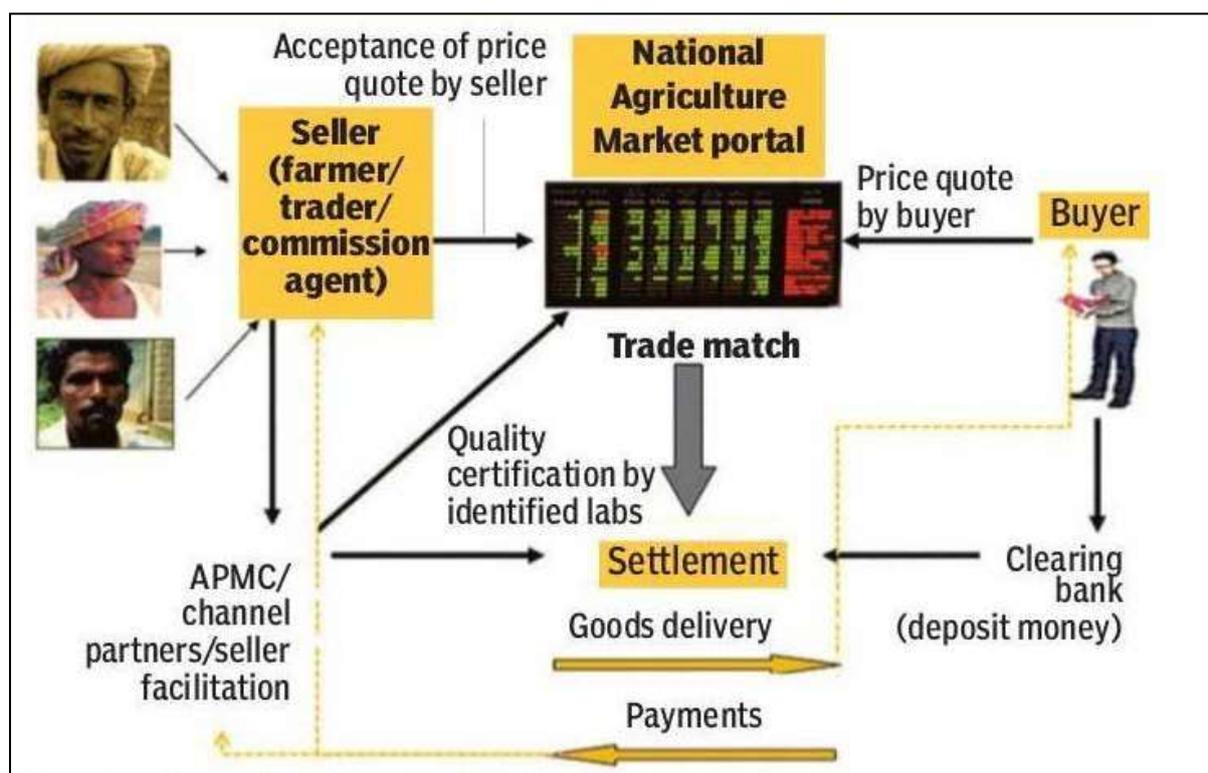
Moreover, in these mandis there are few middlemen and often they collude to prevent the farmers from getting the true market price. In addition, the limited bargaining power of the farmers can lead to delayed payment. The farmers are also not aware what the actual price wholesale dealers and processors are paying to the Arthias (Banerjee and Meenakshi, 2004).

In order to make the system more transparent and to improve efficiency, the Government of India amended the APMC Act in 2003 (now known as the Model Act). With this amendment, it is now the responsibility of state government to bring in necessary amendments permitting the establishment of private markets, giving freedom to market functionaries to operate in different markets through registration and licensing, and allowing electronic procurement of food grains.

Karnataka was a pioneer state in leading the implementation of the Model Act, 2003. The Government of Karnataka, in collaboration with the National Commodity Derivative Exchange (NCDEX) implemented the concept of a Unified Market Platform in 2014, and a separate institution called Rashtriya e-Market Service Private Limited (ReMS) was created for providing electronic (e) market service. E-mandis or e-markets are expected to provide a level playing field for the farmers by reducing information asymmetry between farmers and traders essentially by promoting real time price discovery (Government of India, 2016). E-markets help the farmers to know the prices in different markets beyond their geographical jurisdictions and the price offered by the processors.

The Government of India's Electronic National Agricultural Market (e-NAM) initiative (undertaken during April 2016) was borrowed from this idea of ReMS. Initially, 21 wholesale markets across eight states were connected. These states and corresponding markets which initially participated through e-NAM are Telangana (5), Uttar Pradesh (5), Gujarat (3), Haryana (2), Himachal Pradesh (2), Jharkhand (2), Madhya Pradesh (1), and Rajasthan (1). e-NAM is an online platform with a physical mandi at the backend. The market platform under e-NAM operates electronically. One of the prerequisites for participating in e-NAM is that the concerned state needs to amend its APMC Acts.

Figure 6: Benefit from E-Market Transactions



Source: Small Farmers' Agribusiness Consortium

As e-market is a recent phenomenon, there is little empirical evidence to assess the impact of e-mandi on a farmer's income. It is however expected that prices realized by the farmers will increase as a result of the introduction of e-mandi. Banker and Mitra (2007) find coffee traded through electronic tendering fetches a 4% higher price over the price determined through physical auction in Karnataka. Also, because the role of intermediaries (in the supply chain logistics) will be limited, it is expected price volatility will come down. To understand the impact of e-market on groundnut price in Karnataka, Reddy (2016) considered groundnut prices from 16 e-markets³⁷ and compared them with 16 other adjacent markets where groundnut was traded but did not have e-markets³⁸. This study mentions that, between 2007 and 2015, there was a 128% increase in average price in e-markets compared to 88% increase in average price in non-e-markets. Moreover, competition amongst traders increased and there was reduced scope for collusion, which benefitted the farmers. In fact, NITI Aayog paper suggests, "After introduction of online trading modal prices in mandis in Karnataka witnessed much higher increase than the increase in wholesale prices of the same

³⁷These markets are Raichur, Shimoga, Tumkur, Bailahongal, Bagalakot, Bijapur, Bellary, Davangere, Gulbarga, Hubli, Koppal, Kottur, Mysore, Gadag, Soundati and Yadgir.

³⁸These non e markets can be Lingasugur, Sorabha, Madhugiri, Nippani, Hungund, Sindagi, H.B. Halli, Jagalur, Shahapur, Kundagol, Kustagi, Hospet, Nanjangud, Laxmeshwar, Sankeshwar and Shorapur.

commodity. The increase in real terms varies from 1 percent to 43 percent. The average increase for the 10 commodities for which data is available was 38 percent in nominal terms and 13 percent in real terms." (pp. 13, NITI Aayog, 2017). Table 8 analyses the impact of the introduction of e-mandi on the price of various crops in Karnataka.

Table 8: Effects of online trading on prices received by farmers in mandis in Karnataka.

Commodity	Prices received by farmers Rs./quintal		Increase in 2015-16 over 2013-14 %	
	2013-14	2015-16	Nominal	Real@
Tur	3939	7672	95	16
Green gram	5308	7318	38	1
Black gram	3817	7976	109	12
Bajra	1261	1419	13	11
Copra	5189	9325	80	43
Turmeric	5937	7931	34	13
Jowar	1492	1774	19	6
Maize	1257	1356	8	6
Groundnut	3398	4346	28	14
Bengal gram	3057	4541	49	15
Weighted increase			39	13

Source: NITI Aayog, 2017, pp. 13.

In another related study, considering the case of pigeon pea traded in Karnataka, Pavithra et al. (2018) find the modal price of pigeon pea was 12 to 14% higher in the Gulbarga market where e-procurement has been happening since 2011. This is in comparison to neighbouring Sedum and Chittapur markets that opposed the idea of e-procurement.

Rajasthan joined the e-Nam initiative in 2017. To start with, only the Ramjang mandi in Kota started operating under e-NAM where black gram (chana) is traded. Now 25 markets have e-market facilities. Although the benefit is competitive price discovery for the farmers, there are multiple costs involved - costs of creating software and hardware for running e-markets, cost of setting up other ICT infrastructures such as broadband connectivity, and training farmers to be computer literate. As the Government estimates suggest, the cost of setting up an e-mandi is INR 3.4 lakh. This is based on the experience of setting up the ReMs system in Karnataka, as well as the allocated budget for Rajasthan and Himachal Pradesh. There are 139 e-mandis in Rajasthan so 114 mandis need to be

setup and integrated with e-market platform. The one-time total cost (fixed cost) of setting-up e-mandi is therefore INR 39 crore. Once these e-mandis are set up there is an operational cost of running these e-mandis. We assume that the operational cost are 10% of setup annually, and will increase linearly with the growth of crop output. In case of Rajasthan the agricultural output is growing at 6%, annually. The cost of setting up and running e-mandis up to 2037 (20-year time horizon) is Rs 131 crore. The cost of this intervention is relatively modest since it leverages an existing and long-standing ecosystem of traders, farmers and market makers.

To estimate the benefits from expansion of e-markets across the state, we take the estimated price premium from NITI Aayog (2017) of 13%. This partially represents a pareto improvement from reduced transaction costs due to increased competition and liquidity pooling, and partially represents a transfer of resources from middlemen to farmers. Without knowing for sure what the actual breakdown of this premium is, we assume 50% of the price premium is true social gain.

This premium is applied against the total produce being sold in the mandis multiplied by the uptake of e-mandis by farmers and traders. For example, in 2017, the total produce sold through mandis is 44,979 crores and due to an assumed slow start, only 2.5% of produce is traded through the e-mandi. So, the benefit is $44,979 \times 2.5\% \times 13\% \times 50\% = 34$ crore.

For the calculation of benefits beyond 2017 we assume the same effectiveness rate of $13\% \times 0.5$, and expand the amount of produce going through the mandis by the long-term growth rate of agriculture in Rajasthan, 6% p.a. The parameter for which there is least evidence is the assumed uptake of e-mandis. Data from the Government of India's E-NAM portal suggest a slow take up of the service in Rajasthan, with only 2.5% of total produce value traded through the e-portal since its inception in April 2016 to Dec 2017. During this time only 25 out of 139 mandis had an e-platform. On the other hand, Karnataka's ReMS' experience suggests that widespread use of an e-platform for agricultural trading is possible within a few years. For this exercise we assume an 20% increase every year from a low base of 2.5%. This implies by 2026, 10 years after the platform is introduced, only 13% of all produce will be going through the e-mandi. On the same rate almost, full implementation can be expected by 2037. The total benefit of the intervention is 8,523 crores at a 5% discount rate over 20 years. This leads to a BCR of 65. More modest assumptions around uptake, for example capping the uptake rate at 25% or 50% of total produce, still leads to large BCRs of 36 and 53, respectively.

Table 11: BCR Analysis in INR Crore

Intervention	Discount Rate	Benefit	Cost	BCR	Quality of Evidence
E-Mandis	3%	11,779	156	75	Limited to Medium
	5%	8,523	131	65	Limited to Medium
	8%	5,374	104	52	Limited to Medium

Results indicate that for Rajasthan the Benefit-Cost Ratio for the farmers from the introduction of e-mandi is very high. In fact, the numbers are much higher in comparison to the earlier two interventions, suggesting the farmers are likely to gain most if the state government starts to operationalise e-markets.

Conclusion

The results from our analysis suggests, for intervention 1, which is farm loan waiver, the economic cost is higher than the benefit. If the objective of the loan waiver is to help the small farmers, farm loan waiver does not fulfil that objective. This is because only 15% of the smallest farmers have access to institutional credit (formal credit), and loan waiver is necessarily meant for farmers who have taken formal loan. Even for those with 2.0 ha or less, roughly 50% of them access formal credit.

Moreover, studies have shown, long-term impact of loan waiver programme results in a fall in agriculture output and it shrinks the amount of formal loan available for the small and marginal farmers during post-loan bailout period. Also, there is a cost to the national exchequer which results in a higher fiscal deficit. The same money could instead be put for more productive purposes such as electrification of rural areas, building more canals and irrigation facilities.

The second Intervention, which is about building more storages and investing in refer vehicles, is a prudent investment. Interventions in cold chain, with the aim of improving post-harvest management, results in economic benefits that far outweigh the economic costs. Improper post-harvest management not only leads to crops and milk being wasted, but also discourages small and

marginal farmers from growing these high-value items. These items are in high demand in international markets and among corporations with a large presence in the food processing industry. However, small farmers do not want to venture into growing these perishable items as lack of cold chain management either leads to crop wastage or degraded to a standard which is not acceptable internationally by large corporations.

Intervention 3, is about expanding e-markets throughout Rajasthan. E-market is focussed on removing the role of intermediaries (in the supply chain logistics) and enabling improved price discovery for farmers. With the middle-men gone, farmers will have the option to sell their produce to retailers/processors outside of their immediate geographical are. We find evidence that e-markets help to ensure better price realization for the farmers as they will have the option of bypassing the middle-men and traders. There was also evidence about increased competition among the traders weakening their bargaining power.

Summary Table of Interventions

Intervention	Discount Rate	Benefit	Cost	BCR	Quality of Evidence
Farmer loan waiver	3%	9,811	12,156	0.8	Strong
	5%	9,537	11,731	0.8	
	8%	9,156	11,149	0.8	
Cold Chain Infrastructure	3%	103,460	6,527	16	Medium
	5%	92,787	5,985	16	
	8%	79,546	5,307	15	
Expanding e-mandis	3%	11,779	156	75	Limited to Medium
	5%	8,523	131	65	
	8%	5,374	104	52	

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Rajasthan is the largest Indian state. It has a diversified economy, with mining, agriculture and tourism. Rajasthan has shown significant progress in improving governance and tackling corruption. However, it continues to face acute social and economic development challenges, and poverty remains widespread. What should local, state and national policymakers, donors, NGOs and businesses focus on first, to improve development and overcome the state's remaining issues? With limited resources and time, it is crucial that priorities are informed by what can be achieved by each rupee spent. To fulfil the state vision of "a healthy, educated, gender sensitive, prosperous and smiling Rajasthan with a well-developed economic infrastructure", Rajasthan needs to focus on the areas where the most can be achieved. It needs to leverage its core competencies to accelerate growth and ensure people achieve higher living standards. Rajasthan Priorities, as part of the larger India Consensus – a partnership between Tata Trusts and the Copenhagen Consensus Center, will work with stakeholders across the state to identify, analyze, and prioritize the best solutions to state challenges. It will commission some of the best economists in India, Rajasthan, and the world to calculate the social, environmental and economic costs and benefits of proposals.



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