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Input subsidy withdrawal in India: output loss, cash transfer, and redistribution

Seema Bathla^{1*}, Anjani Kumar², and Roopali Aggarwal¹

¹Centre for the Study of Regional Development, Jawaharlal Nehru University, New Delhi 110 067

²International Food Policy Research Institute, New Delhi

*Corresponding author: seema.bathla@gmail.com

Abstract Public expenditure on subsidies for agricultural inputs in India have intensified input consumption and raised the agriculture growth rate. But it exceeds the combined expenditure on capital formation in agriculture and irrigation and is fiscally unsustainable for the exchequer. Input subsidies must be made more effective while sustaining production and farmer income. We estimate the impact on agricultural output if fertilizer and power subsidies are withdrawn. We also consider the resultant increase in their respective prices, the amount to be credited to farmers' bank accounts under the ambit of the Direct Benefit Transfer programme, and other key implications.

Keywords Public expenditure, input subsidy, Direct Benefit Transfer, agricultural output

JEL Codes Q1, Q28, Q12, Q18

The growth rate of agricultural productivity is low in India—as in many developing countries—and the commodity prices volatile, the landholding size small, the imperfections in the input and output markets large, and the input use inefficient. That the role of subsidies is inviolable if input use is inefficient is well understood, as is that inputs should be used efficiently, and technological progress must be made, to accelerate the crop productivity growth rate.

India adopted high yielding varieties (HYV) in the 1960s. Since then, the usefulness of the subsidies on fertilizers, power, and irrigation has been questioned, and their complete removal advocated, because the expenditure on subsidies reduces agricultural investment (Gulati and Chopra 1999). Inputs are used inefficiently, and their market prices distorted, if these are priced below their costs of production. The inefficient use of resources slows down productivity growth and degrades soil and water resources. An untargeted policy, with an inherent regional and farm size bias, leads to income inequalities and lopsided growth (World Bank 2003; Fan, Gulati, and Thorat

2007; Gautam 2015). It has also been proposed that targeting and distribution mechanisms be improved and the subsidies rationalized (Gulati and Banerjee 2017; Chand and Pandey 2008; Sharma 2012).

Despite these long-standing arguments and deliberations, however, public expenditure on agriculture, irrigation, and input subsidies in India increased during the 2000s. We find that a swift increase in the budgetary outlays towards input subsidy across each state from 2003–04—though expensive for the exchequer—has intensified the consumption of fertilizers and other inputs and enabled several states to achieve an agricultural growth rate of more than 6%. The higher marginal returns from additional spending on some of the subsidies—though lower than various public investments—again lend economic reasoning to retain the subsidy support to agriculture, at least in the poorer states. Subsidies seem imperative in many agriculturally dominant low-income states, though they may have outlived their usefulness in several states (Gulati, Ferroni, and Zhou, 2018; Bathla et al. 2020).

Market imperfections and inefficiencies affect agricultural growth in many states in India. One of the ways to address these imperfections and inefficiencies can be engendering reforms in the existing subsidy regime. Many developing countries in Asia and Africa experienced a slow rate of agricultural growth and high food inflation during 2007; their subsidy programme proved beneficial. Their experience attracted global attention to ‘smart subsidies’, encompassing targeting, effectiveness, and sustainability (World Bank 2008; Chirwa and Dorward 2013; Jayne and Rashid 2013). In evaluating the benefits and costs of subsidies, the key is to identify the appropriate approach (universal or targeted), timeline, and instrument of delivering subsidies. The instrument should be non-distorting, such as cash transfers, input vouchers, or—in remote locations—the physical delivery of inputs.

In February 2011, the Government of India constituted a committee under Nandan Nilekani, the chairman of the Unique Identification Authority of India (UIDAI). The committee recommended that the Direct Benefit Transfer (DBT) programme¹ be implemented in three phases. In Phase 1, a digital map of the fertilizer supply chain will be prepared, followed by cash transfers to retailers in Phase 2, and to farmers to purchase fertilizers in Phase 3. The government aims to deliver the subsidy directly to the farmers, although execution and implementation will take considerable time, as will acceptance by producers, retailers, and farmers across the country.

Given the problems—the identification of farmers, scale of operations, interface with markets, variations in prices, the optimum mix of fertilizers, and the level of usage—the modalities for implementing the DBT are complex (Kishore, Praveen, and Roy 2013).² Here, setting these modalities aside, and considering that the key requirement in Indian agriculture is to improve input use efficiency and, thus, enhance, productivity

and growth—while using natural resources sustainably—we raise three questions.

If the subsidies on inputs are withdrawn completely, the input prices will increase, and the agricultural output will decline; what would be the extent of that decline? To maintain the net income of farmers at a given level of input use, what amount will have to be credited to their account under the DBT? Would reallocating the input subsidy across the states improve crop productivity and safeguard the environment?

The government extends support indirectly towards canal irrigation, diesel, and seeds, and directly towards farm machinery, including drip and sprinkler irrigation. But we undertake the exercise for two key inputs—fertilizers and power. And certain limitations apply. Firstly, we use a farm household (HH)-level database based on the representative surveys (59th and 70th rounds) of the National Sample Survey Office (NSSO) because only these surveys make available the state-wise estimates on the value of output and farmers’ income at a given use of farm inputs. However, the major limitations are the availability of decennial estimates, the latest being the 70th round for the year 2012–13, and that the inputs used and output are reported in value terms. Considering values in the estimations imply that the commodity prices are assumed to be constant. Some gaps remain since the data—such as on the utilization of surface/canal irrigation water, cost of irrigation water supply (irrigation water rate), and of other inputs—does not exist for all the states. And it is difficult to segregate groundwater usage for irrigation, and other uses based on the NSS data.

Secondly, Aadhar cards/e-machines would have to be linked to farmers’ bank accounts to transfer cash; and the transaction costs would be high and the administrative expense hard to estimate. Thirdly, cash

¹Under the DBT scheme, fertilizer companies will receive the subsidy from the government after retailers sell the subsidized fertilizers to farmers through Aadhaar authentication (a unique ID) via Point of Sale (PoS) machines installed in every retail shop in a state. This system is expected to maintain records and encourage usage, avert overcharging by retailers, and check subsidy claims on urea by producers. This move is also expected to raise productivity, reduce urea imports, and save government resources. During the financial year 2017–18, the fertilizer subsidy was budgeted at INR 70,000 crore (USD 11 billion).

²Media reports highlight the necessity of Aadhar card, lack of effective communication between farmers and retailers, inability of retailers to handle sales in peak season due to pre-authentication requirement of buyers, and high transaction loads. In some states, sales are through the primary agriculture cooperative societies (PACS), where machines are yet to be installed. The producers selling to retailers may get delayed dues on account of the subsidy, adding to their burden.

transfers would increase the resources, or income, of farmers; and the output may fall if the farmers do not spend the extra resource in cultivating crops or if it is used up in cross-subsidization. While such diversion is likely, we presume that rationality wins through. On the flip side, cash transfers would increase the ready cash with farmers, and raise their demand for fertilizers, thereby raising their market price and minimizing the increase in farmers' real income.

Lastly, it remains to be seen whether this policy change would favour the redistribution of subsidies from the developed states to the poorer states and concurrently forestall resource degradation. In Punjab, for instance, the over-extraction of water, and the imbalance of fertilizers in the cultivation of wheat and paddy, have already depleted the soil and groundwater resources. A reduction in subsidy on fertilizer and power may lower wheat production in the state and not degrade its soil and water resources. But its concurrent increase in Madhya Pradesh, though compensating for the loss in output, may turn out to be unsustainable in due course.

Nevertheless—and presuming that the government continues to subsidize inputs—a better delivery mechanism, based on the DBT, would have an edge over the present price-based support system in controlling rampant corruption, preventing overuse of water and other natural resources, and saving the government's resources, which can be utilized for further investments.

The analysis is exploratory in nature. The underlying conjecture is that devising a better strategy for implementing, and distributing, input subsidies will improve efficiency. We expect that the analysis may encourage farmers to use inputs judiciously and aid their respective state governments in devising a new subsidy delivery mechanism. And the government will have to

- maintain a record for each farmer and link it with their Aadhar/bank account;
- inflation-adjust the transfer amount to maintain the farmers' purchasing power;
- check the supply–demand gaps;
- prioritize savings, if any, for investments in agriculture; and
- consider reallocating the fertilizer subsidy across geographical locations to trade-off the output loss—due to subsidy reduction and lower input use—against environmental sustainability.

Data and methodology

The analysis is based on the NSSO 59th and 70th Situation Assessment Survey, relating to 2002–03 and 2012–13. The consumption estimates and price of three selected inputs—fertilizers, power, and canal water—are sourced from, respectively, the Fertilizer Statistics of India, Annual Reports of State Electricity Board, and Water and Related Statistics.

Since the estimates on surface water potential created and utilized are given as per basins across the country, we have bifurcated it into states by taking the drainage area given for each state under each basin. The total drainage area in a basin is taken as weight to divide the surface water in each state.

We used the unit-level data of the NSS Situation Assessment Survey, GoI to estimate the value of agricultural output; net returns/income from farming; and the expenditure on key inputs such as fertilizers, power, and irrigation. Notably, the 59th and 70th rounds are not comparable because these define 'farmer'³ differently; to make them parallel, we dropped households that did not possess land during the 70th round. Further, INR 3,000 in 2012–13 is found to be equivalent to INR 1,400 at 2002–03 prices.⁴ We have

³The possession of land, which was an essential condition for defining a person as a farmer (farmer household) in the 59th round was relaxed in the 70th round. In the 70th round, only those households were included in the survey that have at least one member self-employed in agriculture, either in principal or subsidiary status, and have a total value of produce amounting to more than INR 3,000 with respect to the last 365 days.

⁴The state-wise monthly CPI-Agricultural labour with the base 1986–87 base is used to deflate the prices of 2012–13. The All-India CPI-AL has been calculated by taking the weighted average of the state CPIs. For the year July 2002–June 2003, it comes out to be 322 and for July 2012 – June 2013, it is 691. By changing the base to 2002–03, the CPI – AL for these time periods becomes 100 and 214, respectively. Therefore, the factor by which the prices of 2012–13 data deflated is 100/214=0.4667. In other words, INR 3,000 in 2012–13 was equivalent to INR 1,400 in 2002–03. Appendix 1 provides detailed calculation.

included from the 59th round only those households that have an annual income of INR 1,400 from agriculture, with at least one member engaged in the same during the previous 365 days.⁵

A total of 51,770 households were surveyed in 2002–03. After making adjustments, 46,174 agricultural households were left to be taken up for analysis. Similarly, in the 70th round, out of 35,200 households surveyed, 35,146 were included. The data has been extracted for 20 major states and for India as a whole. Telangana is clubbed with Andhra Pradesh to make the two rounds comparable. Some of the inputs have been clubbed to maintain greater clarity and a reasonable sample size for the empirical analysis; the expenses on fertilizer and manure, for example, are clubbed into ‘fertilizers/manures’. Expenditure on ‘labour’ includes human and animal cost. The cost of diesel and electricity consumption is added to irrigation as most households use tube wells to draw irrigation water. The cost of hiring machinery is added to ‘other expenses’ as no such category is given in the 59th round. The Commission on Agriculture Cost and Prices (CACP) defines the ‘cost of cultivation’; by that definition, the total household expenditure corresponds to the paid-out cost. The NSS does not provide any information on family labour used.

The value of output, expenditure on inputs, and net farm household income is analysed per hectare (ha). The annual rate of growth in the value of output and inputs is estimated at 2004–05 prices using the gross state domestic product (GSDP) deflator from National Accounts Statistics, Central Statistics Office. This is followed by an estimation of the elasticity of value of output with respect to expenditure on each input (fertilizer, irrigation, power, and ‘others’) based on the ordinary least squares (OLS) method in double log functional form. The regression is estimated for 2012–13 using each input as an explanatory variable along with operated land and expenditure on farm assets. The states are included as dummies in the all-India regression; and the districts are included as dummies in the state-wise regression exercise. Moreover, dummy

variables are specified for various categories of farm size to see the variations in income.⁶

The OLS analysis estimates the elasticity of the response of output to the selected inputs used. The estimates relating to own price elasticity of demand of fertilizer and irrigation are taken from Kumar et al. (2010), while that of power are sourced from Bhattacharyya and Ganguly (2017). These are considered to be the same across the states, because consistent data on energy (power), irrigation prices, and the fixed price of fertilizers is not available. Based on these, the elasticity of production with respect to input price is estimated as a product of elasticity of value of output with respect to value of input and elasticity of input consumption with respect to input price (that is, price elasticity of demand for inputs). The percentage change in output, in a hypothetical situation of removal of input subsidy, is estimated during 2012–13 by using the following two methods.

Under the first method, data pertaining to the physical quantity of fertilizer, power, and energy consumed, their respective unit price, and the cost of production is taken. The percentage increase in input price in a situation of subsidy removal is estimated and multiplied with the estimated cross-price elasticity (elasticity of production with respect to input price) to quantify the percentage reduction in the value of agricultural output. The estimated amount represents loss in net agriculture income due to consumption of inputs at (unsubsidized) market price, thereby providing the case that the same amount be directed towards transfers in the form of an income support measure.

In the second approach, instead of physical quantities and their prices, we use the actual expenditure on each input. The percentage increase in expenditure on input is the (subsidy per ha /actual expenditure*100). Multiplying this percentage change (increase) with cross-price elasticity provides an estimate of the impact of subsidy withdrawal on percentage loss in value of output per ha. Both approaches are found to be comparable, with the exception of a few states where the estimated subsidy amount is much higher than the

⁵Although the definition mentions “at least one member self-employed in agriculture either in principal status or subsidiary status”, due to unavailability of this data in the 59th round, the HHs that have at least one member engaged in agriculture during last 365 days have been included in the sample.

⁶Farming households are grouped by farm size into marginal (up to 1 ha), small (1.01–2 ha), medium (2.01–10 ha), and large (more than 10 ha).

actual expenditure incurred by the farmers. Such discrepancies are identified in the case of the fertilizer subsidy in Punjab, Haryana, and Uttaranchal; and the power subsidy in Punjab, Haryana, Rajasthan, and several southern states.⁷ We have presented results based on the first approach.

The estimates on cash transfer worked out for the year 2012–13 are updated to 2017–18 using the state-wise consumer price index for agriculture labour (CPI-AL). The index is available at base 1986–87, which is rebased to 2012–13, and then to 2017–18. Taking value in 2017–18=100, the conversion factor is taken to estimate the amount of cash transfer at 2017–18 prices.

Subsidy withdrawal, reduction in output, and required DBT

The economic theory propounds taxes and subsidies to be distortionary in nature as both lower total surplus and create deadweight loss. A judicious mix of taxes and subsidies is said to be quite useful under imperfect market conditions where positive and negative externalities are inevitable. But the efficiency and usefulness of subsidies continues to be debatable, especially in developing countries that often face constraints due to multiple market failures, rampant leakages, poor targeting, and the use of political clout to woo the masses. Charging input prices below the cost of production (or market price) is a strategy that aims to relieve such constraints, aid farmers to adopt technology, boost productivity, and reduce the cost of cultivation (Morris et al. 2007; World Bank 2008; Gautam 2015). However, this policy instrument has become distorted over the years. The perceived gains have often outweighed the costs in terms of efficiency, productivity, income equality, and environmental outcomes (Vondolia, Eggert, and Stage 2012; Gautam and Kar 2017).

More than 60% of the population in India is engaged in agriculture. Agriculture has been undergoing a slow structural transformation, and observing a high incidence of rural poverty and income inequality when compared with income in urban areas. During the green revolution, various inputs were subsidized indirectly, because subsidies were considered to be an easy

solution to adopt technology and accelerate crop yield (Fan, Gulati, and Thorat 2007). As short-term measures, charging lower prices for fertilizer and irrigation (canal and groundwater) in tandem with a public policy of minimum support price for output, and investments in major irrigation infrastructure, were successful in incentivizing farmers to adopt technology. These catapulted the country to be self-reliant in food grain production, achieve economies of scale, and stabilize market prices of agricultural commodities. Unfortunately, the measures took a heavy toll in terms of government resources, overuse of inputs, and damage to soil and groundwater resources in several regions. A policy shift was discernible during the 1990s: the expenditure on subsidies was redirected towards investments. In the case of irrigation water, the suggestion was to improve governance through participatory irrigation management (Hazell and Rosegrant 2000; Smith and Urey 2002; Rashid et al. 2013).

Are subsidies on agricultural inputs useful? How do these subsidies affect private (farmer) investment and production? These key questions remain unanswered. The literature on these issues is scant, and it varies by state and crop grown. Gulati and Chopra (1999) found a very small effect of reduction in irrigation subsidy on the production of sugar in Maharashtra compared to its significant but low effect on paddy/rice. The study revealed that a 1% increase in energy/irrigation cost would reduce rice acreage/production in Punjab by 0.027%. The authors explained the low elasticity estimate by a small ratio of irrigation cost to gross revenue such that a marginal increase in cost hardly affected farmers' revenue. Since both crops tend to be water guzzlers and overexploit groundwater resources, the study advocated more than a 100% hike in the energy prices in Punjab.

On the matter of fertilizer subsidy, Gulati and Chopra (1999) quoted results from Parikh and Suryanarayana (1992) and Sidhu and Sidhu (1985): support reduction would influence not only the price of fertilizers but also the growth and overall welfare of farmers. It is, therefore, necessary to plough back savings from reduction in subsidy to initiate investments in irrigation

⁷This may point towards diversion of the fertilizer subsidy to companies, and also the fact (stated in the annual reports) that consumption of power in agriculture is an overestimate. Also, the losses incurred by the electricity boards are often accounted for in the agricultural sector.

and welfare schemes. The study quoted that a 30% increase in the real price of fertilizer would result in an 18% decline in its consumption and further 5.4% fall in food grain production. For the year 2004–05, Chand and Pandey (2008) estimated a nearly 8% reduction in food grain output at an all-India level due to the removal of fertilizer subsidy. Sharma (2012) echoed these concerns if the fertilizer subsidy was to be curtailed. The results obtained in the present study also advocate a cautious approach and suggest an increased focus towards relatively less developed states in India for higher growth and alleviation of rural poverty.

In what follows, we estimate the percentage decline in agricultural output contingent upon the elimination of input subsidies in each of the major states. The exercise is based on a representative unit-level data of agricultural households collected under the NSS based

on the methodology. Table 1 and Figure 1 provide the value per hectare of output, expenditure on inputs, and net returns from crop cultivation in each of the selected states during 2002–03 and 2012–13 in current prices.

At the national level, the value of agricultural output per ha increased from INR 16,212 in 2002–03 to INR 59,026 in 2012–13. Across the states, household earnings in Punjab (INR 37,241), Kerala (INR 44,446), and Uttarakhand (INR 43,459) exceeded that in other states during 2002. In the subsequent round, Punjab earned the maximum (INR 145,922), followed by Kerala (INR 115,883), Haryana (INR 105,328), and Jammu and Kashmir (INR 85,780). In terms of the annual rate of growth, the real value of agricultural output grew at an annual rate of 4.3%, the maximum being almost 8% each in Punjab and Andhra Pradesh and the minimum 1.3% in Jharkhand. Importantly, the value of output in Odisha and Rajasthan continued to

Table 1 Value of output, input expenses, and net returns from agriculture (INR/ha) at current prices

| States | Value of output | | Input expenses | | Net returns | |
|-------------------|-----------------|-------------------|----------------|-------------------|-------------|-------------------|
| | 2002–03 | 2012–13 (CAGR) | 2002–03 | 2012–13 (CAGR) | 2002–03 | 2012–13 (CAGR) |
| Jammu and Kashmir | 38,379 | 85,780 (–3.3) | 7,687 | 13,068 (–5.9) | 30,692 | 72,712 (–2.8) |
| Himachal Pradesh | 18,903 | 83,933 (6) | 6,473 | 21,482 (2.9) | 13,044 | 62,451 (7.3) |
| Punjab | 37,241 | 1,45,922 (8.3) | 14,177 | 61,087 (9.3) | 24,348 | 84,835 (7.6) |
| Uttarakhand | 43,459 | 76,808 (–1.1) | 6,674 | 15,485 (1.6) | 38,842 | 61,322 (–1.7) |
| Haryana | 29,659 | 1,05,328 (6.2) | 13,743 | 38,263 (3.6) | 17,237 | 67,065 (8) |
| Rajasthan | 5,505 | 32,073 (6.6) | 3,038 | 10,874 (1.5) | 2,587 | 21,198 (10.8) |
| Uttar Pradesh | 21,320 | 81,660 (3) | 9,636 | 29,830 (0.8) | 12,668 | 51,830 (4.5) |
| Bihar | 24,780 | 60,785 (–0.1) | 9,565 | 26,324 (1.1) | 16,212 | 34,461 (–0.9) |
| Assam | 24,592 | 66,452 (3.3) | 3,640 | 10,079 (3.5) | 23,056 | 56,373 (3.2) |
| West Bengal | 30,276 | 74,724 (–0.6) | 15,169 | 47,931 (1.9) | 16,591 | 26,793 (–3.8) |
| Jharkhand | 14,474 | 38,386 (1.3) | 3,270 | 10,689 (3.4) | 12,168 | 27,697 (0.6) |
| Odisha | 7,541 | 38,721 (5.8) | 3,621 | 15,891 (4.2) | 4,336 | 22,829 (7.1) |
| Chhattisgarh | 9,051 | 43,074 (6.9) | 3,499 | 10,660 (2.3) | 5,978 | 32,413 (9.2) |
| Madhya Pradesh | 9,925 | 51,499 (5.3) | 3,918 | 18,026 (4.0) | 6,433 | 33,473 (6) |
| Gujarat | 15,428 | 45,182 (3.1) | 7,304 | 17,601 (1.1) | 8,687 | 27,581 (4.6) |
| Maharashtra | 12,503 | 49,195 (5.8) | 5,689 | 19,537 (4.4) | 7,486 | 29,657 (6.9) |
| Andhra Pradesh | 14,661 | 62,730 (7.7) | 8,538 | 39,222 (8.5) | 6,563 | 23,508 (6.6) |
| Karnataka | 14,361 | 55,006 (6) | 6,162 | 19,258 (3.9) | 8,587 | 35,747 (7.4) |
| Kerala | 44,446 | 1,15,883 (5.9) | 16,211 | 44,819 (6.5) | 30,663 | 71,064 (5.5) |
| Tamil Nadu | 17,543 | 52,003 (3) | 9,076 | 26,336 (2.7) | 9,171 | 25,667 (3.2) |
| All India | 16,212 | 59,026 (4.3) | 6,953 | 23,381 (3.5) | 9,992 | 35,645 (4.9) |

Note Andhra Pradesh includes Telangana; figures in parentheses represent CAGR of average HH income at 2004–05 price.

Source NSS 59th and 70th rounds (Schedule 33)

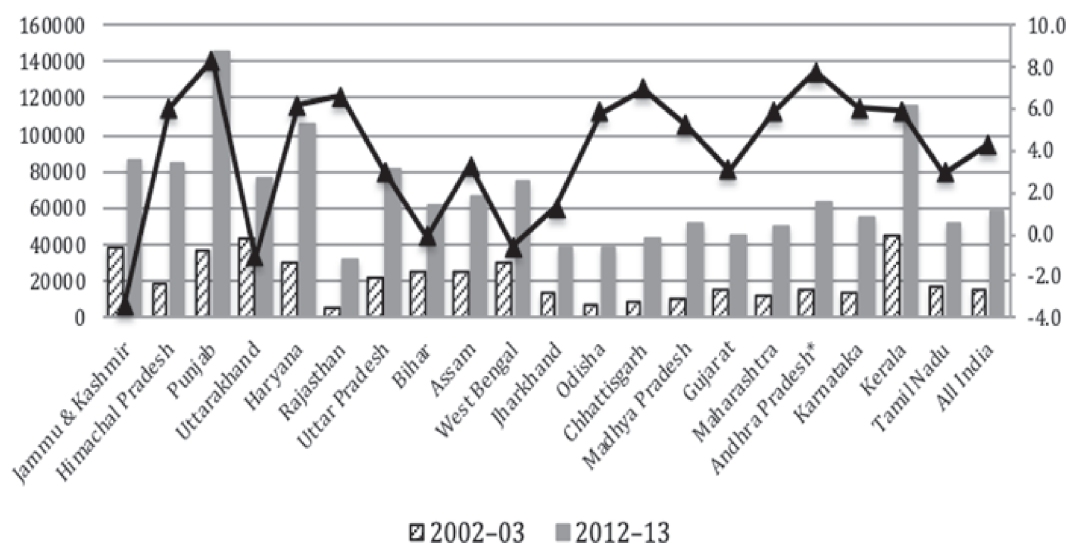


Figure 1 Value of agriculture output (INR/ha current price) and annual rate of growth (2004–05 price)

be the lowest during both years, but the rate of growth was much higher at nearly 5.8% per year (Odisha) and 6.6% per year (Rajasthan).

In comparison to output, the expenditure on inputs used in the cultivation of various crops increased from INR 6,953 per ha during 2002 to INR 23,381 per ha during 2012. It grew at an annual real rate of 3.5% per household. Among the states, Punjab, West Bengal, and Kerala were the highest spenders in both the years, whereas Rajasthan, Assam, Jharkhand, and Chhattisgarh spent the least. The annual rate of growth in input expenditure was relatively higher in Punjab (9.3%), Andhra Pradesh (8.5%), and Kerala (6.5%) (Table 1 and Figure 2). The net returns from agriculture—calculated as the difference between the

value of output and the expenditure on inputs—have also risen significantly. At the national level, it increased almost four times in current prices, from INR 9,992 in 2002–03 to INR 35,645 per ha in 2012–13. However, at the subnational level, the highest annual net returns per ha were observed in Uttarakhand (INR 38,842), Jammu and Kashmir (INR 30,692), and Punjab (INR 24,348) during 2002–03.

In the subsequent decade, households in Punjab earned the maximum at INR 84,835 per ha and in Jammu and Kashmir and Kerala at INR 72,712 per ha and INR 71,064 per ha. The relatively higher income of farmers in these states is due to the higher value of their output despite increased spending on inputs. The real annual rate of growth in net income was the maximum in

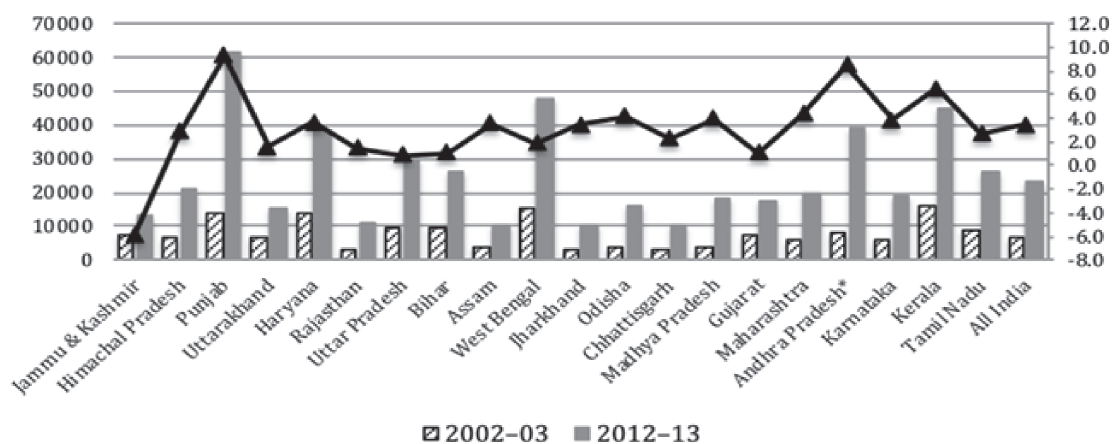


Figure 2 Input expenditure (INR/ha current price) and annual rate of growth (2004–05 price)

Table 2 Share of key inputs in total input expenditure (%)

| States | Fertilizer/ Manure | | Labour | | Seeds | | Other expenses | |
|-------------------|--------------------|---------|---------|---------|---------|---------|----------------|---------|
| | 2002–03 | 2012–13 | 2002–03 | 2012–13 | 2002–03 | 2012–13 | 2002–03 | 2012–13 |
| Jammu and Kashmir | 38.8 | 26.1 | 17.1 | 27.3 | 10.3 | 9.9 | 33.7 | 36.7 |
| Himachal Pradesh | 24.5 | 18.0 | 20.3 | 23.6 | 20.2 | 8.7 | 34.9 | 49.7 |
| Punjab | 18.8 | 15.0 | 20.0 | 13.2 | 8.1 | 5.4 | 53.1 | 66.4 |
| Uttarakhand | 33.2 | 24.2 | 19.0 | 19.1 | 18.8 | 14.9 | 29.0 | 41.9 |
| Haryana | 16.3 | 16.5 | 13.5 | 16.2 | 8.7 | 12.4 | 61.5 | 54.9 |
| Rajasthan | 20.2 | 18.6 | 10.0 | 15.1 | 14.8 | 17.5 | 55.0 | 48.8 |
| Uttar Pradesh | 22.9 | 25.6 | 13.8 | 15.3 | 18.2 | 9.9 | 45.2 | 49.2 |
| Bihar | 22.0 | 25.9 | 22.2 | 20.9 | 14.9 | 10.1 | 40.9 | 43.1 |
| Assam | 19.4 | 23.0 | 23.4 | 32.2 | 22.1 | 8.7 | 35.2 | 36.2 |
| West Bengal | 21.6 | 21.8 | 34.9 | 37.1 | 12.2 | 8.8 | 31.4 | 32.3 |
| Jharkhand | 25.0 | 27.8 | 24.9 | 22.9 | 31.6 | 19.0 | 18.5 | 30.3 |
| Odisha | 20.8 | 27.5 | 33.7 | 31.7 | 13.5 | 4.6 | 32.0 | 36.1 |
| Chhattisgarh | 23.4 | 30.7 | 31.4 | 22.0 | 18.3 | 9.7 | 27.0 | 37.6 |
| Madhya Pradesh | 20.7 | 25.8 | 19.1 | 13.5 | 29.0 | 14.9 | 31.3 | 45.9 |
| Gujarat | 21.3 | 21.1 | 19.2 | 21.5 | 18.9 | 19.1 | 40.7 | 38.2 |
| Maharashtra | 26.3 | 31.4 | 29.0 | 23.4 | 18.6 | 17.4 | 26.1 | 27.8 |
| Andhra Pradesh | 21.6 | 21.7 | 25.3 | 25.4 | 13.5 | 9.3 | 39.6 | 43.5 |
| Karnataka | 29.9 | 29.5 | 26.4 | 31.0 | 12.9 | 9.6 | 30.8 | 29.9 |
| Kerala | 31.4 | 25.2 | 48.7 | 47.8 | 3.1 | 4.6 | 16.9 | 22.3 |
| Tamil Nadu | 20.6 | 25.3 | 33.1 | 29.0 | 14.3 | 13.3 | 31.9 | 32.4 |
| All India | 22.6 | 24.0 | 22.6 | 22.5 | 16.1 | 11.4 | 38.8 | 42.1 |

Note Based on NSS 59th and 70th rounds.

Rajasthan (10.8%), Haryana (8%), Himachal Pradesh (7.3%), Punjab (7.6%), Chhattisgarh (9.2%), Karnataka (7.4%), Maharashtra (6.9%), Odisha (7.1%), and Andhra Pradesh (6.6%); the national average was 4.9%. But, disquietingly, the growth rate was lower in low-income states (barring a few), and the rate of growth in input expenses is higher than that of value of output in Punjab, Jharkhand, Andhra Pradesh, and Kerala. This trend reflects a departure from a 'low input and high output price regime' experienced during the green revolution era towards a 'high input and low output price regime'.

An increased expenditure on inputs⁸ is mainly due to an increase in the consumption or cost of fertilizers and labour. The share of expenditure on fertilizers/manure and labour was the maximum and increased in

multitude during the decade in every state, excepting those in the North (Table 2). The share of expenditure on labour was the highest in Kerala, Tamil Nadu, and Assam, and that on seeds was the maximum in Jharkhand, Gujarat, and Maharashtra. On average, the share of fertilizers in total input expenditure was around 24%, while that of labour was close to 23% and that of seeds was 11.4%.

The share of fertilizer in total cost has increased more in the less developed states. The share of expenditure on seeds declined in most states in northern and central India. Expenses on the account of surface water irrigation, and on energy for the extraction of groundwater, constituted a smaller share in total expenses on inputs. Appendix 1 furnishes estimates on the annual rate of growth in key inputs at 2004–05

⁸Expenses on account of fixed inputs include interest and land lease rent, while that on variable inputs include seed, pesticides and insecticides, fertilizers and manure, irrigation, labour, diesel, electricity, and the cost of hiring machinery (NSS, GoI).

Table 3a Subsidy withdrawal, % change in input price and agricultural output (2012–13)

| States | Increase in input price (%) due to subsidy removal | | Reduction in output (%) | | Total reduction in output (%) |
|-------------------|---|--------|-------------------------|--------|----------------------------------|
| | Fertilizer | Energy | Fertilizer | Energy | |
| Jammu and Kashmir | 69.11 | — | −3.25 | — | −3.25 |
| Himachal Pradesh | 69.11 | 100 | −1.87 | −0.6 | −2.47 |
| Punjab | 69.11 | 99.94 | −3.52 | −0.1 | −3.62 |
| Uttaranchal | 69.11 | 53.82 | −3.96 | 0.19 | −3.77 |
| Haryana | 69.11 | 92.93 | −10.59 | −0.19 | −10.78 |
| Rajasthan | 69.11 | 79.59 | −8.29 | −1.64 | −9.93 |
| Uttar Pradesh | 69.11 | 64.76 | −8.53 | −0.44 | −8.97 |
| Bihar | 69.11 | 58.7 | −10.97 | −0.46 | −11.43 |
| Assam | 69.11 | 34.8 | −8.83 | −0.29 | −9.12 |
| West Bengal | 69.11 | 30 | −13.83 | −0.11 | −13.94 |
| Jharkhand | 69.11 | 90.61 | −12.1 | −0.23 | −12.32 |
| Odisha | 69.11 | 79.27 | −10.86 | −0.89 | −11.76 |
| Chhattisgarh | 69.11 | 67.68 | −3.64 | −0.43 | −4.07 |
| Madhya Pradesh | 69.11 | 43.38 | −8.11 | −0.57 | −8.68 |
| Gujarat | 69.11 | 55.65 | −13.66 | −1.24 | −14.9 |
| Maharashtra | 69.11 | 56.39 | −13.19 | −0.86 | −14.05 |
| Andhra Pradesh | 69.11 | 96.44 | −10.94 | −0.5 | −11.44 |
| Karnataka | 69.11 | 40.4 | −9.73 | −0.77 | −10.5 |
| Kerala | 80.33 | 76.84 | −7.37 | −0.36 | −7.73 |
| Tamil Nadu | 69.11 | 100 | −9.61 | −0.77 | −10.38 |
| All India | 69.23 | 65.32 | −11.26 | −0.65 | −11.90 |

prices. A higher increase in the annual rate of growth in expenditure on irrigation⁹ was observed in Jammu and Kashmir, Himachal Pradesh, Punjab, Madhya Pradesh, Maharashtra, Odisha, and Jharkhand. The maximum growth in expenditure per ha per year has been in interest (8.1%), land lease rent (9.9%), and ‘other expenses’ (8.2%).

Impact of withdrawal of input subsidy on output and cash transfers¹⁰

Among all the inputs, fertilizer constitutes the maximum share of more than 20% in total input expenses though available at a subsidized rate. We estimate an increase in total input expenditure in a situation of complete abolition of fertilizer subsidy and its resultant impact on output during 2012–13. A similar exercise is carried out for power used for groundwater

extraction using tube wells. Changes are made only in the respective prices of inputs while keeping their demand, price of other inputs, and output unchanged (see Table 3a for the key results and Appendix Tables 2 and 3 for the details). The response of output to input is positive for fertilizer and power in each of the selected states. The elasticity of output with respect to fertilizer is above 0.18 in most of the states, with the all-India average at 0.25. It is relatively much lower for power at 0.08. Similarly, consumption of fertilizer, and power is negatively influenced by the respective prices with a significant elasticity estimate at 0.65 for fertilizer and 0.12 for power. Based on these two estimates, the elasticity of output with respect to input price turns out to be negative in almost every state. Using these estimates and price of inputs (subsidized and market price), the impact on output is evaluated.

⁹Includes diesel and electricity in NSS 70th round (2012–13).

¹⁰Some portion in this section draws on Bathla, Joshi, and Kumar (2020).

Taking fertilizer first, an elimination of subsidy on fertilizer will result in 69.1% increase in its price for the farmers and hence 11.26% annual decline in agricultural output at all-India level. The states experiencing a greater reduction are Haryana, Bihar, West Bengal, Jharkhand, Odisha, Gujarat, Maharashtra, and Andhra Pradesh. A larger decline is associated with higher input consumption and the responsiveness of output to the input price. The elasticity estimates are also found to be relatively higher (greater than 0.15) in these states. States such as Haryana and Punjab that have an excess consumption of fertilizer would be the most affected due to the hike in the fertilizer price. Hilly states such as Uttaranchal, Jammu and Kashmir, and Himachal Pradesh would be least affected with less than 3% projected decline in the output.

In the case of power/energy used to run the electric pumps for groundwater irrigation, many state governments provide it almost free of cost, or at the most at a flat rate to the agricultural sector. The elasticity of output with respect to energy cost is very low (0.02) in each state. Due to long power cuts, farmers in many states use diesel, and perhaps some farmers do not possess tube wells. Our analysis shows that withdrawal of the power subsidy would raise input expenditure by 65% at the national level, and to an exponential degree of 90% in states such as Punjab, Haryana, Tamil Nadu, Andhra Pradesh, and Himachal Pradesh due to zero tariff. Nonetheless, the level of output affected due to increase in energy prices is not as severe as found in the case of fertilizer. At all-India, an increase in tariff rate from the existing level would result in a meagre 0.65% fall in output. Among the states, Rajasthan, Odisha, Gujarat, and Maharashtra would be affected more as their expenditure on power would increase by more than 90%, hence a subsequent output reduction between 1–2% would be observed.

Taking fertilizer and power together, a no input subsidy regime would result in almost 12% decline in output from the existing level at the national level, *ceteris paribus* changes in demand, price of output, and other factors. Nearly all the states would be adversely affected. The least affected states, where impact is less than 7%, include Jammu and Kashmir, Himachal Pradesh, Punjab, Uttaranchal, and Chhattisgarh. This also reflects a low usage of fertilizer input in these states (except in Punjab) given the dominance of horticulture crops. A lower output impact in Punjab is explained

by its low value of elasticity with respect to input price.

Assuming that the price of inputs and output remain constant, if the government decides to switch from price support to a system of DBT, we have estimated the amount that would compensate farmers for net income foregone on account of removal of subsidy. Table 3b furnishes estimates for fertilizer and power at 2012–13 prices, which are updated to 2017–18 prices using the CPI-AL. For fertilizer, a cash transfer of INR 4,012 per ha at 2012–13 price and INR 5,179 per ha at 2017–18 price would compensate farmers for net income foregone on account of removal of subsidy. In other words, this amount would enable them to purchase fertilizer without having any adverse impact on income.

Across the states, the minimum amount to be transferred during 2017–18 varies from nearly INR 1,300/ha in Chhattisgarh, Andhra Pradesh and Himachal Pradesh to a maximum of INR 10,000/ha in Tamil Nadu and Haryana. These estimates are based on the price of input, and its consumption, elasticity, and level of subsidy. In the case of power, the anticipated cash transfers lie within a range of INR 36/ha in West Bengal to INR 822 per ha in Tamil Nadu, the all-India average being INR 298 per ha during 2017–18.

The total projected average amount to be transferred to farmers' accounts under DBT contingent upon withdrawal of price support for fertilizer and power is INR 5,477 per ha of which a larger share is on account of fertilizers. The agriculturally advanced states consuming more fertilizer and power would need higher compensation than the national average, up to a maximum INR 11,037 per ha. This is the amount that is to be transferred to farmers without having much impact on output/income.

In decreasing order, Tamil Nadu, Haryana, Kerala, Assam, Uttar Pradesh, Maharashtra, Karnataka, and Gujarat would require the highest transfers between INR 11,037 and INR 5,358 per ha, followed by West Bengal, Bihar, Punjab, Jharkhand, Odisha, Madhya Pradesh, Jammu, and Kashmir, Uttaranchal (between INR 4,575 and 2,877 per ha) and then the remaining states requiring less than INR 2,700 per ha. Large inter-state differences in these estimates are attributable to level of consumption of inputs, and value of output, which again are a consequence of the choice of crops grown, availability of water through rainfall and other sources, prices of inputs, and output.

Table 3b Amount of cash transfer required to compensate for output loss, 2012–13 and 2017–18 (INR/ha in nominal prices)

| States | Cash transfers (INR./ha) at 2012–13 price | | Total cash transfers (INR./ha) at 2012–13 price | Cash transfers (INR./ha) at 2017–18 price | | Total cash transfers (INR./ha) at 2017–18 price |
|-------------------|---|-------|--|---|-------|--|
| | Fertilizer | Power | | Fertilizer | Power | |
| Jammu and Kashmir | 2,363 | – | 2,363 | 2,988 | – | 2,988 |
| Himachal Pradesh | 1,169 | 375 | 1,545 | 1,445 | 463 | 1,908 |
| Punjab | 2,988 | 84 | 3,071 | 4,044 | 114 | 4,157 |
| Uttaranchal | 2,427 | 172 | 2,599 | 2,877 | – | 2,877 |
| Haryana | 7,103 | 126 | 7,230 | 9,869 | 175 | 10,045 |
| Rajasthan | 1,757 | 349 | 2,105 | 2,290 | 455 | 2,745 |
| Uttar Pradesh | 4,421 | 228 | 4,649 | 5,241 | 270 | 5,512 |
| Bihar | 3,782 | 159 | 3,940 | 4,314 | 181 | 4,495 |
| Assam | 4,980 | 163 | 5,143 | 6,086 | 199 | 6,285 |
| West Bengal | 3,706 | 29 | 3,735 | 4,539 | 36 | 4,575 |
| Jharkhand | 3,350 | 63 | 3,413 | 3,821 | 72 | 3,893 |
| Odisha | 2,480 | 204 | 2,684 | 3,041 | 250 | 3,291 |
| Chhattisgarh | 1,179 | 139 | 1,318 | 1,302 | 153 | 1,455 |
| Madhya Pradesh | 2,715 | 190 | 2,904 | 2,998 | 210 | 3,207 |
| Gujarat | 3,768 | 341 | 4,110 | 4,913 | 445 | 5,358 |
| Maharashtra | 3,911 | 256 | 4,166 | 5,286 | 346 | 5,632 |
| Andhra Pradesh | 1,036 | 48 | 1,084 | 1,391 | 64 | 1,456 |
| Karnataka | 3,478 | 275 | 3,753 | 5,011 | 396 | 5,407 |
| Kerala | 5,236 | 257 | 5,493 | 7,271 | 357 | 7,628 |
| Tamil Nadu | 6,733 | 542 | 7,275 | 10,215 | 822 | 11,037 |
| All India | 4,012 | 231 | 4,243 | 5,179 | 298 | 5,477 |

The exercise is undertaken for canal irrigation as well. Results are not presented due to lack of state-wise data on per ha cost of supply of irrigation water. Akin to power, canal irrigation water is found to be highly subsidized in most states. The elasticity estimates are fairly the same as those obtained in the case of power. As such, the response of value of irrigation as an input to value of output is low at 0.04 (elasticity value) across each state except in Tamil Nadu and Rajasthan at 0.18 and 0.25. It is, however, found to be negative in Punjab, Odisha, and Karnataka.

The low and statistically insignificant response could be explained by a low share of cost of water in total value of output. In addition, farmers may have lower dependence on canal irrigation due to inefficiency in the timely delivery, and distribution of water and negligible development of the command area and channels. In every respect, similar to power, the impact

of removal of subsidy on canal water on output turns out to be minuscule.

Conclusions

This paper estimates the impact on agricultural output in a hypothetical situation wherein the subsidies on fertilizers and power are eliminated and their prices increase. It then calculates the amount to be credited to farmers' bank accounts if the existing input-based price support policy is replaced with an income support policy under the ambit of the DBT scheme. The paper assumes that the cash transfer system will enable optimal input use and improve efficiency and productivity. It assumes, also, that input use, and agricultural output prices, are constant. The analysis will help in drawing inferences about the possibility of reallocating subsidies across states.

The analysis indicates that the national agricultural output will fall 11.95% if the government withdraws its support to fertilizers and power. The lowest impact is detected in Himachal Pradesh (2.47%) and the highest in West Bengal (13.94%). The decrease is primarily on the account of fertilizers. The literature holds that curtailing the subsidy is difficult unless output prices are raised significantly and/or the consumption of inputs—if used sub-optimally—rises. Our findings are in line with those in the literature. Switching to the DBT system while retaining the current income level would entail providing INR 5,477 per ha to farmers to purchase inputs at market price (INR 5,179 for fertilizers and INR 298 for power). The amount varies from a maximum of INR 11,037 in Tamil Nadu and INR 10,045 per ha in Haryana to as low as INR 1,400 per ha in Chhattisgarh and Andhra Pradesh. Large inter-state variations in the estimates are explained by the quantum of input consumption, responsiveness of output to inputs, and of inputs consumed to their respective prices.

The second important finding that aligns with the existing literature is that *ceteris paribus*, the developed states seem to be the beneficiaries of subsidies—not the less developed where the land productivity is low. The key question is whether targeting subsidies towards less developed states would help increase input consumption and yield. We map the existing status of input usage, land productivity, and environmental outcomes in each state. The analysis reveals that agricultural output is highly responsive to fertilizer

price, albeit mildly to energy price and hardly at all to canal irrigation water. This indicates that the dependence of farmers on surface irrigation water is low. That seems plausible—the increase in the share of surface water bodies in the irrigated area is negligible. The net sown area is 143 million ha, but only 46% is irrigated. However, more than 70% of the net sown area in Punjab, Haryana, Uttar Pradesh, and Bihar is irrigated (Figure 3).

More of groundwater is used for irrigation; the net area irrigated by tube wells has increased at 2.5% per annum, and it is almost double the net area irrigated by tube wells. But the area irrigated by canals has grown at hardly 0.6% per year. More of surface water than groundwater is used for irrigation in Jammu and Kashmir, Assam, Chhattisgarh, Andhra Pradesh, Kerala, Tamil Nadu, and Gujarat. Other states depend much more on groundwater. The dependence can be attributed largely to the subsidy on electricity and diesel and to the time and cost of building canal networks. The government has invested sizeably in major and medium irrigation systems year on year, and on the generation and distribution of rural energy, but the irrigation intensity has not increased; the investments, and systems, have been ineffective. Raising the rates for canal water and energy in accordance with their costs of supply have affected output only in Himachal Pradesh, Assam, Gujarat, and Rajasthan (by almost 2%); the effect may not be significant elsewhere. But revising the rates to recover at least the cost of operation and maintenance will help sustain the facilities and

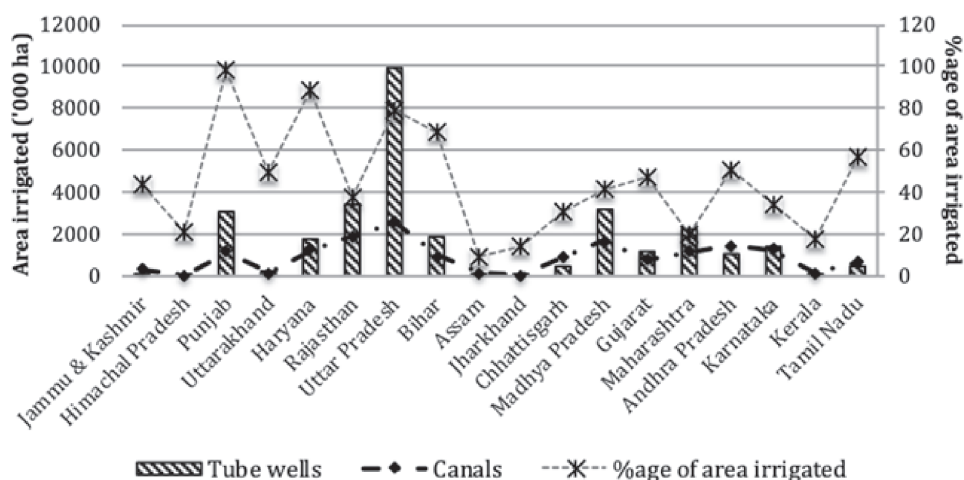


Figure 3 State-wise net irrigated area by sources (2013–14)

Source: Agricultural Statistics at a Glance, MOA&FW, GoI, 2016.

prevent overuse, as argued in Gulati and Banerjee (2017).

The annual per capita availability of water will fall below 1,000 cubic metres (m³) by 2030. Given its current population growth rate, water will soon become scarce in India. Paddy, a water-intensive crop, dominates agriculture in Punjab, Haryana, and Tamil Nadu. These agriculturally developed states are already ‘dark zones’—over 86% of their available groundwater

has been exploited (Table 4), and there is little scope for increasing the usage of groundwater. If the subsidy on energy is removed entirely, the saving in groundwater will be about 29–82%; but farmers may shift away from cultivating paddy, which would considerably affect their incomes (Srivastava et al. 2017). The development of groundwater is below 65% in several states, particularly the eastern states, and their groundwater potential can be harnessed. But

Table 4 Land productivity and consumption status of key agriculture inputs

| Land productivity | 000/ha | 5–40 ‘000/ha J&K, Chhattisgarh, Himachal Pradesh, Assam | 41–75 ‘000/ha Madhya Pradesh, Bihar, Uttarakhand, Uttar Pradesh, Odisha, Jharkhand, Rajasthan, Gujarat | 76–115 ‘000/ha Haryana, Punjab, Andhra Pradesh, Maharashtra, Karnataka, Kerala, Tamil Nadu, West Bengal |
|-------------------------------|--|---|--|---|
| | | Deficit consumption | Normal Consumption | Excess Consumption |
| Fertilizer* | Excess/Deficit % (normative–actual/ normative) | Assam, Chhattisgarh, Gujarat, Himachal Pradesh, Jharkhand, J&K, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Odisha, Rajasthan, Uttarakhand, Uttar Pradesh, West Bengal | Bihar, Tamil Nadu | Andhra Pradesh, Haryana, Punjab |
| Energy** | Stages of groundwater development (%) | White area (less than 65%) Assam, J&K, Odisha, Jharkhand, Chhattisgarh, West Bengal, Bihar, Andhra Pradesh, Kerala, Maharashtra, Uttarakhand, Madhya Pradesh, Himachal Pradesh | Grey area (65–85%) Karnataka, Uttar Pradesh, Gujarat, Tamil Nadu | Dark area (more than 85%) Haryana, Punjab, Rajasthan |
| Surface water resource *** | Utilizable/ Potential (%) | <40% utilizable Assam, Kerala, Tamil Nadu | 40–60% utilizable Haryana, Rajasthan, Uttar Pradesh, Bihar, West Bengal, Jharkhand, Madhya Pradesh, Maharashtra, Karnataka | >60% utilizable Himachal Pradesh, Punjab, Odisha, Chhattisgarh, Gujarat, Andhra Pradesh |

Source Land productivity is the sum of food grains, oilseeds, sugarcane, and cotton during TE 2014–15. State names are listed in increasing order. *Chand and Pavithra (2015); **Dynamic Ground Water Resources of India, as on 31 March 2013. ***Based on data given in Water and Related Statistics, Central Water Commission (2015)

investments in energy may be required, and the supply of electricity must be assured. In Odisha, where the groundwater is underutilized, the cost of extracting it at the de-subsidized electricity tariff is less than that of diesel-operated pumps even at the subsidized price, find Srivastava et al. (2014).

The cumulative irrigation potential created from major and medium irrigation systems is 47.97 million ha, of which 34.95 million ha (73%) has been utilized so far; the potential from micro irrigation systems is 65.56 million ha, and 52.91 million ha (80.7%) has been utilized so far—going by the statistics presented for the 11th Five Year Plan (2007–12) (CWC 2015). The cumulative surface water potential in India is 1,869.4 billion m³. About 37%, or 690.3 billion m³, is utilizable; so there is some scope to increase the supply. The percentage share of surface water utilized to potential exceeds 80% in Himachal Pradesh, Punjab, Odisha, Chhattisgarh, Gujarat, and Andhra Pradesh. Given this water usage scenario, some scope for development exists in the other states. Investments should be made in canal irrigation systems to improve their efficiency, currently 30–65% for surface irrigation systems and 65–75% for groundwater irrigation systems (Gulati and Banerjee 2017). Incentivizing farmers to use water-saving micro-irrigation (drip and sprinkler) systems, and implementing technological advancements to carry water from the canals to the fields efficiently, would go a long way.

Following the green revolution in the 1960s, the consumption of nitrogen, phosphorus, and potash (NPK) increased tremendously (Figure 4). The consumption is skewed highly towards nitrogen, mainly through urea; the application of NPK exceeds the recommended dose of 4:2:1. The consumption of urea increased from 250,000 metric tons in 1961–62 to 16.946 million metric tons in 2014–15 in comparison to phosphorus and potash. Andhra Pradesh, Punjab, and Haryana apply NPK fertilizers in excess (Chand and Pavithra 2015). The application of NPK is moderate in Bihar and Tamil Nadu, and up to 60% in the other states—less than the optimum. Nitrogen is applied in excess through urea in Andhra Pradesh, Assam, Bihar, Haryana, Jharkhand, and Punjab. The use of NPK in excess of the recommended dose is solely the result of the subsidy on urea, hold Chand and Pavithra (2015), and the excessive use has affected soil quality. In 2010, the government altered its

fertilizer policy: it introduced a nutrient-based subsidy (NBS), which mandates a fixed rate of subsidy on NPK on an annual basis, and it decontrolled the maximum retail price (MRP) of each fertilizer (barring urea). But this move has encouraged the over-consumption of N relative to P and K. The focus should be to achieve the optimum level of application of NPK rather than a particular ratio in composition, emphasize Chand and Pavithra (2015).

In the agriculturally advanced states—Haryana, Andhra Pradesh, Gujarat, Maharashtra, Tamil Nadu, and Karnataka—agricultural production will fall 10–14% if fertilizer and power subsidies are cut unless output prices increase to a reasonable level. Withdrawing the subsidies would affect the less developed states the most—Assam, Bihar, Rajasthan, Uttar Pradesh, Odisha, Jharkhand, and West Bengal. The government would need to transfer INR 5,477 per ha (2017–18) to enable farmers to purchase inputs and make the same net income; this estimate, for the all-India level, varies significantly by state.

The analysis makes evident that the consumption of fertilizers—and energy, for the extraction of groundwater—has crossed the limit in most of the agriculturally advanced states. Since paddy is the dominant crop in these states, it is important to look into alternative crops and/or rationalize input use so that farmers' incentives are not jeopardized. The government subsidizes urea, and the fertilizer mix is skewed; the subsidy delivery system through the DBT scheme must aim to correct the fertilizer mix.

The option of reallocating subsidies away from Haryana, Punjab, Tamil Nadu, and Andhra Pradesh towards other states, with an emphasis on the less developed ones, holds promise. Fertilizer and power consumption is increasing fast in several less developed states, but it is within the prescribed limits, and the ecological impact is little. If the government revamps the distribution system, and targets the subsidies towards the states appropriately, farmers will have the incentive to increase the application of inputs without compromising efficiency. However, and as advocated in many studies, the policy should have a clear 'exit' strategy in view of the fiscal and environmental costs of subsidies. And it must support complementary investments in R&D, energy, and major, medium, and micro irrigations (drip and sprinkler) for productivity gains in the long run.

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Appendix

Table 1 Annual rate of growth in expenditure (%/ha) on key inputs (2002–2012, at 2004–05 prices)

| States | Seeds | Pesti- cides— Insecti- cides | Fertilizer— Manure | Irrig- ation | Minor repair and mainte- nance of machinery | Interest payment | Land lease rent | Labour | Other expenses | Total |
|------------------|-------|---------------------------------------|-----------------------|-----------------|--|---------------------|-----------------------|--------|-------------------|-------|
| Jammu & Kashmir | −1.7 | −9.5 | −5.2 | 10.5 | 10.0 | — | 24.1 | 3.4 | 2.0 | −1.3 |
| Himachal Pradesh | −1.9 | 10.8 | 3.4 | 14.7 | 5.3 | −6.6 | 2.3 | 8.3 | 10.8 | 6.7 |
| Punjab | 4.6 | 6.5 | 6.5 | 9.1 | 4.7 | 17.5 | 18.2 | 4.5 | 9.8 | 8.9 |
| Uttarakhand | 0.4 | 6.1 | −0.4 | 7.0 | 17.5 | 21.7 | −7.8 | 2.8 | 3.7 | 2.8 |
| Haryana | 7.2 | 7.7 | 3.6 | 1.4 | 2.4 | −6.5 | 0.9 | 5.4 | 2.6 | 3.5 |
| Rajasthan | 7.5 | −2.0 | 4.8 | 2.1 | 11.7 | 20.7 | −11.5 | 10.1 | 8.7 | 5.7 |
| Uttar Pradesh | −1.2 | 9.4 | 6.1 | 4.3 | 9.1 | 13.2 | 8.2 | 6.1 | 5.2 | 4.9 |
| Bihar | −0.6 | 1.3 | 5.0 | 3.5 | 1.8 | 18.9 | 4.9 | 2.7 | 4.5 | 3.3 |
| Assam | −5.3 | 1.5 | 5.8 | −0.1 | 9.6 | −15.1 | −16.8 | 7.4 | 12.2 | 4.0 |
| West Bengal | 1.6 | 1.9 | 5.1 | 4.2 | 3.4 | 18.3 | 8.4 | 5.6 | 7.0 | 4.9 |
| Jharkhand | 1.8 | 5.7 | 8.3 | 8.2 | 7.3 | 74.2 | 45.9 | 6.3 | 17.6 | 7.1 |
| Odisha | −2.9 | 14.2 | 11.2 | 9.0 | 6.4 | 5.0 | 5.4 | 7.5 | 11.9 | 8.1 |
| Chhattisgarh | −1.5 | 9.1 | 7.7 | −2.7 | 8.9 | 0.4 | 3.2 | 1.2 | 14.7 | 4.8 |
| Madhya Pradesh | 2.5 | 12.3 | 12.0 | 14.7 | 12.8 | 13.9 | 14.2 | 5.8 | 13.8 | 9.5 |
| Gujarat | 3.8 | 1.7 | 3.6 | 2.7 | 2.7 | −13.5 | 8.9 | 4.9 | 5.3 | 3.7 |
| Maharashtra | 6.2 | 7.8 | 8.8 | 7.8 | 10.4 | −6.3 | −4.5 | 4.7 | 9.3 | 6.9 |
| Andhra Pradesh | −1.2 | 4.0 | 3.5 | −2.7 | −5.3 | 8.3 | 10.9 | 5.3 | 7.9 | 4.8 |
| Karnataka | 1.8 | 2.2 | 4.7 | −0.4 | 3.7 | 8.6 | 10.0 | 6.6 | 7.0 | 4.9 |
| Kerala | 9.3 | 0.2 | 2.7 | −3.6 | 6.0 | 19.3 | 23.8 | 4.7 | 3.8 | 4.9 |
| Tamil Nadu | 14.5 | 18.6 | 18.3 | 4.1 | 9.0 | 10.4 | 23.2 | 12.6 | 21.0 | 15.5 |
| All India | 2.6 | 6.7 | 6.8 | 4.3 | 6.6 | 8.1 | 9.9 | 6.1 | 8.2 | 6.2 |

Source Based on NSS 59th and 70th rounds, GoI.

Table 2 Impact of withdrawal of fertilizer subsidy on agricultural output, 2012–13

| States | No. of observ- ations | Elasticity of value of output w.r.t. fertilizer expenditure | Elasticity of fertilizer consumption w.r.t. real price of fertilizer | Elasticity of output w.r.t. input price | Weighted price of NPK 2012–13 INR/kg | Fertilizer subsidy in 2012–13: INR million | Fertilizer consumption 2012–13: Thousand tons | Subsidy (INR/kg) | % increase in fertilizer price due to subsidy removal | % reduction in agri output |
|------------------|-----------------------------|---|---|--|--|---|---|---------------------|---|-------------------------------------|
| Jammu & Kashmir | 428 | 0.07*** | -0.65 | -0.05 | 40 | 3032 | 110 | 27.64 | 69.11 | -3.25 |
| Himachal Pradesh | 110 | 0.04 | -0.65 | -0.03 | 40 | 1318 | 48 | 27.64 | 69.11 | -1.87 |
| Punjab | 339 | 0.08 | -0.65 | -0.05 | 40 | 54,521 | 1972 | 27.64 | 69.11 | -3.52 |
| Uttaranchal | 99 | 0.09 | -0.65 | -0.06 | 40 | 4216 | 153 | 27.64 | 69.11 | -3.96 |
| Haryana | 257 | 0.24* | -0.65 | -0.15 | 40 | 37,325 | 1350 | 27.64 | 69.11 | -10.59 |
| Rajasthan | 524 | 0.18* | -0.65 | -0.12 | 40 | 37,159 | 1344 | 27.64 | 69.11 | -8.29 |
| Uttar Pradesh | 2219 | 0.19* | -0.65 | -0.12 | 40 | 128,572 | 4651 | 27.64 | 69.11 | -8.53 |
| Bihar | 535 | 0.24* | -0.65 | -0.16 | 40 | 42,207 | 1527 | 27.64 | 69.11 | -10.97 |
| Assam | 182 | 0.20* | -0.65 | -0.13 | 40 | 7620 | 276 | 27.64 | 69.11 | -8.83 |
| West Bengal | 609 | 0.31* | -0.65 | -0.2 | 40 | 43,136 | 1560 | 27.64 | 69.11 | -13.83 |
| Jharkhand | 226 | 0.27* | -0.65 | -0.18 | 40 | 5463 | 198 | 27.64 | 69.11 | -12.1 |
| Odisha | 147 | 0.24* | -0.65 | -0.16 | 40 | 13,551 | 490 | 27.64 | 69.11 | -10.86 |
| Chhattisgarh | 75 | 0.08 | -0.65 | -0.05 | 40 | 16,633 | 602 | 27.64 | 69.11 | -3.64 |
| Madhya Pradesh | 816 | 0.18* | -0.65 | -0.12 | 40 | 51,675 | 1869 | 27.64 | 69.11 | -8.11 |
| Gujarat | 363 | 0.30* | -0.65 | -0.2 | 40 | 37,097 | 1342 | 27.64 | 69.11 | -13.66 |
| Maharashtra | 572 | 0.29* | -0.65 | -0.19 | 40 | 68,353 | 2473 | 27.64 | 69.11 | -13.19 |
| Andhra Pradesh | 239 | 0.24* | -0.65 | -0.16 | 40 | 75,941 | 2747 | 27.64 | 69.11 | -10.94 |
| Karnataka | 153 | 0.22* | -0.65 | -0.14 | 40 | 42,328 | 1531 | 27.64 | 69.11 | -9.73 |
| Kerala | 134 | 0.14* | -0.65 | -0.09 | 40 | 8906 | 277 | 32.13 | 80.33 | -7.37 |
| Tamil Nadu | 297 | 0.21* | -0.65 | -0.14 | 40 | 26,174 | 947 | 27.64 | 69.11 | -9.61 |
| All India | 7957 | 0.25* | -0.65 | -0.16 | 40 | 705,227 | 25,466 | 27.69 | 69.23 | -11.26 |

Note *, **, and *** significant at 1, 5 and 10 % level of significance; Source Based on NSS 70th round, GoI.

Table 3 Impact of withdrawal of power subsidy on agricultural output, 2012–13

| States | No. of observations | Elasticity of value of output wrt expenditure on power | Elasticity of power use w.r.t. real price of power | Elasticity of output w.r.t. input price | Average cost of supplying power 2012–13 (INR/kwh) | Power subsidy : 2012–13: INR million | Power consumption : 2012–13: INR Million/kwh | Subsidy (INR/kwh) | % increase in energy price due to subsidy removal | % reduction in agri output |
|------------------|---------------------|--|--|---|---|--------------------------------------|--|-------------------|---|----------------------------|
| Himachal Pradesh | 110 | 0.05 | -0.12 | -0.01 | 5.44 | 197 | 36 | 5.44 | 100 | -0.6 |
| Punjab | 339 | 0.01 | -0.12 | -0.001 | 5.45 | 62,363 | 11,456 | 5.44 | 99.94 | -0.1 |
| Uttaranchal | 25 | — | -0.12 | 0.004 | 4.95 | 970 | 364 | 2.66 | 53.82 | — |
| Haryana | 257 | 0.02 | -0.12 | -0.002 | 6.8 | 52,020 | 8237 | 6.32 | 92.93 | -0.19 |
| Rajasthan | 524 | 0.17* | -0.12 | -0.021 | 7.21 | 96,930 | 16,894 | 5.74 | 79.59 | -1.64 |
| Uttar Pradesh | 2219 | 0.06* | -0.12 | -0.01 | 6.72 | 42,525 | 9771 | 4.35 | 64.76 | -0.44 |
| Bihar | 535 | 0.07* | -0.12 | -0.01 | 8.64 | 2432 | 479 | 5.07 | 58.7 | -0.46 |
| Assam | 182 | 0.07 | -0.12 | -0.01 | 6.85 | 88 | 37 | 2.38 | 34.8 | -0.29 |
| West Bengal | 609 | 0.03*** | -0.12 | -0.004 | 5.91 | 2518 | 1421 | 1.77 | 30 | -0.11 |
| Jharkhand | 226 | 0.02 | -0.12 | -0.003 | 7.48 | 488 | 72 | 6.78 | 90.61 | -0.23 |
| Odisha | 147 | 0.09** | -0.12 | -0.011 | 5.33 | 748 | 177 | 4.22 | 79.27 | -0.89 |
| Chhattisgarh | 75 | 0.05 | -0.12 | -0.01 | 4.18 | 7139 | 2525 | 2.83 | 67.68 | -0.43 |
| Madhya Pradesh | 816 | 0.11* | -0.12 | -0.013 | 6.01 | 31,255 | 11,980 | 2.61 | 43.38 | -0.57 |
| Gujarat | 363 | 0.19* | -0.12 | -0.022 | 4.85 | 38,932 | 14,438 | 2.70 | 55.65 | -1.24 |
| Maharashtra | 572 | 0.13* | -0.12 | -0.02 | 5.5 | 68,370 | 22,054 | 3.10 | 56.39 | -0.86 |
| Andhra Pradesh | 239 | 0.04 | -0.12 | -0.01 | 5.27 | 111,773 | 21,997 | 5.08 | 96.44 | -0.50 |
| Karnataka | 153 | 0.16* | -0.12 | -0.02 | 5.0 | 35,403 | 17,509 | 2.02 | 40.4 | -0.77 |
| Kerala | 134 | 0.04 | -0.12 | -0.005 | 6.59 | 1486 | 293 | 5.06 | 76.84 | -0.36 |
| Tamil Nadu | 297 | 0.06** | -0.12 | -0.01 | 7.01 | 63,947 | 8956 | 7.14 | 100 | -0.77 |
| All India | 7957 | 0.08* | -0.12 | -0.01 | 5.94 | 577,131 | 148,752 | 3.88 | 65.32 | -0.65 |

Note *, ** and *** significant at 1, 5 and 10 % level of significance; Value of input includes expenditure on diesel; Source NSS 70th round.

