THE IMPACT ON DOMESTIC PRICES AND GOVERNMENT COSTS OF LIMITING WHEAT PROCUREMENT IN INDIA

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by

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and hereby certify that, in their opinion, it is worthy of acceptance.

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ABSTRACT

India's government plays a major role in the Indian wheat market, procuring wheat at a minimum support price for distribution to consumers at a subsidized rate through fair price shops. The costs of this program have been growing recently in real terms. Studies suggest different options for addressing these growing costs through means such as: reducing per-unit operating expenses, changing the scope of the program, altering pricing schemes, or limiting procurement operations. This study assesses the impact of limiting government procurements on the domestic market and government expenditures. A partial equilibrium model is developed to help estimate the impact of this policy change. The model represents the Indian wheat market and the relevant government policy variables necessary to estimate the change in government costs from this policy alternative. Results suggest that there are saving available from limiting government procurements of wheat. The domestic market would likely see lower prices because of these reduced government interventions. Sensitivity analysis suggests that limiting import could help to ease the pressure on domestic prices caused by the policy change.

Introduction

Wheat is a major food commodity in India and one that is important to both producers and consumers. According to food grain estimates form the Directorate of Economics and Statistics (2015), between 2009 and 2014, wheat made up an average of 24 percent of the area sown to food grains and 36 percent of the food grain production in India. Rice is the other important food grain. During this same time period, Rice area made up 35 percent of the food grain area and 40 percent of the food grain production (ibid). Together, these two grains account for the majority of food grain area and production. Wheat is also significant for consumers since cereals make up 15.6 percent of consumer expenditures for the rural population and 9.1 percent for the urban population, according to the 2009/2010 66th NSS survey on Level and Pattern of Consumer Expenditures (2011). Furthermore, this source reports, wheat makes up between 38 percent (rural) and 46 percent (urban) of the cereals reported consumed in 2009. Wheat and rice account for between 92 percent (rural) and 96 percent (urban) of total cereal consumption reported in the survey (ibid).

Government policy also affects the Indian wheat market at various stages. The government is involved in subsidizing inputs for agriculture, ensuring a minimum price, purchasing grains, holding stocks, distributing food grains to consumers and occasionally undertaking exports. The government has a standing offer to buy wheat from producers at a minimum support price (MSP) which goes into government storage and later distributed to consumers at fair price shops (FPS) located throughout India. Occasionally, grain must be sold out of government stocks to avoid continuously rising stock levels. The Food Corporation of India (FCI) administers this procurement and distribution program. These government interventions have become costly.

The FCI incurs costs at many stages of operation. Each of the following stages require at least some expenditures: (1) procurement; (2) transportation to warehouse and storage; (3) transfer of grain from storage to states; (4) carrying stocks to the next year; and (5) selling stocks at prices below the cost of acquisition. Recently, the food subsidy totaled almost one percent of India's Gross Domestic Product (GDP) (Kozicka et al. 2015; Saini and Kozicka 2014).

Several studies have offered potential solutions to these rising costs by streamlining the FCI operations, reducing the FCI's involvement in markets, trading grain transfers for cash transfers or limiting procurement levels. Many studies investigate the feasibility and impact of the first three possible solutions named but none has looked at the potential impact of limiting government procurements.

In the present study, we investigate how limiting government procurements to the expected use of the coming season plus some limited stocking requirements, instead of open ended procurement, would affect the Indian wheat market and government costs. A partial equilibrium model representing the Indian wheat market and the relevant agricultural policies is constructed to estimate these impacts.

In theory, a policy with less direct intervention would push down prices in the producing regions. These lower market prices would be expected to increase consumption, limiting the extent of the price decrease. Government costs would decline, as there would be lower overall procurements under this alternative policy, lower stockholding and thus lower costs of carrying those stocks and no expense incurred for disposing of excess stocks through- domestic market or export sales.

As a first step to develop empirical estimates of the impacts of such a policy change, we review the literature on modeling of government policy, those studies being specific to

India, and outline each of the equations necessary to build a partial equilibrium model to answer this question. Specific attention is given to the domestic procurement and distribution program run by the FCI and government stock holding, two significant policies in Indian agriculture.

The next step is to build a structural economic model. This model represents supply and demand as a series of behavioral equations and includes identities that reflect biological or economic requirements. Other equations developed represent government costs of the policy to procure, store and distribute subsidized wheat. All equations attempt to take into account key provisions of this program. The model is partly estimated, but many parameters are drawn from the literature. The economic model is used for simulations that estimate how the policy change would affect markets and government costs. The estimation process requires that an initial simulation develops a baseline of market and expenditure outcomes with constant policy and a subsequent simulation estimates the new market and expenditure outcomes imposing the alternative policy. The difference between the simulated outcomes for each variable is the estimated impact of the policy change on that variable.

The final section offers some conclusions, as well as limitations. The limitations, chief of which are exogenous competing prices, might be significant. The conclusions from this research are that both market prices and government costs are expected to decrease because of this policy alternative. Cost savings are estimated to be Rs. 831 billion over the next 15 years while domestic prices are expected to decrease by an average of 4 percent going forward.

Literature Review

The literature relevant for this study is divided into three main sections: supply and its components, demand for wheat and government stockholding.

Supply

Krishna and Chhibber (1983, 27) estimate own-price elasticities of wheat area that are larger than would be estimated if most production was from subsistence agriculture. This finding suggests the wheat production system in India is mostly for commercial production and subsistence production accounts for a smaller share. The implication of this finding is that producers respond to market prices and price expectations as microeconomic theory of the firm would lead us to expect, informing the decision to model the production response to prices and the chosen equation specification. Using cost, price and government policy terms should capture the decisions made by Indian wheat producers. Profit maximization is therefore driving the decision by the producer about how much area to plant to wheat.

Acreage has not always been responsive to prices. Mythili (2008) uses data from 1970 to 2004 to estimate the price elasticity of acreage and yield both before the 1990 reform and after those policy changes. In that study, Nerlove's adjustment model is applied to analyze the differences in short run and long run elasticities. The conclusion from the study is the response of wheat area and yield between pre-reform and post-reform periods are not statistically different when using the ratio of own crop output price to substitute crop output prices, with yield being an exception. Table 1 reports these elasticities. Yield response, in both wheat and rice, was the only statistically significant difference. However, when using the ratio of output price to average variable cost as the

price variable, the conclusion is that there are significant differences in the acreage response between pre-reform and post-reform periods. Table 2 reports these elasticities.

Table 1. Pre-1990 and Post-1990 acreage and yield price elasticities, own-price/substitute crop prices

Wheat	Pre-reform			Post-reform		
	Area	Yield	Supply	Area	Yield	Supply
Short Run	0.066	0.083	0.149	0.071	0.097	0.168
Long Run	0.238	0.090	0.328	0.256	0.105	0.361
Note: Price variable was the ratio of own crop output price to substitute crop price; 1970/71-2004/05						
Source: Mythili (2008)						

Table 2. Pre-1990 and Post-1990 acreage and yield price elasticities, own-price/average variable cost

Wheat	Pre-reform			Post-reform		
	Area	Yield	Supply	Area	Yield	Supply
Short Run	0.016	0.027	0.043	0.076	0.087	0.163
Long Run	0.039	0.031	0.070	0.187	0.100	0.287
Note: Price variable was the ratio of own crop output price to average variable cost; 1980/81-2004/05						
Source: Mythili (2008)						

Given that the policy environment and acreage and yield responses are significantly different, it would be inappropriate to try to incorporate pre-reform data to model producers' actions. Estimation in the present study uses data only from the post-reform era (since 1990).

In the FAPRI-CARD, world wheat trade model, area is specified according to a gross returns approach, including a competing crop and lagged area (Devadoss, Helmar, and Meyers 1990). It follows the idea that producers can only respond partially in the short run, but given enough time, they can fully respond to changes in prices.

Yield can be affected by many factors such as weather, soil quality, soil nutrient holding capacity, technology, input use and price. Mythili uses price, rainfall, irrigation and literacy rate (which contributes to technology adoption) as explanatory variables in yield equations. Herdt (1970) estimated a positive response of yields to prices and these

results have been verified many times since then, including by Mythili as discussed above. In the short run, producers can only bring a limited amount of land into production in response to supply, mostly by changing crop rotation. This constraint nevertheless allows other methods by which producers can try to increase production and maximize their profits in the short run. Investment in more or better inputs and technology are two ways producers can attempt to increase yields.

Parappurathu et al. (2014) specify yield as a function of the lagged ratio of revenue-to-cost, trend revenue cost ratio[1] and a trend. This specification intends to estimate the investment in yield-enhancing inputs by including the lagged revenue cost ratio. Technology adoption might be an important feature of Indian agriculture. Patel (2014) argues that investments in yield-enhancing inputs have historically been paid with cash, not financed with loans, because access to credit has been difficult. Though this problem is getting better, it is still plaguing India. This feature suggests inclusion of this term to reflect producers' decisions.

Production has been modeled using two different methods, depending on the goals of the study. Production is either modeled as an identity, the product of area and yield, (Parappurathu et al. 2014) or as a separate function with the factors affecting area and yield decisions combined into one single equation (Kozicka et al. 2015; Krishna and Chhibber 1983). Kozicka et al. includes the MSP as a term in the production function, unlike all the studies reviewed here. They use this government price only as the price to which producers respond in the production function, not a market price. This minimum support price can have an impact on the production decisions of Indian farmers since it sets a price floor for the price at which they can sell their output, limiting their downside price risk. However, out of each 1000 households surveyed during the 70th round annual

[1] The exact calculation of this variable are not defined in the paper.

statistical survey, 368 reported sales of wheat, of which only 25 reported sales to a cooperative or government agency who would directly offer the MSP to the farmers (National Sample Survey Office 2014). Market prices might also be included in the area or yield equations. The 70th round annual statistical survey also reported that, of the 368 households reporting wheat sales, 181 sell to a local private trader, 128 sell to the mandi[2], and the rest sell to a variety of outlets such as input dealers, processors or other places (NSSO 2014). These shares are for the first half of the sample period, July 2012 to December 2013. For the second half of the sample period, January 2013 to June 2013, 29 percent sold to local private traders, 44 percent to the mandi, 19 percent to government agency or cooperative and the rest were to other outlets.

Consumer Demand

The public distribution system is the system by which the government of India distributes grain at subsidized prices. This system consists of procurement agencies at the state level run by either the state or central government, warehouses to store the procured grain, transportation to move the grain from storage to its consumption point or to intermediate storage, and FPSs where the beneficiaries receive their allotments of grain (FCI 2016a; Ramaswami 2005; Saxena 2008). The central government bears most of the costs of this system because it pays either directly or indirectly for all of the costs from procurement through delivery to the FPSs (Swaminathan 1999; Government of India 2013).

Studies have shown the public distribution system suffers inefficiencies and even corruption. Often, grain that is allocated for distribution out of the central pool never reaches the consumer (Khera 2011). Estimates are created by comparing the sample

[2] In Hindi, mandi refers to a market. In this case, mandi refers to a market for selling agricultural products.

NSS consumption data to the offtake quantity reported by the FCI. Khera estimates leakage, grain allocated but never reaching the consumer, to be between 40 and 100 percent, though the study notes that these estimates are likely towards the upper end of the range of real leakages. The exact leakage is not known and as such is generally recognized, but not explicitly broken out when modeling the Indian wheat market.

Proposals to change the FCI and distribution operations generally take one of three forms: eliminate the food subsidy altogether in favor of a cash benefit transfer, reform the system to deal with corruption and inefficient handling of grain or completely decentralize the operation in favor of a state-based approach which is financed by the central government. Mane (2006) argues the PDS has not been overly successful at targeting intended beneficiaries and advocates for better targeting, monitoring and delivery mechanisms. Saxena (2008), in addition to offering similar solutions to Mane, adds reducing transaction costs, increasing transparency and the possibility of a cash subsidy. Saxena (2008) estimates the system is equivalent to a direct subsidy of 70-300 Rupees per family per month. Sharma (2012) looks at the trends in the increasing cost of the PDS and the level of food subsidy to the consumers. The growing gap between the CIPs[3] and the economic cost of wheat is the main driver explaining the increase of the food subsidy cost and, thus, the cost to the central government. Sharma identifies options to reduce this cost, other than increasing the CIPs, which include reducing inefficiencies, raising prices and introduction of a two-tiered procurement price system to limit government costs for grain purchased above the quantity needed for distribution. The two-tiered option sets a procurement price, at which the government buys the quantity it needs for distribution, and a minimum support price that is lower than the procurement price. At the minimum support price, this option proposes the government

[3] The Central Issue Price is the price at which food grains from the central government's stocks transfer to the states' distribution facilities.

issue an open offer to buy all quantity at that price to maintain that minimum price for producers. The scenario in the current study modifies this option by keeping the one support price but limiting procurements to the anticipated distribution quantity plus buffer stocks.

Other studies assess how those receiving PDS benefits respond. A line of research centers on how consumers respond to the transfers in terms of their purchases. This body of research speaks directly to how beneficiaries respond to price and subsidy, and thus the related findings can affect the choice of how to specify this reaction in the present study.

One consideration is how the value of transfers from the government to the consumer compares to the overall expenditures. In the context of this study, that comparison relates the subsidy value of the wheat purchased for the distribution system to the total food expenditures of the Indian consumer. Hoynes et al. (2014) write about this comparison as it relates to the Supplemental Nutrition Assistance Program (SNAP) in the United States. They determine that the subsidized quantity is infra-marginal because the value of the benefit transfer is less than what most families would otherwise spend on food. The consumers treat these transfers as if they were cash. Balasubramanian (2015) recently examined this question in the context of the PDS to investigate if consumers treated the PDS subsidy as if it were a cash subsidy. The findings were definite that for the bottom four deciles of the population[4], PDS grain subsidies were treated as if they were cash. One would have expected grain consumption to increase given that the subsidies were effectively an increase in income. However, the data analyzed from the 1999/2000, 2004/2005 and 2009/2010 NSS rounds indicate that even

[4] Those in the lower 40% of the income distribution are the people whom the PDS mostly targets and who use it most often.

with rising real income transfers, quantity of cereal consumption declined. In 2015, three of India's Union Territories began cash transfers to beneficiaries instead of distribution of grain (Dash 2015). This was possible because they are counted among the 26 states who have fully digitized ration cards under the NFSA and successfully linked those to bank accounts. This trial program relates only to these three territories and represent a very small portion[5] of the Indian population.

Since these PDS grain transfers are treated by recipients as cash transfers, according to previous research, modeling the food demand for India in the present study need not treat the PDS program as having any direct impact on consumer purchases of wheat.

Kumar et al. (2011) estimate income and price elasticities for 7 groups of foods using the QUAIDS model and for 12 individual commodities using the FCDS model across 4 segments of the population. Table 3 and Table 4 show excerpts of the tables of estimated elasticities. This study examines the shifting dietary patterns of the Indian population. From 1983 to 2004, consumption of total cereal grains has fallen, wheat included.

Table 3. Income and Price Elasticities based on QUAIDS Model

	Income Group				
	Very poor	Moderately poor	Non-poor lower	Non-poor higher	All
	Expenditure elasticities of food demand				
Cereals	0.514	0.424	0.312	-0.006	0.187
	Uncompensated own-price elasticities of food demand				
Cereals	-0.309	-0.242	-0.150	-0.127	-0.031
Source: Kumar et al. 2011, p.11					

[5] These three territories combined make up approximately 0.03% of the total population of India.

Table 4. Income Elasticities of food based on FCDS Model

	Income Group				
	Very poor	Moderately poor	Non-poor lower	Non-poor higher	All
	Expenditure elasticities of food demand				
Wheat	0.102	0.083	0.070	0.071	0.075
	Uncompensated own price elasticities of food demand				
Wheat	-0.480	-0.470	-0.300	-1.611	-0.340
Source: Kumar et al. 2011, p.11-12					

Government Stocks

Government stockholding is a main feature of the Indian PDS, and the mechanism that allows the government to have the grain for distribution. Government stocks presumably directly competes with private traders for stockholding. Private traders would normally hold stocks for speculation. For the purposes of the present study, private stocks are ignored and, indeed, market data suggest that private stocks are unimportant. This treatment is reasonable given the scale of government stocks.

The absence of any significant private stock holding in reality, as well as the omission of private stocks in the present study, also reflects the presence of legal constraints. One of the laws that acts as a disincentive to private stockholding is the Essential Commodities Act of 1955 (Government of India 1955) that affects the market in two ways. First, this law can be invoked to limit the movement, production or distribution of essential commodities[6]. This constraint has important market impacts in that it created uncertainty for grain producers, buyers, warehouse operators and traders. At any time, their actions could be banned, putting them in a difficult position of having too many stocks or none, or even leaving them to face legal sanctions. Second, the law effectively limits private

[6] For a full list of commodities covered under this definition see: http://seednet.gov.in/PDFFILES/Essential_Commodity_Act_1955(No_10_of_1955).pdf. Wheat and wheat products are included under this definition.

stockholding by crowding it out with the government stocks. For the purposes here, this study assumes government stocks continue fully to crowd out private stocks for the period of analysis.

Critics of the public stock policy usually show how inefficient the PDS is by pointing to the share of the undernourished population as evidence of these inefficiencies (Saini and Kozicka 2014). Other studies focus on modeling the stockholding problem as it relates to government and private stocks (Balakrishnan and Ramaswami 1995), analyze what impact policies have on stock levels (Gulati and Jain 2013) and examine stocks as a market stabilization tool and a corresponding optimal stockholding policy (Gouel 2014).

Domestic Policies

Overview

The wheat market in India is directly affected by the MSP, government procurement, PDS, crop insurance, trade barriers, domestic market restrictions and various state level polies such as bonuses offered above the MSP from time to time (FCI 2016b). The FCI is the governmental body that administers the majority of these programs, some with the assistance of state governments. They purchase grain in each state at the minimum support price, either directly or indirectly through state agencies. Purchased grain goes to storage in government warehouses and eventually to distribution in the PDS. Occasionally, large stocks are amassed for various reasons. In these cases, the FCI will sell stored grain on the market, either domestic or international, to reduce their stock levels. These mechanisms were used to bring down the stock levels from 2001 to 2003 (Ramaswami 2005). As noted earlier, these programs are not without their flaws, with leakage, spoilage and fraud to be counted among the major problems (Khera 2011; Saxena 2008).

Minimum Support Price

The FCI or its state counterpart has a standing offer to buy production from farmers at the minimum support price, subject to quality restrictions (FCI 2016a). The Commission for Agricultural Costs and Prices (CACP) recommend this price and the central government officially sets it. Recommended prices are intended to incentivize producers to adopt technology and ensure production meets national needs while using resources rationally. Further consideration is given to the broader economic effects of the

recommended MSP, the cost of production of the specific crop, inter-crop price parity and the overall supply and demand situation. (Ministry of Agriculture 2009; CACP 2016).

This policy can have a large impact on farmer's decisions about what crops to plant and how much to invest in planting and producing a particular crop. The MSP effective for the upcoming crop season is announced before the start of that season, so the producers know the floor price before planting and can use that information accordingly when they make their production decisions. For example, the minimum support prices of Rs. 1525 per quintal effective for the 2015-2016 crop year was announced well before planting, which normally begins in the October-November timeframe. Occasionally the government will approve an increase in the MSP, sometimes in the form of a bonus, just before planting time. This announcement for the 2015-2016 crop year was made on November 1, 2015, raising the previous MSP of Rs. 1450 per quintal by Rs. 75 per quintal to the current effective MSP of Rs. 1525 per quintal.

Each state may offer a bonus on top of the nationally set MSP. This bonus might be provided for a variety of reasons, but has historically been justified by arguing the cost of production is not uniform across all states or for political reasons. Since the central government sets one MSP for all of India, some states believe the price is ineffective in their respective states. In 2014, the central government took measures to limit these MSP bonuses by states (Bera 2014). They introduced penalties for those states declaring bonuses and these penalties appear to have stopped this practice. For the states who have decentralized procurement programs (DCP), meaning the state agency actually takes care of the procurement instead of the FCI directly, the procurements from that state will be limited to that state's needs to satisfy their PDS system. For a state that does not have DCP, and consequently the FCI procures the grain, should that state choose to issue a bonus, then that state would then become responsible for

administering the procurement program. No states have declared bonuses since this rule went into effect.

Grain Quality Standards

Wheat delivered by farmers for sale to the government at the MSP must be of a minimum quality, known as fair average quality (FAQ). If grain fails to meet these standards, it can still be purchased if the quality attributes are close but is subject to a schedule of discounts (Swaminathan 1999). The quality standards are announced each year by the FCI prior to harvest to ensure that they do not receive only the "tailings" of the wheat crop and that the grain received is of good enough quality for storage and later human consumption. Table 5 outlines the minimum wheat quality specifications for the 2015-2016 Rabi[7] marketing season.

Table 5. Grain Quality Attributes

Attribute	**Maximum Allowed Percent**
Moisture	12-14 discounted, >14 rejected
Foreign Matter	0.75
Poisonous weed seed	0.4
Of which: Dhatura	0.025
Of which: Akra	0.2
Other Food Grains	2.00
Damaged Grains	2.00
Slightly Damaged Grains	4.00
Shrivelled and Broken grains	6.00

When overall crop quality is poor in some states, the government will issue relaxation notices to reduce some of the quality standards needed for grain to be deliverable for government procurement (FCI 2016c). In the previous six year, relaxation notices have

[7] Rabi season, Rabi crops or Rabi marketing year refer to crops planted in the winter and harvested in the spring.

been issued in at least one state in every year. In the 2015-16 Rabi marketing year, they issued relaxations for all five major producing states.

Decentralized Procurement Operations

In each state, grain is procured by either the FCI directly or by a state agency working on their behalf (Balani 2014). In the case where grain is procured by a state agency, they are paid a commission fee by the FCI for collecting and warehousing this grain. Of the grain procured by these agencies, part is kept at the state level for distribution and sales to consumers through the PDS and some is moved by road or rail to deficit areas. These are typically areas where there is no wheat production or where production is insufficient to meet PDS obligations. The majority of the procured wheat is acquired in Punjab, Haryana, Uttar Pradesh, Madhya Pradesh and Rajasthan totaling 27.998 million metric tons in the 2015-16 Rabi marketing season, accounting for over 99% of all procurements (FCI 2016a). The FCI has a stated goal of always having a minimum quantity of food grains in the central pool as buffer stocks. Currently this quantity is 3 million metric tons. This quantity is kept on hand in case of a shortfall in production. A separate goal is to maintain the buffer stock norms at target levels that vary by quarter. Operational stock goals are much higher with a goal of 24.58 million metric tons on hand for July 1, 2015[8]. Operational stocks are strictly related to the public distribution system requirements within the span of a marketing year.

[8] July 1 is the start of the first quarter after the procurement season, so stocks are likely to be at the largest level of the marketing year at that time.

Public Distribution System

The Public Distribution System (PDS) in India is currently the main way food grains, including wheat, and other products[9] get distributed to the poorer segments of the population across the country (Ramaswami 2005). The focus here is only on wheat, but other grains and products are available. The current targeted system began in 1997 as a reformed system that was intended to be more transparent and accountable because the old PDS was seen to be rampant with fraud, abuse, and huge inefficiencies (Kattumuri 2011). The previous PDS was accessible to the entire population, which began to be phased out in 1992. With the 1997 reform, the decision was made to only subsidize wheat to those determined to be below the poverty line (BPL). This determination is made at the state level and by the state governments (Ramaswami 2005). In this paper, PDS refers to the system before and after these reforms, unless otherwise stated.

The new system establishes different prices for those determined to be above the poverty line (APL) and those determined to be BPL. The current price for grain issues to APL citizens is Rs. 6.1 per kilogram.

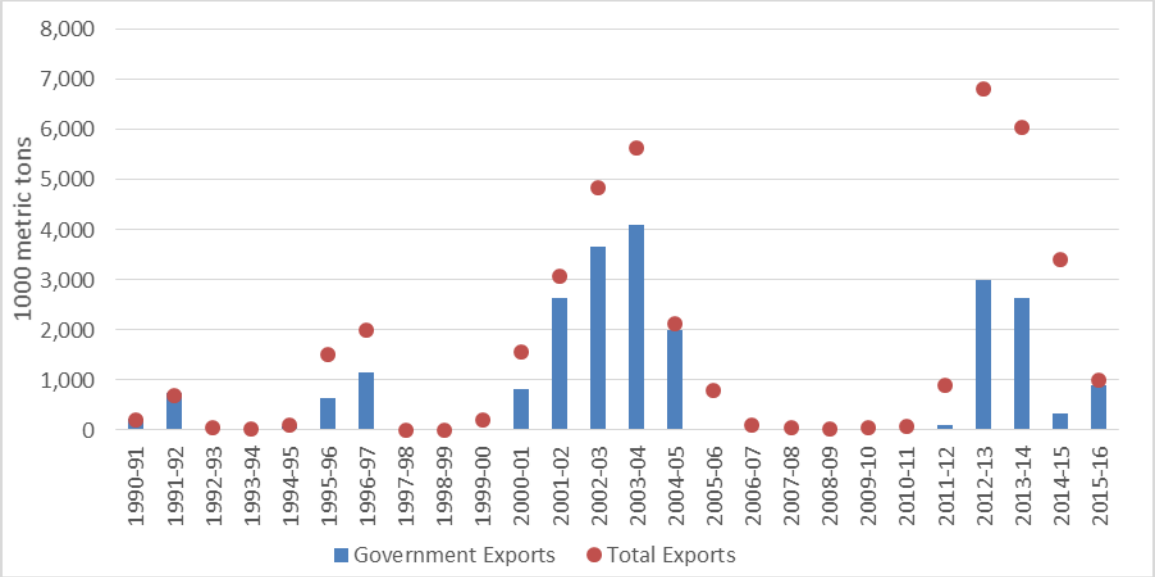
Studies have been conducted (Khera 2011), to assess the effectiveness of this system. These studies report varying levels of success across states and cases of fraud and abuse. Recently some states have taken it upon themselves to combat these problems. Gujarat is one of the states leading the fight against abuses of the PDS by implementing a biometric system to match people with their ration cards, reducing the number of ration cards by 1.6 million between 2010 and 2012 (Mahurkar 2013).

[9] Main products available through the PDS are wheat, rice, and kerosene, although there are many more.

In December of 2000, a new level of the PDS was introduced to target the “poorest of the poor” population. This policy change reflects the argument that this segment of the population is poor enough that BPL issue prices are still too high for them to afford. Under this Antyodaya Anna Yojana (AAY) scheme, these recipients are eligible to receive 35 kilograms per household of rice each month at a price of Rs. 2 per kilogram (Mayilvaganan and Varadarajan 2012). Unlike the regular TPDS, the cost of distribution and margin for the Fair Price Shop is paid by the state so the full value of the subsidy reaches the poor and the price stays at Rs. 2 per kilogram.

The states get their grain from the FCI at the CIP, the price at which grain is transferred from the FCI’s stocks to the state governments for sales in the FPS (Balani 2014). This is one way the FCI recovers part of the cost of operating their central procurement and distribution programs. The other two mechanisms for recovering costs are through Open Market Sales Schemes (OMSS) whereby the FCI sells grain out of government stocks into either the domestic or export market. The export option is used only sporadically. Figure 1 shows the level of total exports and the quantity that was exported by the government, including OMSS and non-OMSS sales, through 2015-16. In recent years, private exports have grown to account for a larger share of the total than in the past because of reduced restrictions on private exports.

Figure 1. Government Exports and Total Exports



The National Food Security Act

On September 10, 2013, Parliament passed the National Food Security Act (NFSA) to "…provide for food and nutritional security in human life cycle approach, by ensuring access to adequate quantity of quality food at affordable prices to people to live a life with dignity and for matters connected therewith or incidental thereto" (Government of India 2013). Instead of allowing the states to design the cutoff for subsidy benefits, the NFSA explicitly states that 75 percent of the rural population and 50 percent of the urban population are eligible to receive subsidized grain (Government of India 2013, 3). The actual number of people eligible is determined by multiplying the percentages above by the official census figures for a given state. Every person belonging to this group, known collectively as "priority households" under the law, is entitled to 5 kilograms of food grain per person per month at the subsidized prices[10] determined by the Central Government.

[10] For wheat, the subsidized price is 2 rupees per kg until September 2016. The price after that will be set by the central government, but according to the law it shall not exceed the minimum support price for wheat.

Those covered under the Antyodaya Anna Yojana Scheme (AAY) are entitled to an additional 35 kilograms of food grain per household per month. The number of eligible people is calculated at the state level and then notified to the central governments. It is the responsibility of the central government to move grain between states as necessary to make available the amount of food grains needed in each state. The notifications of total eligible people is intended to help ensure efficient movement of grain by the central government. Allocations are made according to the quantities outlined in the law and shown in Table 7 until the central government is notified by each state government of the number of eligible people. In the case of a shortage of grain in the central pool, the law compels the central government to transfer money to the state governments in the amount necessary to meet their food availability obligations as outlined in the NFSA. If for some reason grain cannot be supplied, the government is authorized to make a payment to the people entitled to the unavailable grain.

Loss of food grains due to inadequate or improper storage has been a large problem historically and is often mentioned when critiquing the food policy of India. The NFSA takes action to correct this known problem. It states "…every state shall, create and maintain scientific storage facilities at the State, District and Block levels, being sufficient to accommodate food grains required under the TPDS and other food based welfare schemes" (Government of India 2013, 9). The FCI is constructing modern silos with a combined capacity of 10 million metric tons to be completed by 2020 (Press Information Bureau 2016) at the pace indicated in

The NFSA also outlines some goals for advancing food security. These goals are to revitalize agriculture, improve living conditions for the population and, the goal relevant to this study, make the procurement, movement and storage of grain more efficient. To accomplish this last set of objectives, the law incentivizes decentralized procurement

and encourages procurement operations to be as geographically diverse as possible with grain stored in modern scientific facilities. Encouraging geographically diverse procurement is intended to lessen the transportation needed to move food grain from storage to the fair price shops, reducing transportation costs to the government. When food grain is to be moved, the law encourages grain to be given the highest priority for movement and for rail companies to make available sufficient cars and line capacity to make movements quick and efficient.

Under the previous PDS, ration card abuse was prevalent and is discussed in almost any study of the PDS or leakage of food grains and in the media (TNN 2015; Vijapurkar 2016; IndianExpress 2015; Sriraman 2011; Dreze and Khera 2015; Rosengard 2009). To illustrate how large this problem can become, when the state of Chhattisgarh was implementing its Food Security Act, there were more ration cards issued than there were households in the state (Bhardwaj 2014). The state government conducted a thorough review soon after the Act was implemented and eliminated 1.4 million ration cards (ibid). Some studies offer solutions to these problems or at least suggest ways to reduce leakage and fraud through increased use of technology (Garg and Sundar 2013; Muralidharan, Niehaus, and Sukhtankar 2014). The NFSA sets out guidelines for states to pursue to reduce this fraud. These guidelines include use of biometric information to match ration cards to actual people and employing technology to record and coordinate transactions to make the entire system more transparent and efficient (Government of India 2013).

Table 6. Addition of Storage to Existing Capacity of Covered Storage

Year	Capacity Added (million metric tons)	Estimated Total Capacity (million metric tons)
As of March 31, 2015		28.5
2015-16	0.5	29.0
2016-17	1.5	30.5
2017-18	3	33.5
2018-19	3	36.5
2019-20	2	38.5
Source: Press Information Bureau 2016, FCI Annual Report 2014-15		

Table 7. Initial State Allocation of Food Grains under NFSA

State Name	**Quantity (million mt)**	**State Name**	**Quantity (million mt)**
Andhra Pradesh	3.210	Mizoram	0.066
Arunachal Pradesh	0.089	Nagaland	0.138
Assam	1.695	Odisha	2.109
Bihar	5.527	Punjab	0.870
Chhattisgarh	1.291	Rajasthan	2.792
Delhi	0.573	Sikkim	0.044
Goa	0.059	Tamilnadu	3.678
Gujarat	2.395	Tripura	0.271
Haryana	0.795	Uttar Pradesh	9.615
Himachal Pradesh	0.508	Uttarakhand	0.503
Jammu & Kashmir	0.751	West Bengal	3.849
Jharkhand	1.696	Andaman & Nicobar Is.	0.016
Karnataka	2.556	Chandigarh	0.031
Kerala	1.425	Dadra & N. Haveli	0.015
Madhya Pradesh	3.468	Daman & Diu	0.007
Maharashtra	4.502	Lakshadweep	0.005
Manipur	0.151	Puducherry	0.050
Meghalaya	0.176		

The Consumer Side of the Public Distribution System

Consumers access their food rations though the use of their ration cards at a FPS. These ration cards are issued by the state according by what class of subsidy the recipient qualifies to receive (APL, BPL, etc.). The distinctions between classes used to

be set by each state, but now under NFSA rules, it will be determined by the central government, as stated earlier. As of 2011, there were over 500,000 FPSs in all of India (PIB, GOI 2016). They not only distribute food grains such as wheat and rice, but also sugar, kerosene, and other goods.

Domestic Market Restrictions

The Essential Commodities Act of 1955 regulates the "production, supply and distribution of, and trade and commerce, in certain commodities." This Act identifies the many commodities it covers, ranging from industrial inputs like coal and its derivatives to agricultural products, paper and newsprint. The main provisions of this act are the ability to regulate how these commodities are moved, whether they can be hoarded[11] or not and how to pay citizens for confiscated commodities, if necessary.

[11] In the law, no explicit definition is given for what amount may be considered hoarding.

The Market for Wheat

Area, Yield and Production

Wheat area in India has been growing steadily since 1950, and reached just under 31 million hectares in 2014-15 (Figure 3). This accounted to 25 percent of the 122 million hectares used for cultivation of food grains in 2014-15 (Figure 2). These data indicate that total crop area for food grains has changed little since the mid-1970s, staying around 125 million hectares. Wheat production has increased dramatically over the same time period (Figure 4) as yields have more than doubled since the mid-1970s largely due to better wheat seed varieties as well as increased use of irrigation and fertilizer (Tripathi 2013).

Reserve Bank of India (RBI 2016) data indicate the location of production and total procurements. Eight states account for over 90 percent of production of wheat in India (RBI Stats). These states are, in alphabetical order: Bihar, Gujarat, Haryana, Madhya Pradesh, Maharashtra, Punjab, Rajasthan and Uttar Pradesh. Not surprisingly, these states also are where most of the wheat is procured by either the FCI or a state agency acting on its behalf (India 2015). In fact, on average from 2010-11 to 2014-15, five states accounted for 98.8 percent of the wheat procured by the FCI or similar state agency. These five states are, in alphabetical order: Haryana, Madhya Pradesh, Punjab, Rajasthan and Uttar Pradesh.

Share Procured

On average, 31 percent of the total wheat production in India between 2010-11 and 2014-15 was procured for government distribution. This share varies from year to year and within that time period it ranged from a low of 26 percent in 2010-11 to a high of 41

percent in 2012-13. When looking historically, the share of production that was procured has been much lower. From 1980-81 to 2009-10, an average of just 19 percent of production was procured, ranging from a low of 11 percent to a high of 31 percent. To aid in procurement, the government has the ability to limit private movements of grain through the Essential Commodities Act of 1955 (Government of India 1955). This restriction can lead to larger regional differences in prices (removing arbitrage opportunity), making it easier and cheaper for the government to procure wheat in certain regions such as in the major producing states. Although, these provisions have not been used lately, they remain on the books. Anti-hoarding language included in the Act has partly contributed to the low levels of private stockholding since it could represent a threat to their operations.

Where wheat is procured and where it is consumed are, for the most part, not the same locations. In order to geographically balance out supply and demand, the FCI moves grain from the surplus areas to deficit areas. During the 2014-15 marketing year, Punjab shipped out 22.181 million metric tons of food grain to other states according to FCI records on movements of food grains. The food grain moved from the seven states in which procurement occurred totaled almost 41 million metric tons that year.

Export Trends and Policies

Exports of wheat have occurred under a few different regimes. The current environment is different from export practices of the past. Historically, exports were undertaken by the government through sales from the FCI to government agencies, such as the State Trading Corporation, for export (USDA GAIN various). This practice eventually gave way under political pressure to allow private exports. If the FCI accumulates stock levels well in excess of what they are estimated to need plus their buffer quantities, they will release

some of the grain through an OMSS. Under this scheme, grain is released from FCI warehouses for sale on the domestic market (OMSS-D) which can then either be used in the domestic industry or exported to the world market by private traders. Occasionally, the FCI will undertake export operations directly, also through the OMSS, but called OMSS-E.

Import Trends and Policies

Trade does occasionally flow the other way, though not nearly as often. Imports are undertaken by the FCI if authorities perceive a need, such as when stocks are deemed to be low. This last occurred in 2006 when approximately 6.7 million metric tons of wheat were imported due to low carry in stocks and low procurements. Stock levels beginning April 1, 2016 were at 2 million metric tons. Since 2006, India has imported only small quantities of wheat. As a national policy, they wish to avoid importing wheat and remain largely self-sufficient in wheat production. Currently wheat is imported mostly by private firms under the Open General License (OGL).

Industrial needs can also lead to imports when, otherwise, there would seem to be no need to import wheat. Flour millers need to have a minimum quality of wheat to meet specifications for the flour blends they are milling. If Indian wheat is of lower quality than their standards require, due to weather or other factors, it may be necessary to import higher quality wheat to blend. Imports of quality wheat usually come from Australia (USDA GAIN various).

At various points in history, India has used trade bans and tariffs to limit trade. Usually, the intended goal has been to protect domestic wheat production and maintain prices above the world price. This has helped the farmers but contributed to larger government expenditures on procurement and distribution efforts since the prices are higher.

Currently there is a 25 percent ad valorem tariff on wheat imports and no ban on exports (Clarke 2015).

The Grain Comes to Market

After harvest, farmers have a few options about where and to whom to sell their excess crops above what they choose to keep for own consumption. Between January and June 2013, 368 per 1000 agricultural households surveyed reported selling wheat; 391 per 1000 reported growing wheat (National Sample Survey Office 2014). Those growing wheat for own consumption could possibly make up the difference. While there are several different options throughout the country for marketing grain, local options can be limited. There might, in some cases, be only one feasible buyer for a farmer. The available options include local private traders, mandi, input dealers, cooperative and government agency, processors or other outlets. According to the 70th NSS, between January 2013 and June 2013 wheat entered the market through the following outlets: 29 percent private trader, 44 percent mandi, 7 percent input dealer and 19 percent cooperative or government agency (National Sample Survey Office 2014). No farmers reported selling wheat to a processor or other outlets. This is not out of line with what was expected since 19 percent reported selling directly to go a cooperative or government agency and overall statistics show that on average between 20 and 30 percent of wheat production is procured for the PDS. The difference could likely be made up of intermediaries who purchased the grain from the farmer and then sold it to a procurement agency. While there are not data relating to these activities, the likelihood seems high, particularly in more remote regions where the procurement system might not be fully implemented.

Crop Insurance

Crop Insurance is currently available to Indian farmers and has been for many years. The first insurance scheme was introduced in 1972-73 for cotton (Raju and Chand 2008a). There has been much experimentation with types and forms of insurance since then both by government entities and by private insurance companies. The Pilot Crop Insurance Scheme (PCIS) was implemented in 1979 and operated until 1984 when the Comprehensive Crop Insurance Scheme (CCIS) became available beginning with the 1985 crop. The CCIS ran until 1999. Beginning with the Rabi crop in 1997, the Experimental Crop Insurance Scheme (ECIS) was launched to provide insurance to those farmers who did not have bank loans. Up to this point, the crop insurance schemes were available only to those who had taken out operating loans for their crop. ECIS operated for only one year and the knowledge gained from this experimental program was used to start the National Agricultural Insurance Scheme (NAIS) which still operates to this day. Farm Income Insurance Scheme and Weather/Rainfall Insurance have also been launched but do not have near the participation yet that some of the other insurance schemes have, partly due to those schemes not being available in all states and districts (Raju and Chand 2008b)

These various crop insurance schemes had many problems over the years. Initially they were available only to those who had bank loans. Also, introduction of the insurance has not been uniform; a particular scheme will launch in a limited number of states or districts, increasing in scope later. Knowledge of these crop insurance schemes can also be a factor limiting adoption. From January to June 2013, the National Sample Survey Office (2014) reports that per 1000 farmers surveyed, 959 of them did not insure their crops. Furthermore, of those who did not insure their crops, these data show that over 50 percent of them gave “not aware” or “not aware about availability of facility” as the

reason for not insuring their crop. Only 20 percent of those not insuring a crop did so because they were not interested or saw no need in it. These statistics show how, even recently, there are still many problems with the crop insurance system in India. Use of crop insurance, especially in wheat, is very low even today.

Recent discussions within the government and by Prime Minister Narendra Modi have focused on reworking the crop insurance system to provide more support to farmers and reduce some of the risk they bear. Among reform priorities announced are the expanded definition of disaster, lower premiums, making use of technology such as mobile phones/smartphones and has an aim to assess damages quicker so indemnities can be paid faster (PTI 2016b). The premiums are said to be reduced to 2 percent for summer crops and 1.5 percent for winter crops, like wheat (*Reuters* 2016). Technology is playing an important part in the new push for crop insurance as the government has already launched a new website and mobile application for the new crop insurance scheme (PTI 2016a).

Operating Loans

Many producers finance wheat production with some type of operating loan. The characteristics of these loans, their size and where they originate vary with size of farm (as measured by number of hectares cultivated). Loans to producers cultivating between zero and one hectare of land are mostly sourced from either agricultural or professional money lenders or relatives and friends according to the NSS 70th Round survey (National Sample Survey Office 2014). The proportion of operating capital borrowed from banks tends to increase as farm size increases, especially for the category of the largest farms that have 10 hectares or more. The distribution of money borrowed from

the government and cooperative societies tend to be relatively even across all land holding classes (ibid).

Taxes Levied on Sale of Grain

Some states levy taxes on the sale of grain in markets and this contributes to the costs incurred by the FCI in procuring grain. These taxes vary by state and can range from nothing up to 10 percent or more, as in Haryana and Punjab (Saini and Kozicka 2014). Because producers must receive at least the MSP by law, the FCI pays state taxes when it procures grain rather than illegally paying producers less than the MSP. These taxes are used as a way for states with wheat procurements to extract more funds from the central government. These taxes have been criticized as discouraging private trade and distorting markets (Bureau 2012).

Milling Industry

Most of the wheat consumed by humans is milled into flour by local small-scale millers. They custom mill wheat mostly for consumption at home, but also for feed use for those who have livestock. The wheat a consumer purchases either from the open market or acquired through the PDS system is usually brought to one of these small-scale millers for milling. This whole wheat flour is then used to make chapattis or rotis, which are Indian staple foods (Singh 2016).

As reported in the 2016 USDA Global Agricultural Information Network (GAIN) Report, the formal milling sector is estimated to mill 12 to 13 million metric tons, utilizing 40 to 50 percent of their milling capacity. Approximately 1000 medium sized flour mills, that mill flour for urban industry and retail sale, make up this sector. These millers get their wheat either on the open market or from the government through the OMSS-Domestic operations.

Feed Industry

Wheat is also used for feed, though to a lesser extent since human consumption accounts for the vast majority of use. Food, seed and industrial (FSI) consumption of wheat is roughly 20 times greater than the amount used for feed. Of the wheat used for feed, most of it goes to dairy cattle. Poultry and aquaculture account for some feed use also, but small amounts. (Singh 2016). Inferior quality wheat, which is not fit for human consumption, will occasionally be used whenever it is released by the FCI from their warehouses. Low quality FCI stocks going to feed use usually only happens during times of large government stocks. In this context, wheat becomes inferior due to being exposed to the weather as a result of stocks exceeding the FCI storage capacity. The presence of cheaper feed alternatives, such as corn and other coarse grains, helps to limit wheat use for feed.

Figure 2. Area under Food grain Cultivation

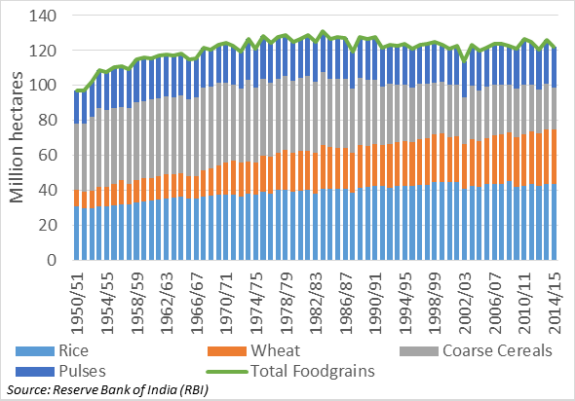


Figure 3. Wheat area cultivated

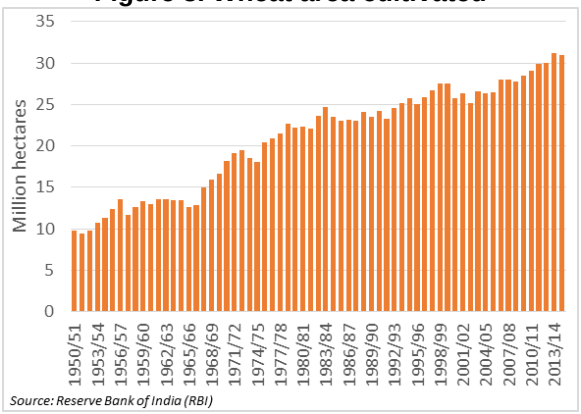


Figure 4. Wheat Yield in India

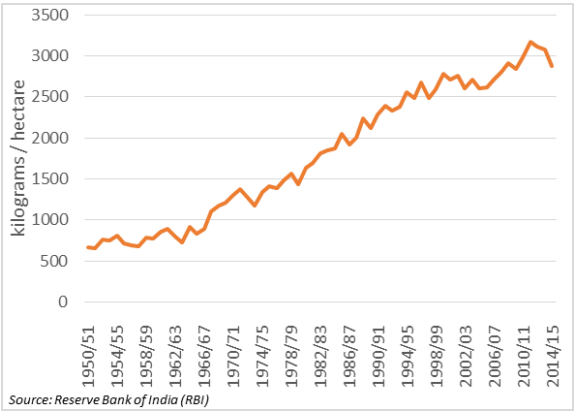


Figure 5. Wheat Production, Procurement, and Share Procured

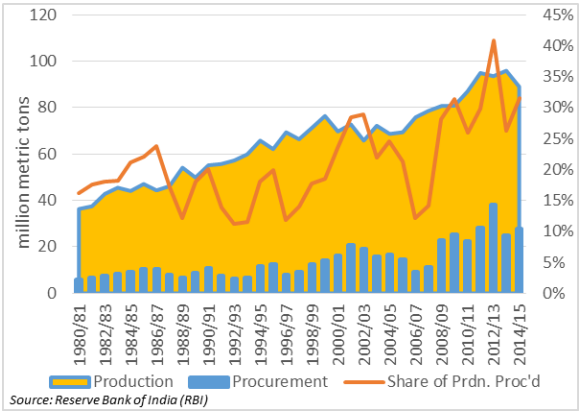


Figure 6. Wheat Production by Major States and Others

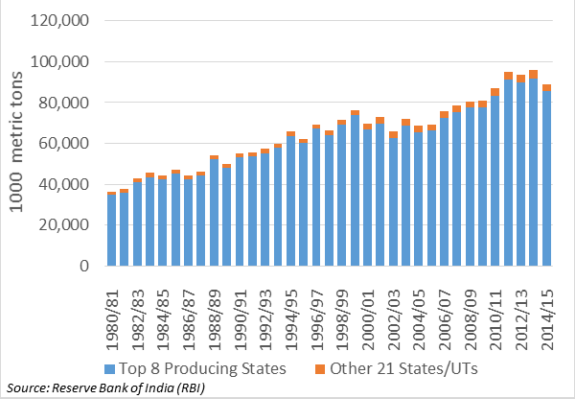
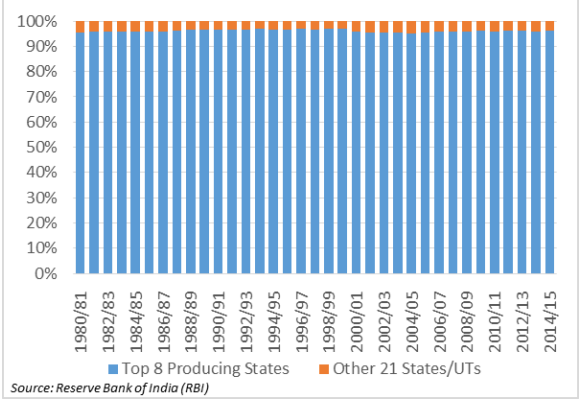


Figure 7. Main Producing States' Share of Total Production



Modeling Indian Wheat Production, Utilization, Stocks and Costs

Idea behind modeling

The equations listed in this section represent supply and demand in the Indian wheat market, along with the relevant government policy variables, to assess the impact of changing procurement policy on the domestic market and government costs. The independent variables in each of these equations are consistent with economic theory about what drive decisions. The signs of the coefficients of these variables are correct according to economic theory. These conditions are not only important for sound economic analysis but also needed to ensure the model solves correctly and arrive at an equilibrium price that balances supply and demand. Below, each of the equations used in this model is discussed in more detail. On the supply side, only one representative equation for area and yield is shown to give an understanding of the structure. A more complete list of the parameters and elasticities used for each state or other region are in the appendix.

Data

The data for this model are based on the India wheat supply and use data available from the USDA PSD. These data are used as the starting point, to which other data are added to achieve the detail desired. Area, yield and production data for all states are from the Reserve Bank of India. The historical competing crop yields as well as farm harvest prices come from the Directorate of Economics and Statistics, Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Government of India. Procurement, offtake and stock quantities are also from the Reserve Bank of India. FCI annual reports supply the data on total offtake by welfare class, the effective subsidy cost to the government for each class, government OMSS

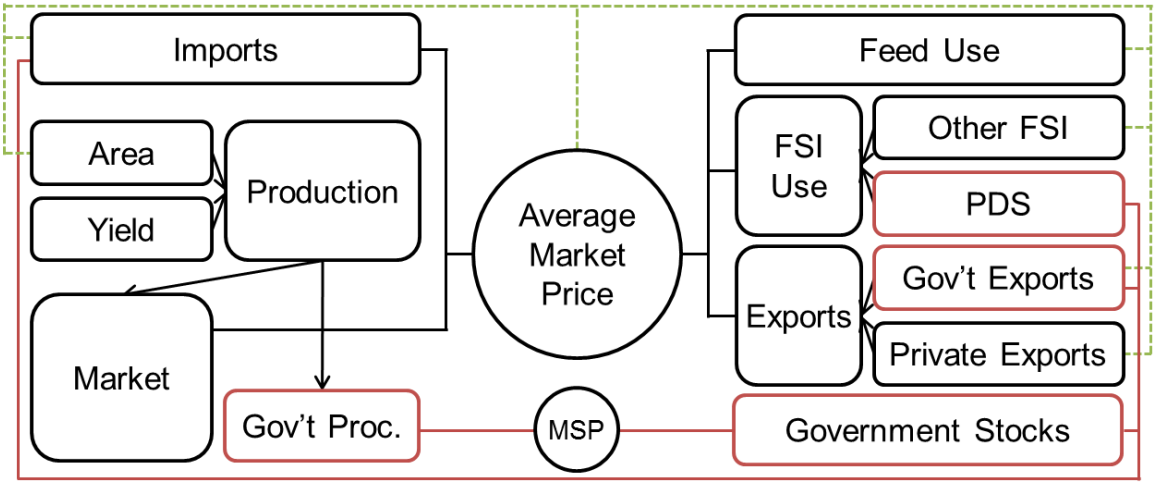
quantities and the value of the wheat consumer subsidy. The Department of Food and Public Distribution's "At a Glance" publications provides the procurement quantities by state. Retail prices are sourced from the Retail Price Query Report System by the Directorate of Economics and Statistics, Government of India.

Exogenous variables such as GDP, exchange rate, consumer price index, GDP deflator, international wheat prices, and livestock units are from the World Agricultural Economic and Environmental Services (WAEES) November 2015 forecast (World Agricultural Economic and Environmental Services 2015).

Model Description

The model outlined next is a partial equilibrium model, projecting the supply and use of wheat in India. Figure 8 shows how the supply, demand, prices and government policy components interact. It is comprised of equations to represent each of the components of supply (area, yield, stocks and imports) as shown on the left hand side, demand (feed, FSI, exports and stocks) as shown on the right hand side and relevant government variables (procurements, policy prices, government exports, stocks, costs and distribution quantities) as shown in red. The average market price will change until supply and demand quantities balance. The model calculates total government costs of the wheat portion of the PDS. This model is then used to estimate the change in government costs of changing the procurement policy to only procure wheat in the quantity necessary for distribution in the upcoming year. Each equation is now covered in more detail.

Figure 8. Model Overview



Area Equation

There are three equations and two identities that make up the supply side of this Indian wheat model. These equations represent area, yield, production, imports and beginning stocks. Area is modeled as a function of lagged area and expected real gross crop returns both of wheat and competing crops. Lagged area is included because crop area allocation cannot be changed entirely in one year for a variety of reasons, which could include specific investments, cropping rotation choices or other commitments. Area is modeled for each of the major wheat producing states: Bihar, Gujarat, Haryana, Madhya Pradesh, Maharashtra, Punjab, Rajasthan, Uttar Pradesh and Other States. The elasticities used for lagged area, own gross returns and competing crop gross returns are from the Cereal Outlook Model (Parappurathu et al. 2014) and imposed for the selected states based on their geographic location within the country. Parappurathu et al. estimate wheat area in six regions[12] instead of by state. Their elasticities for area were originally estimated outside the system using data from the Indian Directorate of Economics and Statistic's *Agricultural Statistics at a* Glance publication for the period

[12] These regions are North, South, East, West, Hills, and North-East.

1994/95 to 2010/11. These elasticities are estimated by fitting acreage response models by crop and region using time-series data (ibid). The final elasticities were a combined result of these initial estimations and calibration. The exact estimation methods are not reported in the paper but it is stated that the elasticities were estimated “using appropriate methodologies” (11). Table 8 shows the short run elasticities imposed, their implied long run elasticities and one set of coefficients of this model equation. Table 47 reports coefficients and elasticities for all states.

Table 8. Area Cultivated Equation and Parameters

Area Cultivated			
Coefficient	Variable	SR El.	LR El.
4,032.83	Intercept		
0.56	* Lagged Area	0.549	
12.29	* (max(lagged Wheat price, MSP)/DEFL) * E(Yield)	0.048	0.108
-7.44	* (max(lagged Rapeseed price, MSP)/DEFL) * E(Yield)	-0.024	-0.053

Yield Equations

For the purposes of this model, yield is estimated at a function of trend, omitting some variables that other studies have used such as rainfall index, lagged gross crop returns and price. This specification captures the improvements in technology and wheat seed varieties over time and their contributions as a whole to increasing yields across time. Rainfall, while likely important to the variation in yields, is not included in the yield equation here even though it has been included in previous studies. The equation fit to historical data, as measured by r-squared, of each yield equation is reported in the appendix. Inclusion of a rainfall term would likely improve the equation fit to historical data but presents a problem for projections.

Two parts are needed to include weather as a variable in predicting yields. The first is data for each state represented in the model. Accurate rainfall data are difficult to find at

the state level for a long enough period to use in estimation. Some weather data are available more recently, but as the equations were estimated over yields between 1997 and 2012, continuous data for the full period proved difficult to obtain. The second part is future weather. Since future weather is largely unknown, especially 15 years into the future, assumptions would need to be made about the weather going forward. Weather prediction is beyond the scope of this paper. For example, weather might have been assumed to be a continuation of historical trends for the future projections. Had weather been included in this way, both yield impacts from technology and weather would have been driven by a trend for the future projection. In this example, adding weather would not add economic content to the model or affect the policy scenario results. Due to both of these considerations, and the assumption that weather is not to change in the scenario, it has been excluded from the yield equation, in favor of estimating and projecting yields as a single trend only. Table 9 shows a representative yield equation of this model. Table 48 reports coefficients for all states.

Table 9. Yield Equation

Yield			
Coefficient	Variable	SR El.	LR El.
2,280.67	Intercept		
30.50	* trend	0.211	

Production Equation

Production is modeled as an identity, the product of area and yield. Table 10 shows this identity for a specific state, while Table 11 shows that these state production levels aggregate to the national total production quantity.

Table 10. State Production Identity

Production			
Coefficient	Variable	SR El.	LR El.
1.00	Area Cultivated		
1.00	Yield		

Table 11. National Production Identity

Production, ALL INDIA			
Coefficient	Variable	SR El.	LR El.
1.00	Production, Bihar		
1.00	Production, Gujarat		
1.00	Production, Haryana		
1.00	Production, Madhya Pradesh		
1.00	Production, Maharashtra		
1.00	Production, Punjab		
1.00	Production, Rajasthan		
1.00	Production, Uttar Pradesh		
1.00	Production, Other States		

In order to facilitate calculations of government costs associated with the PDS for wheat, the government procurement levels are needed. Procurement is estimated at the state level, for the same states mentioned before, as a share of total state production using the wholesale wheat price to MSP difference, as shown in Table 12. As the wholesale price approaches the minimum support level, on average, we would expect more grain to be sold to the government at the minimum support price. The three part equation allows procurements to be more or less responsive at different MSP-wholesale prices to account for differences of market operations between states. The sign on these variables are expected to be positive since as the wholesale price moves away (negative change) from the minimum support level, less procurements are anticipated as producers will seek other markets for their grain where there are higher prices to be received.

Table 12. Procurement Share Equation

Procurement Share			
Coefficient	Variable	SR EL.	LR. EL
62.71	Intercept		
0.001 , 2.75	+ Max(0, b1a*(b1b*MSP-WSL Price))		
0.001 , 1.65	+ Max(0, b2a*(b2b*MSP-WSL Price))		
0.001 , 0.99	+ Max(0, b3a*(b3b*MSP-WSL Price))		

Domestic Use

One method to model the PDS offtake as more-or-less an accounting equation. The calculation would multiply the portion of the population using a particular government program and their eligible offtake for that program, and then sum across all programs. This method is difficult in practice. Data about the exact proportion of people utilizing each program are not regularly available, making this calculation impossible. The massive number of illegal ration cards that have been distributed or used in that past would make the estimation, in this case, very difficult. The exact number of these cards is unknown, leading to estimation problems and likely large errors. As ration cards and record keeping become digital, the data for this method may become available. In this model, PDS offtake is specified as a function of population only, as shown in Table 13. This specification is consistent with policy going forward, namely to target a fixed share of the population with a set ration amount. Small fluctuations could occur as the prices of wheat and substitute grains fluctuate relative to one another.

Table 13. Public Distribution System Offtake

Food Use, PDS (PDS OFFTAKE)			
Coefficient	Variable	SR El.	LR El.
2,740.60	Intercept		
0.02	Population		

Since data are available for the amount of wheat that was issued to FPSs under the PDS, FSI use is decomposed into PDS offtake and Other FSI Use. This other use includes wheat that is used for seed in the upcoming year, food consumption of wheat above what is received from the PDS system and industrial demand for wheat, mostly by the milling sector. This Other FSI Use is modeled on a per capita basis and GDP/Population is used as a proxy for per capita income. Within the diet, wheat and rice usually compete with one another to supply carbohydrates, giving reason to include the real rice price in this equation, as shown in Table 14. When the rice price increases relative to the wheat price, it is expected that consumers would substitute, to some degree, the cheaper grain for the more expensive one. The elasticities for food demand are used from the Cereal Outlook Model (Parappurathu et al. 2014) where they were estimated for the period 1994/95 to 2010/11 using household consumption data and the Almost Ideal Demand System (AIDS). It is noted the final elasticities come from model calibration. The data for food use used in the Cereal Outlook Model also come from the USDA PSD Database.

Table 14. Other FSI Use Equation

Other FSI Use

Coefficient	Variable	SR El.	LR El.
-3.59	Intercept		
0.00	PDS		
-0.26	* LN(Retail Price Wheat/CPI)	-0.198	
0.06	* LN(Retail Price Rice/CPI)	0.046	
0.04	* LN(Real GDP/Population)	0.020	

Some wheat is use for the domestic livestock industry, though not as much as might be used in other countries. In India, wheat is primarily a food grain. The wheat that is fed usually goes to dairy cattle, aquaculture or poultry as noted previously.

Feed use in this model is specified as a function of lagged feed demand, an animal index measure and the average real price of wheat, as seen in Table 15. An animal unit index is included in the feed equation to capture the change in feed demand arising from a change in animal numbers or a change in the composition of the animal population in India. It is expected that, assuming no change in the feed ration, an increase in animals would result in a corresponding increase in demand for wheat for feed of the same proportion. Parameters for this equation are estimated using OLS and the regression output is included in the Appendix. One limitation of this specification (exogenous animal index) is that there is no response in the animal index number as the price of wheat changes.

Table 15. Feed Use Equation

Feed Use			
Coefficient	Variable	SR El.	LR El.
-4.07	Intercept		
0.38	* lagged feed demand	0.354	
0.11	* Animal Index	1.000	
-118.08	* Average Wholesale Wheat Price/CPI	-0.350	

Finally, since USDA PSD data were used as the basis for supply and demand, FSI use must be aggregated to be consistent with the reported value. Table 16 represents this aggregation within the model as an identity.

Table 16. Food, Seed and Industrial Use Identity

FSI Total			
Coefficient	Variable	SR El.	LR El.
1.00	PDS Food Use		
1.00	Other FSI		

Trade

Exports occur in one of two ways, as noted earlier; either the government exports the grain, or private traders export in response to the market conditions subject to government imposed restrictions, such as tariffs or bans. For this reason, the exports are disaggregated into one equation representing government exports (Table 17) and another equation representing other exports (Table 18). Because government exports are taken from the central pool, and occur when stocks are very large, lagged ending stocks relative to the stated desired minimum stock levels are used to help predict these exports. While the government does not have to make money on their exports, prices would play a role if government exports are not intended to be heavily subsidized. This potential for price sensitivity justifies including the real export margin in this equations, although the estimated coefficient suggests only minimal impact. For private traders, exports are driven by the profit opportunity available by exporting grain, subject to any government imposed bans. Included in this equation is the real export margin, and an indicator of the presence of an export ban. This last variable forces private exports to zero when the government imposes a ban, as was the case for part of marketing year 1996/1997 and again from 2007 to 2011. The ban variable is structured such that it can be imposed for a certain number of months per year because the export bans historically have been imposed mid-year. These equations are estimated using OLS for the relevant years. Their regression output is in the Appendix.

Table 17. Government Exports Equations.

Government Exports			
Coefficient	Variable	SR El.	LR El.
-752.71	Intercept		
0.06	* (World Price* Exchange Rate/DEFL - Domestic Price/DEFL)		
0.77	* Lagged Ending Stocks/Buffer Norm		

Table 18. Other Exports Equation

Other Exports			
Coefficient	Variable	SR El.	LR El.
-3,344.05	Intercept		
38.28	* (World Price * Exchange Rate/DEFL - Domestic Price/DEFL)	3.005	
	(BAN/12)*0 + (1-BAN/12)*SUM		

To match these export quantities back up with the USDA PSD supply and use numbers used as the base for this model, an identity sums the two components of exports and yields a total export quantity (Table 19).

Table 19. Total Exports Identity

Total Exports			
Coefficient	Variable	SR El.	LR El.
1.00	Government Exports		
1.00	Other Exports		

Similar to the case for exports, both government and private traders have the ability to import wheat. The government mostly imports wheat when stocks are low in the central pool, replenishing stocks so they are able to continue to meet the obligations of the PDS system. Private traders also import wheat for domestic consumption, part of which is a higher quality wheat used to supplement the domestically produced wheat used for milling (USDA GAIN various). Since data are not readily available for government imports, one equation was used to represent the actions of both of these entities, combining the explanatory factors into one equation (Table 20). The regression statistics for this equation are in the Appendix.

Table 20. Import Equation

Imports			
Coefficient	Variable	SR El.	LR El.
2,072.00	Intercept		
-0.16	* Lagged Ending Stocks/buffer norms		
-6.48	* ((World Price * Exchange Rate * Import tariff)/DEFL) - Dome	-14.444	
5,803.72	D_2006		

Government Stocks

Calculating government stocks is mostly an accounting exercise. In Table 21, calculations are reproduced that combine the stocks of the previous year, subtract a deterioration or loss factor, add current procurement quantity, add imports by the government, subtract PDS grain offtake and subtract government exports. The method of modeling government stocks is consistent with Kozicka et al. (2015). The deterioration rate helps account for some amount of shrinkage and normal loss encountered from normally storing grain and carrying from year to year.

Table 21. Government Stock Accounting

Government Stocks, May 31			
Coefficient	Variable	SR El.	LR El.
0.00	Intercept		
0.93	* Lagged Stocks		
1.00	* FCI Procurements		
-1.00	* PDS Food Offtake		
-1.00	* Government Exports		

Government Costs

Calculating the government costs of the wheat portion of the PDS program is also an accounting exercise once the costs are projected into the future. Table 22 shows the three major costs incurred by the government as it related to expenditures on the wheat portion of the PDS program. These unit costs are forecast using the CPI as they mostly consist of expenses such as labor, supplies, taxes or freight.

Table 22 Unit Costs at Various Stages of the PDS

Procurement Incidentals			
Coefficient	Variable	SR El.	LR El.
-29.48	Intercept		
1.68	* CPI		

Acquisition Cost			
Coefficient	Variable	SR El.	LR El.
-124.76	Intercept		
1.00	* Procurement Incidentals		
1.00	* MSP		

Distribution Cost			
Coefficient	Variable	SR El.	LR El.
17.35	Intercept		
2.03	* CPI		
-0.001	* Distribution Quantity		

To calculate total government costs (Table 23), the quantities procured, distributed, exported or held are combined with the associated unit cost to estimate the total cost of the program. These costs have been increasing over time and as of 2014, estimated to be Rs. 40,590 Crore[13] or 405.9 billion Rupees.

Table 23. Government Costs of the Wheat Portion of the PDS

Government Costs		
Coefficient	Variable	Units
-20,615.4	Intercept	
1.00	**+ Procurement Quantity**	**1000 mt**
1.00	** Economic Cost*	*Rs. / 100 kgs*
1.00	**+ PDS Offtake [net offtake]**	**1000 mt**
1.00	** Distribution Costs*	*Rs. / 100 kgs*
-1.00	**+ Distribution Q**	**1000 mt**
1.00	** Central Issue Price*	*Rs. / 100 kgs*
-1.00	**+ Government Exports**	**1000 mt**
1.00	** Export Price*	*Rs. / 100 kgs*

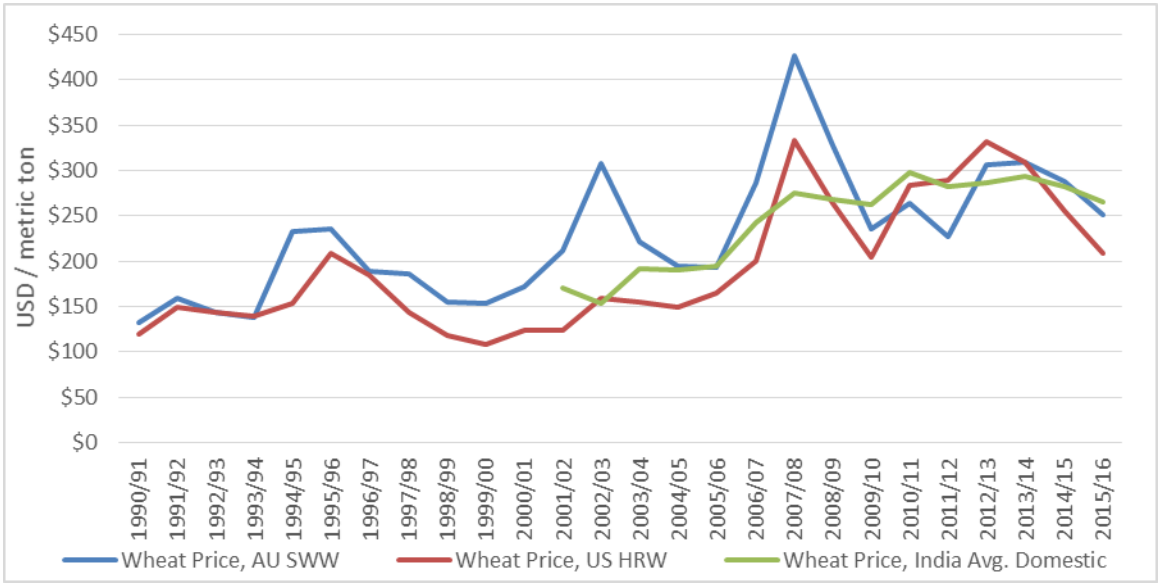
Prices

Markets respond to prices and getting these price signals correct are critical when modeling the market. The domestic industry can respond to prices in two ways. They can respond to a world price, in the case of a price taker, where the domestic price is the world price converted by the exchange rate and multiplied by any applicable tariffs.

[13] 1 Crore = 10,000,000

Alternatively, the country can react as though the market is autarkic. This latter structure is appropriate for the India wheat market in that prices tend to follow the world prices in path and direction, but do not respond directly to price fluctuations due to trade policy and government interventions (Dasgupta, Dubey, and Satish 2011). The authors estimate these world price relationships both with OLS and through a series of cointegration tests. These results all lead to the conclusion that India's wheat market functions more like an autarky than like an open market that readily responds to world wheat prices. When modeling the Indian wheat market, these test results suggest that it would be appropriate to use an internal India price when equating supply and demand and solving the market. This is the approach taken with the model in this study. As you can see in Figure 9, the domestic wheat price in India tends to move in the direction of the world wheat markets but does not display the same price dynamics experienced by the two international prices.

Figure 9: India Domestic Average Wholesale Price and International Wheat Prices



Since domestic Indian wheat prices tend not to respond fully to world prices and since the government plays a major role in the wheat market, a domestic price equilibrator

would be the best and most accurate representation of the market. Table 24 shows the summation of supply and demand; the balance or imbalance is noted. Price will adjust until the identity holds.

Table 24. Model Closure

Closure			
Coefficient	Variable	SR El.	LR El.
1.000	Opening Government Stocks		
1.000	Imports		
1.000	Production		
-1.000	Government Exports		
-1.000	Other Exports		
-1.000	PDS Food Use		
-1.000	Other Food Use		
-1.000	Feed & Residual Use		
-1.000	Closing Government Stocks		

Model Baseline

The equations presented in the previous section are calibrated to recent data and solve simultaneously to generate a baseline case of the Indian wheat market to 2030/2031. This baseline gives initial values of all endogenous variables against which the scenario in the next section will be compared to answer the research question posed in the beginning. Certain assumptions had to be made regarding exogenous variables going into the future. The exogenous assumptions and their values assumed are outlined in Table 28 and 29. The CIPs are assumed to continue at the current levels while the MSP is assumed to grow 4 percent annually. The growth of the MSP is similar to that experienced in the previous 4 years. Table 25 and 26 present the baseline supply and use balance and the costs corresponding to the model baseline. In this baseline, area is expected to grow from 29.30 million hectares in 2016/2017 to 30.45 million hectares in 2013/2031. Yield is also expected to grow over the baseline period at an annual rate of almost one percent. Growth in both yield and area leads to production increasing at a rate of 1.2 percent per year, from 91.25 million metric tons to 109.12 million metric tons by 2030/2031. Every category of wheat use is projected to grow except other exports. Since the world price of wheat and the domestic price of wheat diverge in the baseline (domestic India price is higher), there is no incentive for private traders to export wheat. Other export quantity goes to zero by 2025. However, since the government accumulates stocks under the baseline, the government exports a growing amount of wheat as stocks accumulate. Prices in the baseline grow at an average annual rate of 5.9 percent, similar to the 6 percent average annual rise in prices seen from 2002 to 2015. The estimated difference between the average wholesale price and MSP starts at 265 Rupees per 100 kilograms and grows to 1225.24 Rupees per 100 kilograms by 2030/31.

Total procurement quantity grows at an annual rate of 1.76 percent, starting at 28.50 million metric tons in 2016/17 and grows to 37.00 million metric tons by 2030/31. This quantity of grain being procured by the government has costs associated with it. The first cost associated is the acquisition cost. These costs represent the MSP paid for the grain and the other charges related to this transaction such as labor, market charges and initial transportation costs. Further costs are incurred after the grain is initially purchased and moved. These costs are called distribution costs and represent expenses such as freight, handling, storage, interest and losses. The acquisition expenses are incurred on every unit purchased where the full distribution expenses are incurred only on the units allocated to states under the PDS. Some of the costs are recovered when the grain is issued to the states or when grain is sold out of government stocks. The net cost to the government from operating the wheat portion of the PDS grows from 527 billion Rupees in 2016/2017 to 1,530 billion Rupees in 2030/2031. Costs of this program as a percent of GDP are approximately 0.4 percent each year of the baseline, similar to the cost share since 2013.

Table 25. Baseline Supply and Use

India Wheat Supply and Use

April-March Marketing Year	Units	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31
Area Harvested	1000 ha	30,000	31,190	30,970	29,298	29,256	29,285	29,355	29,448	29,547	29,656	29,760	29,865	29,968	30,071	30,172	30,267	30,359	30,451
Yield	mt / ha	3.153	3.123	2.847	3.115	3.149	3.183	3.216	3.250	3.283	3.317	3.350	3.384	3.417	3.450	3.483	3.517	3.550	3.583
Supply	1000 mt																		
Production	1000 mt	94,589	97,413	88,164	91,248	92,116	93,202	94,415	95,705	97,015	98,365	99,702	101,050	102,395	103,748	105,102	106,441	107,778	109,120
Beginning Stocks	1000 mt	24,210	17,830	17,220	14,854	12,933	11,072	9,618	8,735	8,465	8,668	9,381	10,503	12,020	13,863	15,869	17,963	20,133	22,381
Imports	1000 mt	25	52	500	561	580	620	658	704	709	735	738	744	737	728	710	696	678	661
Use	1000 mt																		
Food, Seed & Industrial Use	1000 mt																		
PDS	1000 mt	29,077	26,436	28,337	28,330	28,597	28,862	29,125	29,384	29,640	29,891	30,139	30,382	30,621	30,856	31,086	31,310	31,530	31,744
Other (market)	1000 mt	61,064	63,737	57,493	59,176	59,661	60,153	60,653	61,247	61,780	62,402	62,988	63,598	64,185	64,783	65,417	66,037	66,642	67,234
Feed & Residual Use	1000 mt	4,800	4,500	4,200	4,569	4,798	4,973	5,128	5,284	5,441	5,608	5,782	5,964	6,150	6,341	6,536	6,734	6,935	7,143
Exports, Government	1000 mt	2,636	327	890	1,027	783	585	393	243	152	124	145	218	334	490	679	886	1,102	1,325
Exports, Other	1000 mt	3,417	3,075	110	628	719	703	656	519	509	361	265	115	0	0	0	0	0	0
Ending Stocks (Government)	1000 mt	17,830	17,220	14,854	12,933	11,072	9,618	8,735	8,465	8,668	9,381	10,503	12,020	13,863	15,869	17,963	20,133	22,381	24,716
World Price (US #2 HRW, US Gulf)	USD / mt	309	255	209	204	216	221	226	228	234	233	234	232	231	228	226	223	220	216
World Price*Exchange Rate	Rs / 100 Kgs	1,809	1,557	1,330	1,341	1,448	1,519	1,580	1,605	1,685	1,704	1,746	1,759	1,783	1,793	1,813	1,814	1,814	1,806
All India Price	Rs / 100 Kgs	1,721	1,723	1,689	1,867	2,013	2,162	2,316	2,465	2,631	2,791	2,965	3,143	3,334	3,532	3,730	3,940	4,162	4,396
Minimum Support Price	Rs / 100 Kgs	1,400	1,450	1,525	1,601	1,681	1,765	1,854	1,946	2,044	2,146	2,253	2,366	2,484	2,608	2,739	2,876	3,019	3,170

Note: Prices are in nominal terms.

Table 26. Baseline Costs

India Costs of PDS Attributable to Wheat

	Units	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31
Procurement Quantity	1000 mt	25,090	28,020	28,090	28,496	28,442	28,784	29,322	29,982	30,599	31,347	32,076	32,868	33,656	34,342	34,992	35,649	36,318	37,002
Economic Cost	Rs / mt	19,083	20,512	22,000	23,779	25,051	26,355	27,707	29,132	30,626	32,195	33,841	35,569	37,382	39,285	41,284	43,381	45,584	47,896
Distribution Cost	Rs / mt	3,508	3,869	4,422	4,130	4,388	4,641	4,898	5,170	5,455	5,753	6,065	6,393	6,736	7,096	7,474	7,871	8,287	8,724
Acquisition Cost	Rs / mt	15,575	16,644	17,577	19,649	20,663	21,713	22,809	23,962	25,172	26,442	27,775	29,176	30,646	32,189	33,809	35,511	37,297	39,172
Procurement Incidental Cost	Rs / mt	2,864	3,466	3,605	3,637	3,850	4,060	4,273	4,498	4,735	4,984	5,244	5,518	5,805	6,106	6,423	6,754	7,103	7,468
Minimum Support Price	Rs / mt	14,000	14,500	15,250	16,013	16,813	17,654	18,536	19,463	20,436	21,458	22,531	23,658	24,841	26,083	27,387	28,756	30,194	31,704
Cost of Procuring Wheat For Central Po	Rs Billion	479	575	618	678	712	759	812	873	937	1,009	1,085	1,169	1,258	1,349	1,445	1,547	1,655	1,772
Net Government Cost of PDS, Wheat	Rs Billion	396	406	448	527	542	589	643	703	765	834	905	982	1,064	1,146	1,233	1,325	1,424	1,530

Note: Costs are in nominal terms.

Table 27. Baseline Prices

India Wheat Price (Wholesale Level) by State

	Units	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31
Average Wholesale Price	Rs / 100 Kgs	1,721	1,723	1,689	1,867	2,013	2,162	2,316	2,465	2,631	2,791	2,965	3,143	3,334	3,532	3,730	3,940	4,162	4,396
Major Producing States																			
Bihar	Rs / 100 Kgs	1,384	1,400	1,451	1,546	1,672	1,800	1,932	2,060	2,204	2,342	2,492	2,645	2,809	2,979	3,150	3,331	3,522	3,723
Gujarat	Rs / 100 Kgs	1,858	1,755	1,951	2,015	2,166	2,320	2,478	2,632	2,803	2,969	3,148	3,332	3,529	3,732	3,937	4,153	4,382	4,623
Haryana	Rs / 100 Kgs	1,751	1,566	1,462	1,733	1,866	2,000	2,139	2,273	2,423	2,568	2,725	2,886	3,058	3,237	3,416	3,605	3,806	4,017
Madhya Pradesh	Rs / 100 Kgs	1,642	1,537	1,552	1,720	1,856	1,993	2,135	2,272	2,426	2,574	2,734	2,899	3,075	3,257	3,440	3,634	3,839	4,055
Maharashtra	Rs / 100 Kgs	1,983	2,004	1,797	2,102	2,266	2,432	2,604	2,771	2,957	3,136	3,331	3,530	3,743	3,964	4,186	4,420	4,669	4,930
Punjab	Rs / 100 Kgs	1,567	1,469	1,509	1,653	1,782	1,914	2,049	2,181	2,328	2,470	2,624	2,781	2,950	3,124	3,300	3,485	3,681	3,888
Rajasthan	Rs / 100 Kgs	1,560	1,528	1,576	1,694	1,826	1,959	2,097	2,230	2,379	2,523	2,679	2,838	3,009	3,186	3,364	3,552	3,751	3,960
Uttar Pradesh	Rs / 100 Kgs	1,485	1,480	1,516	1,625	1,748	1,874	2,004	2,129	2,270	2,405	2,552	2,702	2,863	3,030	3,197	3,374	3,561	3,759
Minor Producing States																			
Other States	Rs / 100 Kgs	1,721	1,723	1,689	1,867	2,013	2,162	2,316	2,465	2,631	2,791	2,965	3,143	3,334	3,532	3,730	3,940	4,162	4,396

Note: Prices are in nominal terms.

Table 28. Baseline Policy Price Assumptions

India Policy Prices

	Units	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31
Minimum Support Price	Rs / 100 Kgs	1,400	1,450	1,525	1,601	1,681	1,765	1,854	1,946	2,044	2,146	2,253	2,366	2,484	2,608	2,739	2,876	3,019	3,170
Central Issue Prices																			
APL	Rs / 100 Kgs	610	610	610	610	610	610	610	610	610	610	610	610	610	610	610	610	610	610
BPL	Rs / 100 Kgs	415	415	415	415	415	415	415	415	415	415	415	415	415	415	415	415	415	415
AAY	Rs / 100 Kgs	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
NFSA	Rs / 100 Kgs	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200

Note: Prices are in nominal terms.

Table 29. Baseline Exogenous Assumptions

India Model Assumptions

	Units	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31
Animal Index	Units	32,669	33,983	35,514	36,738	37,776	38,805	39,838	40,876	41,962	43,079	44,231	45,420	46,624	47,850	49,072	50,292	51,549	52,847
Macroeconomic Variables																			
Population	1000 persons	1,228,750	1,243,916	1,259,050	1,274,176	1,289,264	1,304,269	1,319,123	1,333,772	1,348,200	1,362,411	1,376,395	1,390,145	1,403,652	1,416,904	1,429,886	1,442,584	1,454,982	1,467,066
GDP	Rs Billion	99,211	106,440	114,166	122,677	131,927	142,015	152,944	164,787	177,464	191,027	205,532	221,035	237,597	255,281	274,153	294,284	315,746	338,615
GDP Deflator	Index	114	118	124	131	138	144	152	159	167	175	184	193	203	213	223	234	246	258
Exchange Rate	Rs / USD	59	61	64	66	67	69	70	70	72	73	74	76	77	79	80	81	82	84
Consumer Price Index	Index	199	211	222	234	247	260	272	286	300	315	330	346	364	381	400	420	441	463
Trade																			
Import Tariff	percent	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Export Ban	months	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Prices																			
International Wheat Price	USD / mt	309	255	209	204	216	221	226	228	234	233	234	232	231	228	226	223	220	216
Retail Rice Price	Rs / Kg	21	25	25	26	27	29	30	32	33	35	37	38	40	42	44	46	49	51
Rapeseed Wholesale Price	Rs / 100 Kgs	3,529	3,529	3,529	3,529	3,529	3,529	3,529	3,529	3,529	3,529	3,529	3,529	3,529	3,529	3,529	3,529	3,529	3,529

Note: Prices are in nominal terms.

Scenario Results and Analysis

Scenario Description and Implementation

In order to assess the impact of limiting wheat procurement to the anticipated level of offtake for the upcoming season on the domestic market and government costs, the following model changes were made to implement this alternative policy.

1. In each year, the procurement quantity is initially set equal to the PDS offtake. Model equations that estimate procurement based on historical experience are not used to project future procurements.
2. Stocking minimums were imposed to ensure that April 1 stocks never fell below 7.45 million metric tons, the stated minimum quantity to hold in stocks. In the event that stocks would otherwise fall below this threshold, procurements were increased to ensure this outcome would not happen.
3. The procured quantity is allocated back to each of the nine states according to the previous five year average percentage of procurements, ensuring these percentages total exactly one.
4. Price expectations in the area equations are changed too. The MSP will no longer function as a hard floor under the market price because the offer to buy all wheat at that price no longer exists. The price expectation is now the lagged price.
5. Setting government exports to zero. The scenario definition suggests there would be no need for the government to export wheat. Exports are undertaken now when there are large stocks as a result of high procurements. In the scenario, procurement quantity is limited to the PDS volume, all but eliminating the possibility of accumulating large stocks. An exception that could lead to exports

would be if the government consistently over estimates offtake of the PDS and acquires more grain than necessary.

6. Two import path options are built into the model. The main scenario sets import levels to a minimum amount, equal to the average level of the previous seven years[14]. One of the goals of Indian policy is to be more-or-less self-sufficient in wheat production. Allowing rising imports seems possibly counter to this goal. An alternative, allowing imports to fully respond to prices and stocks, is assessed for sensitivity.

Scenario Results

Tables 30 through Table 38 show the estimated scenario supply and use balance, estimated government costs under the policy alternative, and the change of prices under the scenario relative to baseline prices.

Limiting government procurements has an initial impact of leaving more wheat to be absorbed by the private market than would otherwise have been available. This extra supply pushes down scenario prices in the domestic market relative to the baseline prices. Domestic demand response limits the price decrease. Domestic food and feed use increases as prices fall. When the wheat market balances with lower procurement, there is lower acreage, production, stocks and prices. Acreage changes ranged from 0.1 percent increase in 2018-2020 to 1.1 percent decrease in 2030/2031 due to the lower prices. Changing price expectation for area only had an impact on area in 2016/17 one state. Bihar is this exception. Bihar market price is slightly below the MSP for 2016/17. In the rest of the scenario, the average market prices are estimated to be above the MSP. Production was also lower by approximately the same amount because yield was

[14] This period is chosen intentionally to exclude 2007 and 2008, when imports were higher than normal due to the low stock situation mentioned previously.

assumed to remain the same in both the baseline and scenario. Both wheat food and feed use of wheat change between one and three percent in the scenario relative to the baseline because prices were lower than in the baseline in later years.

The net effect of changing intervention and the response of demand and supply on prices is an average reduction of 4 percent through 2030/2031 and state level prices fell below the MSP in only one state. Prices are expected to be near the MSP (less than Rs 100 difference) for Bihar, Punjab and Uttar Pradesh for 2016/17. Prices are expected to rise above this difference in all states in 2017/18 with the exception of Bihar, where prices are expected to remain within Rs 100 until 2021/22.

The cost reduction of the wheat portion of the PDS program appears to be significant. Cost savings ranges from nothing to almost 11 percent between 2016/17 and 2030 with most of the savings coming in the later years. Total cost savings between now and 2030/2031 is estimated at 831 billion Rupees, or between -0.01 and 0.05 percent of GDP annually from 2016/17 to 2030/37. Equivalently, this policy change is estimated to cost about 10 Rupees per person for the next three years before savings are realized. Savings are then projected to grow to be 112 Rupees per person in 2030/31. While this may not seem like a significant amount, this small per capita amount becomes large when it is assumed that India's population will be near 1.4 billion people by 2030/31.

Sensitivity Analysis

The main results presented here and the cost saving estimated have some sensitivities that are worth noting. The import path is one unknown that has an impact on the domestic market. Table 39 shows the potential price impact if imports are not restricted, allowing them to respond to the market. Higher imports relative to the baseline or initial scenario means there is more wheat on the domestic market and prices are lower than

in the initial scenario. In the main scenario, domestic prices fall an average of 4 percent whereas in the sensitivity scenario, prices fall an average of 6 percent. With lower prices, there would be slightly less area and production. Use would be slightly higher than in the initial scenario due to the lower domestic price. One important feature of this alternative is that government costs are not anticipated to be significantly different because the same amount of wheat is procured and distributed in both cases. Table 39 shows the difference in the level of imports and percent difference in prices between the scenario and the alterative import option. The level of imports relative to domestic consumption is relatively small and the import sensitivity analysis suggests that the results presented in the main scenario are not particularly sensitive to the level of imports.

Feed use is another area where there could be some uncertainty. Since livestock units are exogenous to the model, there are not changes in the livestock herd or productivity as prices of feed change as would be expected if there are large changes in feed prices. Since wheat is not widely used as a feed ingredient in India, the expected impact of this is small.

Private stockholding is not modeled here for lack of data and the current crowding out of private stockholding by the government. If the government limited their actions in the market to procure only wheat needed for the PDS, then it is expected that private parties would start to hold stocks. One caution would be the rules regarding hoarding of food grains, which could act to limit the ambitions of private holders of wheat stocks.

Exogenous price assumptions further add uncertainty to this scenario as it is unlikely that a change in the wheat market would not be accompanies by impacts in other markets. These directly related markets are that of rapeseed, a competing crop, and of rice, a competing food grain. To give a sense of how sensitive this scenario is to changes in these prices, both prices have been shocked, the model re-solved and the

results are presented in Table 40 and Table 41 below. The impact of a 10 percent change in either the rapeseed price or the retail rice price moves the average wheat price by between one and two percent in either case. The direction of wheat price movement depends on the direction of the rapeseed or rice price movements. If the rapeseed price increases, wheat price is projected to increase relative to the main scenario price. The same directional effects apply to the change in the rice price too.

Table 30. Main Scenario Supply and Use

India Wheat Supply and Use

April-March Marketing Year	Units	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31
Area Harvested	1000 ha	30,000	31,190	30,970	29,245	29,242	29,321	29,397	29,467	29,529	29,601	29,658	29,719	29,773	29,865	29,944	30,006	30,064	30,120
Yield	mt / ha	3.153	3.123	2.847	3.115	3.149	3.183	3.217	3.250	3.283	3.317	3.350	3.383	3.417	3.450	3.483	3.516	3.550	3.583
Supply	1000 mt																		
Production	1000 mt	94,589	97,413	88,164	91,102	92,089	93,328	94,558	95,772	96,956	98,178	99,357	100,548	101,721	103,030	104,298	105,511	106,715	107,916
Beginning Stocks	1000 mt	24,210	17,830	17,220	14,854	13,793	12,808	11,894	11,044	10,256	9,523	8,843	8,212	7,626	7,460	7,460	7,460	7,460	7,460
Imports	1000 mt	25	52	500	157	157	157	157	157	157	157	157	157	157	157	157	157	157	157
Use	1000 mt																		
Food, Seed & Industrial Use	1000 mt																		
PDS	1000 mt	29,077	26,436	28,337	28,330	28,597	28,862	29,125	29,384	29,640	29,891	30,139	30,382	30,621	30,856	31,086	31,310	31,530	31,744
Other (market)	1000 mt	61,064	63,737	57,493	58,828	59,175	59,902	60,665	61,508	62,208	63,075	63,853	64,694	65,152	65,884	66,713	67,489	68,258	69,022
Feed & Residual Use	1000 mt	4,800	4,500	4,200	4,547	4,758	4,942	5,117	5,296	5,473	5,663	5,857	6,061	6,247	6,446	6,656	6,868	7,084	7,307
Exports, Government	1000 mt	2,636	327	890	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Exports, Other	1000 mt	3,417	3,075	110	615	701	693	657	529	525	386	297	154	23	0	0	0	0	0
Ending Stocks (Government)	1000 mt	17,830	17,220	14,854	13,793	12,808	11,894	11,044	10,256	9,523	8,843	8,212	7,626	7,460	7,460	7,460	7,460	7,460	7,460
World Price (US #2 HRW, US Gulf)	USD / mt	309	255	209	204	216	221	226	228	234	233	234	232	231	228	226	223	220	216
World Price*Exchange Rate	Rs / 100 Kgs	1,809	1,557	1,330	1,341	1,448	1,519	1,580	1,605	1,685	1,704	1,746	1,759	1,783	1,793	1,813	1,814	1,814	1,806
All India Price	Rs / 100 Kgs	1,721	1,723	1,689	1,910	2,078	2,197	2,314	2,424	2,562	2,678	2,813	2,942	3,147	3,309	3,458	3,623	3,794	3,972
Minimum Support Price	Rs / 100 Kgs	1,400	1,450	1,525	1,601	1,681	1,765	1,854	1,946	2,044	2,146	2,253	2,366	2,484	2,608	2,739	2,876	3,019	3,170

Note: Prices are in nominal terms.

Table 31. Main Scenario Costs

India Costs of PDS Attributable to Wheat

	Units	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31
Procurement Quantity	1000 mt	25,090	28,020	28,090	28,330	28,597	28,862	29,125	29,384	29,640	29,891	30,139	30,382	31,000	31,389	31,618	31,843	32,063	32,276
Economic Cost	Rs / mt	19,083	20,512	22,000	23,792	25,060	26,362	27,712	29,135	30,628	32,196	33,843	35,571	37,386	39,292	41,292	43,392	45,597	47,913
Distribution Cost	Rs / mt	3,508	3,869	4,422	4,143	4,398	4,648	4,903	5,173	5,457	5,755	6,067	6,396	6,740	7,103	7,483	7,882	8,301	8,741
Acquisition Cost	Rs / mt	15,575	16,644	17,577	19,649	20,663	21,713	22,809	23,962	25,172	26,442	27,775	29,176	30,646	32,189	33,809	35,511	37,297	39,172
Procurement Incidental Cost	Rs / mt	2,864	3,466	3,605	3,637	3,850	4,060	4,273	4,498	4,735	4,984	5,244	5,518	5,805	6,106	6,423	6,754	7,103	7,468
Minimum Support Price	Rs / mt	14,000	14,500	15,250	16,013	16,813	17,654	18,536	19,463	20,436	21,458	22,531	23,658	24,841	26,083	27,387	28,756	30,194	31,704
Cost of Procuring Wheat For Central Po	Rs Billion	479	575	618	674	717	761	807	856	908	962	1,020	1,081	1,159	1,233	1,306	1,382	1,462	1,546
Net Government Cost of PDS, Wheat	Rs Billion	396	406	448	538	557	600	645	693	744	797	854	914	988	1,060	1,131	1,206	1,286	1,369

Note: Costs are in nominal terms.

Table 32. Main Scenario Prices

India Wheat Price (Wholesale Level) by State

	Units	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31
Average Wholesale Price	Rs / 100 Kgs	1,721	1,723	1,689	1,910	2,078	2,197	2,314	2,424	2,562	2,678	2,813	2,942	3,147	3,309	3,458	3,623	3,794	3,972
Major Producing States																			
Bihar	Rs / 100 Kgs	1,384	1,400	1,451	1,583	1,728	1,831	1,931	2,026	2,144	2,244	2,361	2,472	2,648	2,788	2,916	3,057	3,205	3,359
Gujarat	Rs / 100 Kgs	1,858	1,755	1,951	2,060	2,233	2,356	2,476	2,590	2,732	2,852	2,991	3,125	3,336	3,503	3,656	3,826	4,003	4,187
Haryana	Rs / 100 Kgs	1,751	1,566	1,462	1,772	1,924	2,032	2,137	2,237	2,361	2,466	2,588	2,705	2,890	3,036	3,170	3,319	3,474	3,635
Madhya Pradesh	Rs / 100 Kgs	1,642	1,537	1,552	1,760	1,915	2,026	2,133	2,235	2,362	2,469	2,594	2,713	2,902	3,052	3,189	3,341	3,499	3,664
Maharashtra	Rs / 100 Kgs	1,983	2,004	1,797	2,150	2,338	2,472	2,602	2,726	2,879	3,009	3,160	3,305	3,534	3,715	3,882	4,066	4,258	4,457
Punjab	Rs / 100 Kgs	1,567	1,469	1,509	1,691	1,839	1,945	2,048	2,146	2,267	2,370	2,489	2,604	2,784	2,928	3,059	3,205	3,356	3,514
Rajasthan	Rs / 100 Kgs	1,560	1,528	1,576	1,733	1,884	1,991	2,095	2,194	2,317	2,421	2,542	2,658	2,842	2,987	3,120	3,267	3,421	3,581
Uttar Pradesh	Rs / 100 Kgs	1,485	1,480	1,516	1,661	1,803	1,904	2,002	2,095	2,211	2,309	2,423	2,532	2,705	2,842	2,968	3,106	3,251	3,401
Minor Producing States																			
Other States	Rs / 100 Kgs	1,721	1,723	1,689	1,910	2,078	2,197	2,314	2,424	2,562	2,678	2,813	2,942	3,147	3,309	3,458	3,623	3,794	3,972

Note: Prices are in nominal terms.

Table 33. Main Scenario Supply and Use Difference from Baseline (percent)

India Wheat Supply and Use

April-March Marketing Year	Units	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31
Area Harvested	1000 ha	0.0%	-0.2%	0.0%	0.1%	0.1%	0.1%	-0.1%	-0.2%	-0.3%	-0.5%	-0.6%	-0.7%	-0.8%	-0.9%	-1.0%	-1.1%
Yield	mt / ha	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Supply	1000 mt																
Production	1000 mt	0.0%	-0.2%	0.0%	0.1%	0.2%	0.1%	-0.1%	-0.2%	-0.3%	-0.5%	-0.7%	-0.7%	-0.8%	-0.9%	-1.0%	-1.1%
Beginning Stocks	1000 mt	0.0%	0.0%	6.7%	15.7%	23.7%	26.4%	21.2%	9.9%	-5.7%	-21.8%	-36.6%	-46.2%	-53.0%	-58.5%	-62.9%	-66.7%
Imports	1000 mt	0.0%	-72.0%	-72.9%	-74.7%	-76.2%	-77.7%	-77.9%	-78.7%	-78.7%	-78.9%	-78.7%	-78.4%	-77.9%	-77.4%	-76.9%	-76.3%
Use	1000 mt																
Food, Seed & Industrial Use	1000 mt																
PDS	1000 mt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Other (market)	1000 mt	0.0%	-0.6%	-0.8%	-0.4%	0.0%	0.4%	0.7%	1.1%	1.4%	1.7%	1.5%	1.7%	2.0%	2.2%	2.4%	2.7%
Feed & Residual Use	1000 mt	0.0%	-0.5%	-0.8%	-0.6%	-0.2%	0.2%	0.6%	1.0%	1.3%	1.6%	1.6%	1.7%	1.8%	2.0%	2.2%	2.3%
Exports, Government	1000 mt	0.0%	-100.0%	-100.0%	-100.0%	-100.0%	-100.0%	-100.0%	-100.0%	-100.0%	-100.0%	-100.0%	-100.0%	-100.0%	-100.0%	-100.0%	-100.0%
Exports, Other	1000 mt	0.0%	-2.0%	-2.5%	-1.3%	0.1%	1.9%	3.1%	6.9%	12.0%	34.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Ending Stocks (Government)	1000 mt	0.0%	6.7%	15.7%	23.7%	26.4%	21.2%	9.9%	-5.7%	-21.8%	-36.6%	-46.2%	-53.0%	-58.5%	-62.9%	-66.7%	-69.8%
World Price (US #2 HRW, US Gulf)	USD / mt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
World Price*Exchange Rate	Rs / 100 Kgs	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
All India Price	Rs / 100 Kgs	0.0%	2.3%	3.2%	1.6%	-0.1%	-1.6%	-2.6%	-4.1%	-5.1%	-6.4%	-5.6%	-6.3%	-7.3%	-8.1%	-8.8%	-9.6%
Minimum Support Price	Rs / 100 Kgs	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Note: Prices are in nominal terms.

Table 34. Main Scenario Supply and Use Difference from Baseline (level)

India Wheat Supply and Use

April-March Marketing Year	Units	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31
Area Harvested	1000 ha	0	-53	-14	35	42	19	-18	-56	-102	-146	-195	-205	-228	-261	-295	-332
Yield	mt / ha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Supply	1000 mt																
Production	1000 mt	0	-146	-27	126	143	67	-59	-187	-345	-502	-674	-719	-804	-931	-1,063	-1,203
Beginning Stocks	1000 mt	0	0	860	1,737	2,276	2,310	1,790	856	-537	-2,291	-4,395	-6,403	-8,409	-10,503	-12,673	-14,921
Imports	1000 mt	0	-404	-423	-463	-501	-547	-553	-578	-581	-588	-580	-571	-553	-539	-522	-504
Use	1000 mt																
Food, Seed & Industrial Use	1000 mt																
PDS	1000 mt	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other (market)	1000 mt	0	-349	-486	-251	12	261	427	673	865	1,096	967	1,101	1,296	1,452	1,616	1,788
Feed & Residual Use	1000 mt	0	-22	-39	-31	-11	12	32	55	75	97	97	106	120	134	149	164
Exports, Government	1000 mt	0	-1,027	-783	-585	-393	-243	-152	-124	-145	-218	-334	-490	-679	-886	-1,102	-1,325
Exports, Other	1000 mt	0	-13	-18	-9	0	10	16	25	32	40	23	0	0	0	0	0
Ending Stocks (Government)	1000 mt	0	860	1,737	2,276	2,310	1,790	856	-537	-2,291	-4,395	-6,403	-8,409	-10,503	-12,673	-14,921	-17,256
World Price (US #2 HRW, US Gulf)	USD / mt	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
World Price*Exchange Rate	Rs / 100 Kgs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
All India Price	Rs / 100 Kgs	0	43	65	35	-2	-40	-69	-113	-152	-201	-187	-222	-272	-317	-368	-423
Minimum Support Price	Rs / 100 Kgs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note: Prices are in nominal terms.

Table 35. Main Scenario Cost Difference from Baseline (percent)

India Costs of PDS Attributable to Wheat

	Units	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31
Procurement Quantity	1000 mt	0.0%	-0.6%	0.5%	0.3%	-0.7%	-2.0%	-3.1%	-4.6%	-6.0%	-7.6%	-7.9%	-8.6%	-9.6%	-10.7%	-11.7%	-12.8%
Economic Cost	Rs / mt	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Distribution Cost	Rs / mt	0.0%	0.3%	0.2%	0.2%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.1%	0.2%	0.2%
Acquisition Cost	Rs / mt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Procurement Incidental Cost	Rs / mt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Minimum Support Price	Rs / mt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Cost of Procuring Wheat For Central Po	Rs Billion	0.0%	-0.5%	0.6%	0.3%	-0.7%	-2.0%	-3.1%	-4.6%	-6.0%	-7.6%	-7.9%	-8.6%	-9.6%	-10.7%	-11.7%	-12.7%
Net Government Cost of PDS, Wheat	Rs Billion	0.0%	2.0%	2.7%	1.8%	0.3%	-1.5%	-2.8%	-4.4%	-5.7%	-7.0%	-7.1%	-7.5%	-8.2%	-9.0%	-9.7%	-10.5%

Note: Costs are in nominal terms.

Table 36. Main Scenario Cost Difference from Baseline (level)

India Costs of PDS Attributable to Wheat

	Units	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31
Procurement Quantity	1000 mt	0	-167	155	78	-197	-597	-959	-1,456	-1,937	-2,485	-2,655	-2,953	-3,373	-3,806	-4,255	-4,726
Economic Cost	Rs / mt	0	13	10	7	5	3	2	2	2	3	4	6	9	11	14	17
Distribution Cost	Rs / mt	0	13	10	7	5	3	2	2	2	3	4	6	9	11	14	17
Acquisition Cost	Rs / mt	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Procurement Incidental Cost	Rs / mt	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minimum Support Price	Rs / mt	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cost of Procuring Wheat For Central Po	Rs Billion	0	-4	4	2	-5	-17	-29	-47	-65	-88	-99	-116	-139	-165	-194	-226
Net Government Cost of PDS, Wheat	Rs Billion	0	10	15	11	2	-10	-22	-36	-51	-69	-75	-86	-101	-119	-138	-161

Note: Costs are in nominal terms.

Table 37. Main Scenario Price Difference from Baseline (percent)

India Wheat Price (Wholesale Level) by State

	Units	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31
Average Wholesale Price	percent	0.0%	2.3%	3.2%	1.6%	-0.1%	-1.6%	-2.6%	-4.1%	-5.1%	-6.4%	-5.6%	-6.3%	-7.3%	-8.1%	-8.8%	-9.6%
Major Producing States																	
Bihar	percent	0.0%	2.4%	3.3%	1.7%	-0.1%	-1.7%	-2.7%	-4.2%	-5.3%	-6.5%	-5.7%	-6.4%	-7.4%	-8.2%	-9.0%	-9.8%
Gujarat	percent	0.0%	2.2%	3.1%	1.6%	-0.1%	-1.6%	-2.5%	-3.9%	-5.0%	-6.2%	-5.5%	-6.1%	-7.1%	-7.9%	-8.7%	-9.4%
Haryana	percent	0.0%	2.3%	3.1%	1.6%	-0.1%	-1.6%	-2.6%	-4.0%	-5.0%	-6.3%	-5.5%	-6.2%	-7.2%	-7.9%	-8.7%	-9.5%
Madhya Pradesh	percent	0.0%	2.3%	3.2%	1.6%	-0.1%	-1.6%	-2.6%	-4.1%	-5.1%	-6.4%	-5.6%	-6.3%	-7.3%	-8.1%	-8.8%	-9.6%
Maharashtra	percent	0.0%	2.3%	3.2%	1.6%	-0.1%	-1.6%	-2.6%	-4.0%	-5.1%	-6.4%	-5.6%	-6.3%	-7.3%	-8.0%	-8.8%	-9.6%
Punjab	percent	0.0%	2.3%	3.2%	1.6%	-0.1%	-1.6%	-2.6%	-4.1%	-5.1%	-6.4%	-5.6%	-6.3%	-7.3%	-8.0%	-8.8%	-9.6%
Rajasthan	percent	0.0%	2.3%	3.2%	1.6%	-0.1%	-1.6%	-2.6%	-4.0%	-5.1%	-6.3%	-5.6%	-6.3%	-7.2%	-8.0%	-8.8%	-9.6%
Uttar Pradesh	percent	0.0%	2.2%	3.1%	1.6%	-0.1%	-1.6%	-2.6%	-4.0%	-5.0%	-6.3%	-5.5%	-6.2%	-7.2%	-7.9%	-8.7%	-9.5%
Minor Producing States																	
Other States	percent	0.0%	2.3%	3.2%	1.6%	-0.1%	-1.6%	-2.6%	-4.1%	-5.1%	-6.4%	-5.6%	-6.3%	-7.3%	-8.1%	-8.8%	-9.6%

Note: Prices are in nominal terms.

Table 38. Main Scenario Price Difference from Baseline (level)

India Wheat Price (Wholesale Level) by State

	Units	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31
Average Wholesale Price	percent	0	43	65	35	-2	-40	-69	-113	-152	-201	-187	-222	-272	-317	-368	-423
Major Producing States																	
Bihar	percent	0	37	56	30	-2	-35	-60	-98	-131	-173	-161	-191	-234	-273	-316	-364
Gujarat	percent	0	45	67	36	-2	-41	-71	-117	-157	-207	-193	-229	-280	-327	-379	-437
Haryana	percent	0	39	58	32	-2	-36	-62	-102	-137	-181	-169	-201	-246	-286	-332	-382
Madhya Pradesh	percent	0	40	60	33	-2	-37	-64	-105	-141	-185	-173	-205	-251	-293	-339	-391
Maharashtra	percent	0	48	72	39	-2	-45	-77	-127	-170	-224	-209	-249	-304	-355	-411	-473
Punjab	percent	0	38	57	31	-2	-35	-61	-100	-135	-177	-165	-197	-240	-280	-325	-374
Rajasthan	percent	0	39	58	32	-2	-36	-62	-102	-136	-180	-168	-199	-244	-284	-329	-379
Uttar Pradesh	percent	0	36	55	30	-1	-34	-58	-96	-128	-169	-158	-188	-229	-268	-310	-357
Minor Producing States																	
Other States	percent	0	43	65	35	-2	-40	-69	-113	-152	-201	-187	-222	-272	-317	-368	-423

Note: Prices are in nominal terms.

Table 39. Scenario Sensitivity to Import Level

Model Sensitivities to Import Level

	Units	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31
Baseline Price	Rs / 100 Kgs	1,689	1,867	2,013	2,162	2,316	2,465	2,631	2,791	2,965	3,143	3,334	3,532	3,730	3,940	4,162	4,396
Main Scenario Import Level	1000 mt	500	157	157	157	157	157	157	157	157	157	157	157	157	157	157	157
Higher Import Level	1000 mt	500	561	561	583	609	655	672	717	751	795	833	866	891	922	951	982
Main Scenario Price	Rs / 100 Kgs	1,689	1,910	2,078	2,197	2,314	2,424	2,562	2,678	2,813	2,942	3,147	3,309	3,458	3,623	3,794	3,972
Change v. Baseline	*percent*	*0%*	*2%*	*3%*	*2%*	*0%*	*-2%*	*-3%*	*-4%*	*-5%*	*-6%*	*-6%*	*-6%*	*-7%*	*-8%*	*-9%*	*-10%*
Higher-Level Scenario Price	Rs / 100 Kgs	1,689	1,864	2,045	2,163	2,276	2,381	2,517	2,626	2,757	2,880	3,078	3,232	3,378	3,536	3,701	3,872
Change v. Baseline	*percent*	*0%*	*0%*	*2%*	*0%*	*-2%*	*-3%*	*-4%*	*-6%*	*-7%*	*-8%*	*-8%*	*-8%*	*-9%*	*-10%*	*-11%*	*-12%*

Note: Prices and costs are in nominal terms.

Table 40. Scenario Sensitivity to Exogenous Rapeseed Prices

Model Sensitivities to Rapeseed Price

	Units	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31
Baseline Price	Rs / 100 Kgs	1,689	1,867	2,013	2,162	2,316	2,465	2,631	2,791	2,965	3,143	3,334	3,532	3,730	3,940	4,162	4,396
Rapeseed Baseline Price	Rs / 100 Kgs	3,939	4,096	4,260	4,430	4,608	4,792	4,984	5,183	5,390	5,606	5,830	6,063	6,306	6,558	6,820	7,093
Alternative Higher Price	Rs / 100 Kgs	3,939	4,506	4,686	4,873	5,068	5,271	5,482	5,701	5,929	6,167	6,413	6,670	6,936	7,214	7,503	7,803
Alternative Lower Price	Rs / 100 Kgs	3,939	3,687	3,834	3,987	4,147	4,313	4,485	4,665	4,851	5,045	5,247	5,457	5,675	5,902	6,138	6,384
Normal Scenario Price	Rs / 100 Kgs	1,689	1,910	2,078	2,197	2,314	2,424	2,562	2,678	2,813	2,942	3,147	3,309	3,458	3,623	3,794	3,972
Change v. Baseline	*percent*	*0%*	*2%*	*3%*	*2%*	*0%*	*-2%*	*-3%*	*-4%*	*-5%*	*-6%*	*-6%*	*-6%*	*-7%*	*-8%*	*-9%*	*-10%*
Alt. Higher Rapeseed Price Scenario	Rs / 100 Kgs	1,689	1,910	2,100	2,225	2,345	2,457	2,597	2,715	2,852	2,983	3,191	3,357	3,507	3,674	3,848	4,029
Change v. Baseline	*percent*	*0%*	*2%*	*4%*	*3%*	*1%*	*0%*	*-1%*	*-3%*	*-4%*	*-5%*	*-4%*	*-5%*	*-6%*	*-7%*	*-8%*	*-8%*
Alt. Lower Rapeseed Price Scenario	Rs / 100 Kgs	1,689	1,910	2,056	2,170	2,283	2,392	2,527	2,641	2,774	2,902	3,104	3,262	3,409	3,572	3,741	3,916
Change v. Baseline	*percent*	*0%*	*2%*	*2%*	*0%*	*-1%*	*-3%*	*-4%*	*-5%*	*-6%*	*-8%*	*-7%*	*-8%*	*-9%*	*-9%*	*-10%*	*-11%*

Note: Prices are in nominal terms.

Table 41. Scenario Sensitivity to Exogenous Rice Prices

Model Sensitivities to Retail Rice Price

	Units	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31
Baseline Price	Rs / 100 Kgs	1,689	1,867	2,013	2,162	2,316	2,465	2,631	2,791	2,965	3,143	3,334	3,532	3,730	3,940	4,162	4,396
Baseline Retail Rice Price	Rs / Kg	25	26	27	29	30	32	33	35	37	38	40	42	44	46	49	51
Alternative Higher Price	Rs / Kg	25	29	30	32	33	35	36	38	40	42	44	46	49	51	54	56
Alternative Lower Price	Rs / Kg	25	23	25	26	27	28	30	31	33	34	36	38	40	42	44	46
Normal Scenario Price	Rs / 100 Kgs	1,689	1,910	2,078	2,197	2,314	2,424	2,562	2,678	2,813	2,942	3,147	3,309	3,458	3,623	3,794	3,972
Change v. Baseline	*percent*	*0%*	*2%*	*3%*	*2%*	*0%*	*-2%*	*-3%*	*-4%*	*-5%*	*-6%*	*-6%*	*-6%*	*-7%*	*-8%*	*-9%*	*-10%*
Alt. Higher Rice Price Scenario	Rs / 100 Kgs	1,689	1,950	2,107	2,226	2,343	2,455	2,594	2,711	2,848	2,979	3,186	3,351	3,501	3,667	3,841	4,021
Change v. Baseline	*percent*	*0%*	*4%*	*5%*	*3%*	*1%*	*0%*	*-1%*	*-3%*	*-4%*	*-5%*	*-4%*	*-5%*	*-6%*	*-7%*	*-8%*	*-9%*
Alt. Lower Rice Price Scenario	Rs Billion	1,689	1,866	2,046	2,166	2,282	2,391	2,527	2,641	2,775	2,903	3,105	3,264	3,411	3,573	3,743	3,919
Change v. Baseline	*percent*	*0%*	*0%*	*2%*	*0%*	*-1%*	*-3%*	*-4%*	*-5%*	*-6%*	*-8%*	*-7%*	*-8%*	*-9%*	*-9%*	*-10%*	*-11%*

Note: Prices are in nominal terms.

Concluding Remarks

Partial equilibrium models are useful for assessing the potential impacts of a change in existing policy or implementation of new policy before actual implementation. These models serve to estimate the impact of the proposed policy changes in terms of their impacts on those within a market, providing advanced information to decision makers so those tasked with creating or changing policy can have the best information possible. The model developed in this study is suitable for those purposes within the context of the Indian wheat market, specifically constructed for analyzing the Public Distribution System for wheat and the mechanisms that make it operate.

Models are never truly finished and the model presented here is no exception, leaving room for future work. The limitations of this study include exogenous livestock units, exogenous rice price and no private stockholding are areas for immediate improvement. One application requiring minimal modifications is to assess the impact and potential cost savings from the two-tier pricing plan proposed by Sharma (2012). More in-depth work could focus on estimating the equations for which elasticities were imposed or adding the other major food grain, rice, to provide a more complete picture of the PDS and associated costs. To analyze policy questions outside of the PDS, this model can be expanded to include other commodities to better estimate the cross-commodity impacts of policies and capture the competition between commodities.

As with most proposed policy changes, there are potential winners and losers associated with the policy alternative assessed here. Those who fund the government stand to gain under this policy alternative as costs are estimated to fall. Consumers are also anticipated to win because lower government procurement and storage leads to lower prices. Falling market prices are not good for everyone. Producers stand to lose

from these lower market prices as they will likely be receiving a lower price for their wheat, all else equal.

Producers and some state governments could be two groups who may be opposed to a policy change such as this one, but for different reasons. Producers may be in opposition due to the lower market prices expected. Select state governments may be opposed, also, as some would likely see lower tax revenue received from the tax levied on the sale of grain in the market. In support of this policy alternative could be consumers who would like to see lower market prices for wheat or who are dissatisfied with the costs of the PDS system. Government representatives are one group where support could be ambiguous. Some may support it since it would reduce costs on this one program, freeing up money to be use elsewhere. Opposition could arise from political pressure of producers in their represented region as they are expected to lose from this policy alternative due to lower market prices and softening of the floor on market prices.

A proposed change to the PDS of limiting government procurements of wheat to the anticipated offtake of the upcoming season plus buffer stocks was imposed on the constructed model. Prices are anticipated to fall in the domestic market, leading to less area, less production and more feed and FSI use. Results indicate that there are potential cost savings of 831 billion Rupees over the next 15 years available from implementing this policy. These savings are estimated from -0.01 to 0.05 percent of GDP annually. The market effects, including both greater use and less production, the cost savings, and potential winners and losers are all relevant facts for decision makers in India who contemplate procurement and PDS system reforms.

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Appendix

Table 25. Feed Use Selected Regression Summary

Feed Use		
Coefficient	Variable	p-value
-4.07	Intercept	
0.38	* lagged feed demand	0.1433
0.11	* Animal Index (Simulated Feed Use)	0.0760
-118.08	* Average Wholesale Price/CPI	0.2098
276.94	F Statistic	0.0000
0.99	R^2	

Table 26. Government Exports Selected Regression Summary

Government Exports		
Coefficient	Variable	p-value
-752.71	Intercept	
0.06	* (World Price* Exchange Rate/DEFL - Domestic Price/DEFL)	0.47086
0.77	* Lagged Ending Stocks/Buffer Norm	0.00054
11.97	F Statistic	0.00174
0.69	R^2	

Table 27. Other Exports Selected Regression Summary

Other Exports		
Coefficient	Variable	p-value
-3344.05	Intercept	0.0342
38.28	* (World Price * Exchange Rate/DEFL - Domestic Price/DEFL)	0.0081
8.99	F Statistic	0.0081
0.35	R^2	

Table 28. Costs Selected Regression Summary

Procurement Incidentals

Coefficient	Variable	p-value
-29.48	Intercept	
1.68	* CPI	0.0000
498.20353	F Statistic	0.0000
0.97	R^2	

Distribution Cost

Coefficient	Variable	p-value
17.35	Intercept	
2.03	* CPI	0.0000
-0.001	* Distribution Quantity	0.4435
34.56	F Statistic	0.0000
0.84	R^2	

Table 29. Government Stocks Selected Regression Summary

Government Stocks, May 31

Coefficient	Variable	p-value
0.00	Intercept	
0.93	* Lagged Stocks	0.0000
1.00	+ FCI Procurements	
-1.00	- PDS Food Offtake	
-1.00	- Government Exports	
128.96239	F Statistic	0.0000
0.84	R^2	

Table 30. Elasticities Imposed for Area Equations

Elasticities Imposed for Area Equations .

	Own Gross Retursn		Competing Gross Returns	
State	Short Run	Long Run	Short Run	Long Run
Bihar	0.0506	0.0586		
Gujarat	0.0852	0.1285		
Haryana	0.0480	0.1088	-0.0190	-0.0431
Madhya Pradesh	0.0385	0.0867	-0.0350	-0.0788
Maharashtra	0.0366	0.0766		
Punjab	0.0478	0.1066	-0.0190	-0.0424
Rajasthan	0.0838	0.1258	-0.0160	-0.0240
Uttar Pradesh	0.0437	0.0983	-0.0236	-0.0531
Other States	0.0422	0.0901		

Note: Competing Crop is Rapeseed

Table 31. Trend Yield Selected Regression Summary

Trend Yield Selected Regression Summary .

State	Coefficient	p-value	R^2	F
Bihar	47.2302	0.0000	0.5209	8.6975
Gujarat	49.3009	0.0000	0.5122	14.6997
Haryana	52.1048	0.0000	0.5601	17.8225
Madhya Pradesh	20.5206	0.0000	0.2054	3.6192
Maharashtra	29.7002	0.0000	0.4733	12.5824
Punjab	24.1816	0.0000	0.1971	3.4359
Rajasthan	39.8204	0.0000	0.6489	25.8737
Uttar Pradesh	30.5042	0.0000	0.5552	17.4746
Other States	17.9201	0.0000	0.4904	13.4751

Table 32. Durbin Watson d Statistic by equation

Durbin Watson Summary by Equation

Equation Name	Durbin Watson	Positive AC	Negative AC
Area Cultivated, Bihar	1.2243	INCONCLUSIVE	NONE
Area Cultivated, Gujarat	1.9408	NONE	NONE
Area Cultivated, Haryana	1.1356	INCONCLUSIVE	NONE
Area Cultivated, Madhya Pradesh	1.4175	INCONCLUSIVE	NONE
Area Cultivated, Maharashtra	2.5774	NONE	INCONCLUSIVE
Area Cultivated, Punjab	1.4606	INCONCLUSIVE	NONE
Area Cultivated, Rajasthan	1.8237	NONE	NONE
Area Cultivated, Uttar Pradesh	1.2091	INCONCLUSIVE	NONE
Area Cultivated, Other States	2.3082	NONE	NONE
Yield, Bihar	1.4058	NONE	NONE
Yield, Gujarat	2.4987	NONE	NONE
Yield, Haryana	1.0752	INCONCLUSIVE	NONE
Yield, Madhya Pradesh	2.0031	NONE	NONE
Yield, Maharashtra	2.6037	NONE	NONE
Yield, Punjab	1.0272	INCONCLUSIVE	NONE
Yield, Rajasthan	1.7595	NONE	NONE
Yield, Uttar Pradesh	1.1349	INCONCLUSIVE	NONE
Yield, Other States	1.7209	NONE	NONE
Procurement Share, Bihar	1.2769	INCONCLUSIVE	NONE
Procurement Share, Gujarat	2.2512	NONE	NONE
Procurement Share, Haryana	1.0764	INCONCLUSIVE	NONE
Procurement Share, Madhya Pradesh	0.3359	POSITIVE	NONE
Procurement Share, Maharashtra	2.2368	NONE	NONE
Procurement Share, Punjab	0.7458	INCONCLUSIVE	NONE
Procurement Share, Rajasthan	1.5396	INCONCLUSIVE	NONE
Procurement Share, Uttar Pradesh	1.7397	NONE	NONE
Procurement Share, Other States	1.1270	INCONCLUSIVE	NONE
Feed Use	1.9310	INCONCLUSIVE	NONE
Food Use, PDS (PDS OFFTAKE)	0.0209	POSITIVE	NONE
Other Food/FSI Use	1.2878	INCONCLUSIVE	NONE
Government Exports	2.0695	NONE	NONE
Other Exports	1.4770	NONE	NONE
Imports	1.7035	INCONCLUSIVE	NONE
Procurement Incidentals	1.1323	INCONCLUSIVE	NONE
Acquisition Cost (MSP + Proc. Incidentals)	0.0981	POSITIVE	NONE
Distribution Cost	0.4321	POSITIVE	NONE
Government Stocks, May 31	0.6344	INCONCLUSIVE	NONE
Government Costs	2.2343	INCONCLUSIVE	INCONCLUSIVE

Note: T = 10, alpha = 0.05

Table 50. Model Performance Measures

Historical Equation Performance, 2005-2015, %RMSE

		States								
Equation	All India	Bihar	Gujarat	Haryana	Madhya Pradesh	Maharashtra	Punjab	Rajasthan	Uttar Pradesh	Other States
Area		2.6 %	12.8 %	2.4 %	8.0 %	12.7 %	1.2 %	8.6 %	2.6 %	1.7 %
Yield		6.3 %	7.1 %	5.7 %	9.5 %	6.3 %	4.4 %	4.4 %	5.1 %	5.1 %
Production		8.9 %	16.1 %	6.8 %	16.7 %	16.3 %	3.5 %	8.8 %	6.1 %	4.2 %
Procurment Share		207.5 %	233.2 %	64.9 %	30.8 %	8732.7 %	13.4 %	46.9 %	99.2 %	217.6 %
Feed Use	24.7 %									
Food Use, PDS	2.7 %									
Food Use, Other	2.9 %									
Government Exports	340.7 %									
Other Exports	67.7 %									
Imports	70.3 %									
Government Stocks	139.6 %									
Procurement Incidentals	7.5 %									
Acquisition Cost	8.7 %									
Distribution Cost	17.3 %									
Government Costs	35.0 %									
Price	31.2 %	31.9 %	29.2 %	30.3 %	31.8 %	31.3 %	30.1 %	30.4 %	31.9 %	31.2 %