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Indian agriculture: Key challenges and productivity roadblocks

[1]Gokul S and [2]Geetika

[1] Institute of Rural Management Anand (IRMA), Anand, Gujarat, India

[2] Delhi School of Economics, Delhi, India

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Corresponding Author: Gokul S

Abstract

The paper "Indian Agriculture: Key Challenges and Productivity Roadblocks" aims to provide a critical analysis of ultimatums plaguing agricultural productivity in India. These ultimatums majorly have their roots from three main domains namely: Farm size, Irrigation coverage and Credit. In case of Farm sizes, a regression on the NSSO 77th round data on Agriculture in India proved that there is a negative relationship between land size and productivity in India. A comparison of relative challenges constraining productivity of small farmers and large farmers was done. Polynomial Regression was done to evaluate the marginal impact of irrigation on yield, along with making a distinction for irrigation methods which uses electricity and impact of fertilizers and subsidy was analyzed on yield - irrigation relationship. A panel data regression proved positive relation between formal credit and productivity. This result is supported by another panel data regression proving that formal credit access leads to greater usage of inputs. Further, Regional and analysis on the basis of land size was done to highlight the importance of formal credit.

Keywords: Agricultural productivity, polynomial regression, farm size, irrigation coverage, credit.

Introduction

Agriculture continues to be a significant primary concern for nations around the world, even after its diminishing amount of overall GDP. Agriculture's sharp decline in the proportion of national income and employment has even been referred to as a nation's economic restructuring. Elevating agricultural growth must have long been identified as a crucial major contributor. Intensive land productivity or intensive land availability for each farmer, as well as technological advances, should both increase agrarian labor productivity. Nevertheless, in India, the spectacular rise in land productivity caused by industrial agriculture activities that have caused severe ecological harm and have not improved agricultural labor productivity. Throughout the years ahead, India will face the challenges of intensifying farm productivity whilst still growing adaptive capacity to climate variability. Those certain focus areas might very well compel authorities to make choices. The whole study proposes a new schema in Indian agriculture through most of the surrogacy of agricultural systems beliefs at continuum by exhibiting that India's progression of restructuring is economically unviable.

In the study, there are various consensus conclusions based on Land size and Productivity, Agricultural Credit, and Irrigation. Numerous traditional on-premise concerns have arisen in Indian agriculture over the years. One pattern of hardships is expected to augment labor productivity on a typical Indian pasture. Countless Indian farmlands are stuck in a vicious cycle of low labor productivity, culminating in eroded living standards. Advancement of resources seems to have been one technique for boosting land productivity, of positive findings. Improved irrigation domain since Green Revolution, along with synthetic fertilizers' and pesticides' increased use, have led to greater land productivity. The latter Green Revolution ascertained that India transitioned from something like a cereal imbalance to cereal reserves. Meanwhile, throughout turn increase in farmer expenditures, the advancement of resources has devastating effects on the environment of the country and, as a matter of fact, on the entire planet. Here comes the following stumbling block, which is otherwise closely linked to environmental stewardship including the prevailing holistic approach diagnosed and treated in India, take place. It is imperative that credit is available in agriculture for crop production and associated activities. In the absence of adequate financial resources, most farmers must borrow to survive.

Literature Review

The literature takes shape starting from the late 1960s when evidence towards an inverse relationship between productivity and land size in India started taking a solid shape, 'Both in paddy and wheat agriculture the observed negative relation between output per acre and farm size is likely to be the result of more of an inverse relationship between size and other inputs than of scale diseconomies' (Bardhan, 1973) [5]. The smaller the farm, the farmer applies to input, especially labor, thereby pumping the output higher. The overall family labor being applied increases as the size of the holding falls (Sen, A.K. (1964) [4]. "Size of Holdings and Productivity). On the basis of Food and Agricultural Organization farm management data of fifteen

developing countries in the world, there exists a negative and strong correlation between yields per hectare and farm size (Cornia, G.A.1985. Farm size, land yields, and the agricultural production function).

However, there is no unanimity on the relation between land sizes and productivity. Obasi (2007) from his research concluded a positive relationship between productivity and farm size in Nigeria. Explaining this deviation, Obasi talked about the lack of resource problem that farmers with small farm size face. In the context of advanced economies, the relationship between farm size and labor productivity has been majorly positive. This can be seen in the works of Rahman and Rahman- 2009.

Taking from the 'Situation Assessment Survey of Farmers' by the National Sample Survey Organisation -59th round on "Income, Expenditure and Productive Assets of Farmers Households" for the year 2002-2003. Report no 497 gives us results indicating that large operating farms (over 10 hectares) had very low productivity with less than 33% of the productivity of the smaller farms. In terms of production performance, the smaller farms are better (Situation Assessment Survey, NSSO 59th round, and Report No.497)

The Productivity of Agricultural Credit in India by Sudha Narayanan (January 2015), utilized state level regression analysis from 1995-96 to 2011-12, this research explores the importance of the interaction between structured agricultural credit and agricultural GDP in India, precisely the influence of the notion in assisting overall economic growth. To fix the challenges of unobserved heterogeneity, the paper applied a correlational framework to trace the channels through which institutional credit corresponds to agricultural GDP. According to both the results of the assessment, all the resources are extremely responsive to an expansion in institutional credit to agriculture throughout the timeframe. A 10% enhancement in marginal credit flow pattern in a 1.7% growth in physical fertilizer (N, P, K) usage, a 5.1% rise in pesticide tonnes, and a 10.8% increment in tractor transactions. On the whole, it's indeed clear that reference use is susceptible to credit flow, even though agricultural GDP is not. Credit has seemed to become a facilitating parameter, but its performance is challenged by low technical productivity and efficiency. Irrespective of all these accumulated observations, comprehensive microstudies would've been needed to include perspective further into the matter.

India's agricultural development: a regional perspective by P.S. Vijayshankar, He intended to include an outline of regional variations in agricultural growth over the last four decades in the paper (19622008). The whole publication sought to analyze the possible causes of sectorial divergence and increasing inter-regional imbalances in India by concentrating on agro-based sectors well below the state level. While the integration of such variations in spectral categories is merely an illustration of the versatile forces at work, most empirical research is essential to unmask attributes of these transitions in specific circumstances. Responsiveness to regional variations and booming disparities, as well as the way they structure and yet are influenced by people's consciousness and desires, has a massive effect not just on the theory of development but additionally on representative democracy and a sustainable future.

Power Asymmetry and Unequal Exchange in the Agricultural Value Systems: Case study of paddy by Manish Kumar, in which the power asymmetry and structural complexity within Agricultural Value Systems were examined. The emergence of power asymmetry is due to the distinct characteristics of the AVS's cultivation and non-cultivation sections, as well as varying assets within the agricultural community. AVS's power asymmetry exchanges a balanced budget from cultivation to non-cultivation portions of the AVS. At the policy level, several provisions that deliberately rural workers to achieve a relatively high response from agricultural production were addressed. Nevertheless, even these practices need not apply uniformly throughout India's states. The Allied Government supports fertilizer rebates, that also assist with the cost of cultivation. Free- of-cost electricity for irrigation purposes is offered by the provincial government in Punjab, and the expense of irrigation in Punjab is relatively lower than in Bihar. These very frameworks enable

farmers in continuing to increase their agricultural excess capacity. Government interference in

the forward connectivity aids in reducing overabundance overflows from agriculture. Punjab's public procurement of rice is indeed very high, which adds value to the higher cost obtained by farmers.

Global Agricultural Value Systems and the South: Some Critical Issues at the Current Juncture by Praveen Jha and Paris Yeros, the main thrust of what is alluded to in the paper as Global Value Systems, a concept introduced in its conditions that contribute to the fascinating history. It was then implemented in global agriculture to conclude that perhaps the advancement of Global Agricultural Value Systems, through furthermore to GVSs in manufacturing and services, is a key feature of the contemporary capitalist system. GAVSs have helped to boost major land mergers and acquisitions as well as contract farming approaches in the South's outer fringes. The current dominant frameworks of GVSs, which are intrinsically tied to neoliberal economics, are finely balanced even against the substantial proportion of the South's agrarian society. The governing neoliberal system must have the capacity to adapt to the upliftment of colonial expansion through

GVSs, notably in the agrarian realm, culminating in the transferring of assets, capital, and revenue from the susceptible general populace to wealthier categories and nations. Theories and models have been sorely needed beyond the currently dominant GVSs and agribusinesses. A plethora of examples from history to bring from, yet these are evidently conditional upon the power of social and political redeployment. Throughout the later part, it's the variance within the distribution of power and course of action that needs to be resolved; the tokens have been majorly supported by the majority of major businesses, regardless of whether national or international, as well as profoundly fulfill the needs about what is described as "generalized monopoly imperialism."

Materials and Methods

The study focuses on establishing the relation of productivity with farm size, irrigation coverage and credit.

a) Land size and Productivity

Land size or Farm size as it is interchangeably called refers to the total operational land that a farmer has. It is calculated as the sum of land that the farmer owns and the land that she leases, minus land that is leased out or left barren. Productivity on the other hand, as defined in the context of land, is the amount of output produced from one unit of land.

The relationship between productivity and land size has been a tricky one. One will intuitively assume this to be positive, i.e. increase in land size will increase productivity because of economies of scale, big farmers having access to resources, and several other such reasons. But this is just half the story. There are several other factors at play in deciding the relationship between productivity and farm size. Thus, this does not hold true in the empirical evidence, especially in the context of Asian economies like China and India.

The section establishes the relationship between productivity and farm size in the Indian context. The data on farm size and output are taken from unit-level data and report on NSS 77th round. A regression analysis was carried out with the following model:

$$Y = \alpha X \beta$$

Where:

Y = Output per unit land/productivity
X = Farm Size
The above model can also be transformed as:

$$\ln Y = \ln \alpha + \beta \ln X$$

The relationship between productivity and land size is ascertained by the sign of β coefficient. A negative (-) sign of the β coefficient indicates an inverse relationship between farm size while a positive β coefficient does the opposite.

Having run the regression on NSS's 77th round of data using the above model, the following results were found.

```
Call:
lm(formula = Final$productivity ~ Final$land)

Residuals:
     Min       1Q   Median       3Q      Max
-0.97732 -0.06725  0.03566  0.10179  0.47498

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  1.865126   0.004253 438.529  < 2e-16 ***
Final$land  -0.026711   0.005570  -4.796  1.8e-06 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.1551 on 1377 degrees of freedom
Multiple R-squared:  0.01643,   Adjusted R-squared:  0.01571
F-statistic:    23 on 1 and 1377 DF,  p-value: 1.796e-06
```

The value of the β coefficient is observed to be negative and highly significant (significant at 0.1%). Similarly, the intercept term is also found to be significant at 0.1%. This indicates a negative relationship between farm size and productivity in the Indian context.

To explore the probable reasons behind this result, the 2018 Ministry of Agriculture report (Table 15.7, pg. 372) is referred to, which provides data on the usage of chemical fertilizers, farm yield, manure, and pesticides across different farm size categories. The farm size categories are defined as follows: marginal (below 1 hectare), small (1.0-1.99 hectares), semi-medium (2.0-3.99 hectares), medium (4.0-9.99 hectares), and large (10 hectares and above). The table also includes information on total irrigated land and the area treated with fertilizers for each category.

Using the data from the table, the following conclusions are drawn:

- **Usage of Irrigation**

The significance of irrigation in agriculture cannot be overstated. A good harvest cannot be achieved without ensuring proper irrigation for crops. Given the erratic and sparse rainfall in many Indian regions, reliance on rainfall as the primary water source for crops is not feasible. Uniform water supply and soil moisture are essential for achieving good crop yields.

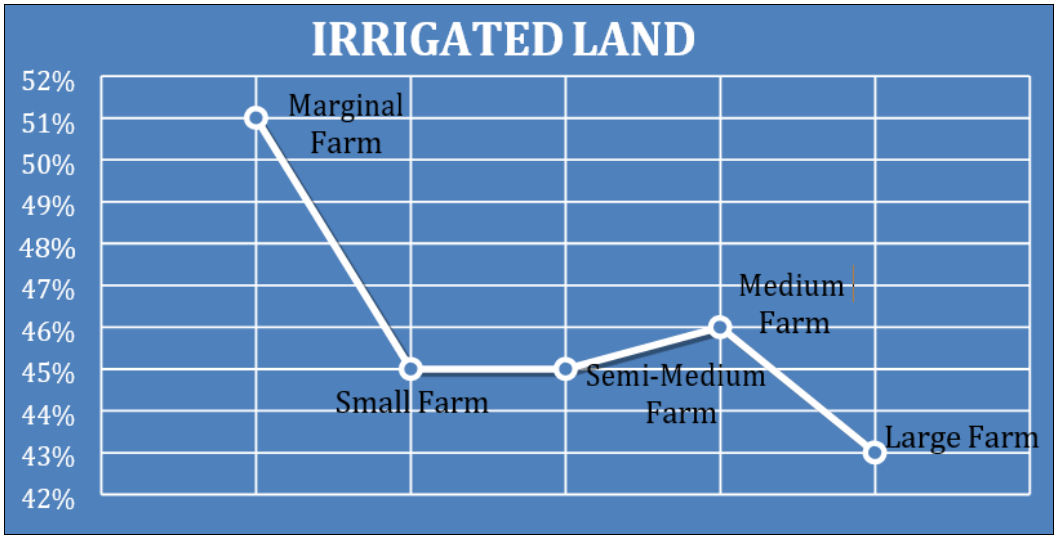


Fig 1: Percentage of irrigation v/s farm sizes

The percentage of irrigated land for various farm sizes is calculated from the table, and the findings are summarized accordingly. From the above observation, it is seen that as farm sizes increase, the total land under irrigation decreases. This indicates that better irrigation facilities are available to farmers with small farm holdings compared to those with larger farm sizes. One possible explanation for this is that smaller farmers, having limited resources to rely on, attempt to maximize output and ensure efficient use of the available land by providing regular irrigation to their fields. This could be a potential reason for the observed decline in productivity with an increase in farm size.

Use of Fertilizers

Soil takes considerable time to replenish its nutrients, and after multiple harvests, it loses essential nutrients necessary for healthy crop yields. Fertilizers are required in agriculture to restore nutrients, enhance the water retention capacity of plants, and ultimately increase the farmer's income. Fertilizers are estimated to contribute to approximately a 50% increase in the country's food grain production.

From the table, the percentage of land under various farm sizes that receives fertilizer treatment is calculated, and the findings are presented accordingly.

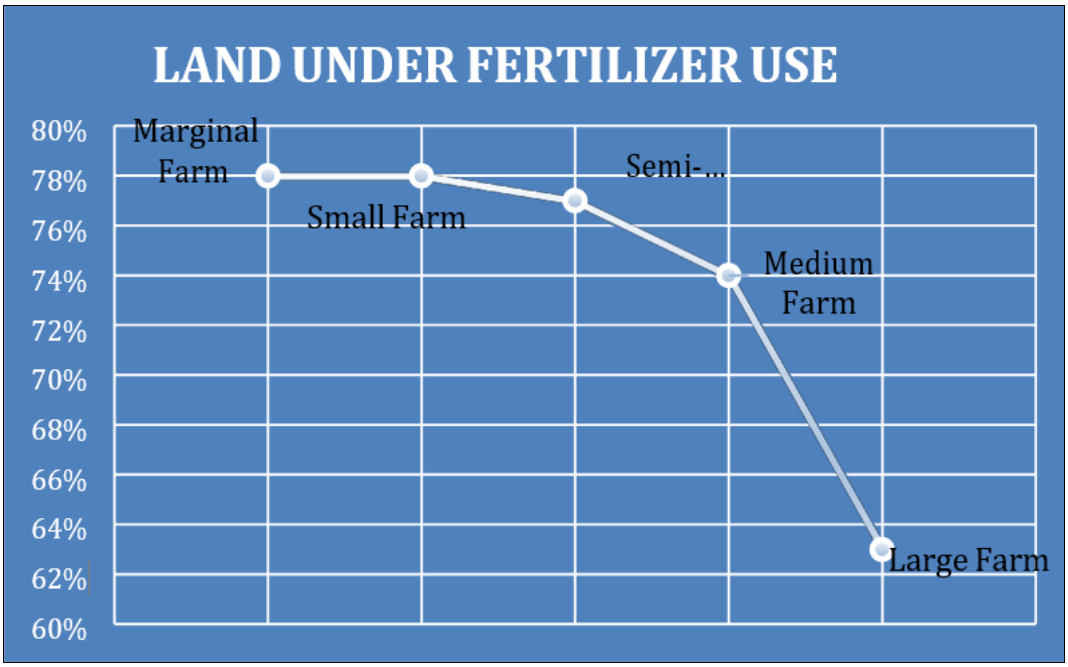


Fig 2: Percentage of fertilizer use v/s farm sizes

Again, a similar trend to irrigation is observed regarding the use of fertilizers and farm size. It is found that smaller farmers use fertilizers more extensively than larger farmers. This behavior of smaller farmers can be attributed to the same reasoning as before. With limited land available, smaller farmers attempt to maximize productivity by using fertilizers intensively. This may be one of the reasons why productivity declines as land size increases.

Evidence from Amartya Sen's 1964 [4] study, Size of Holding and Productivity, supports the regression results:

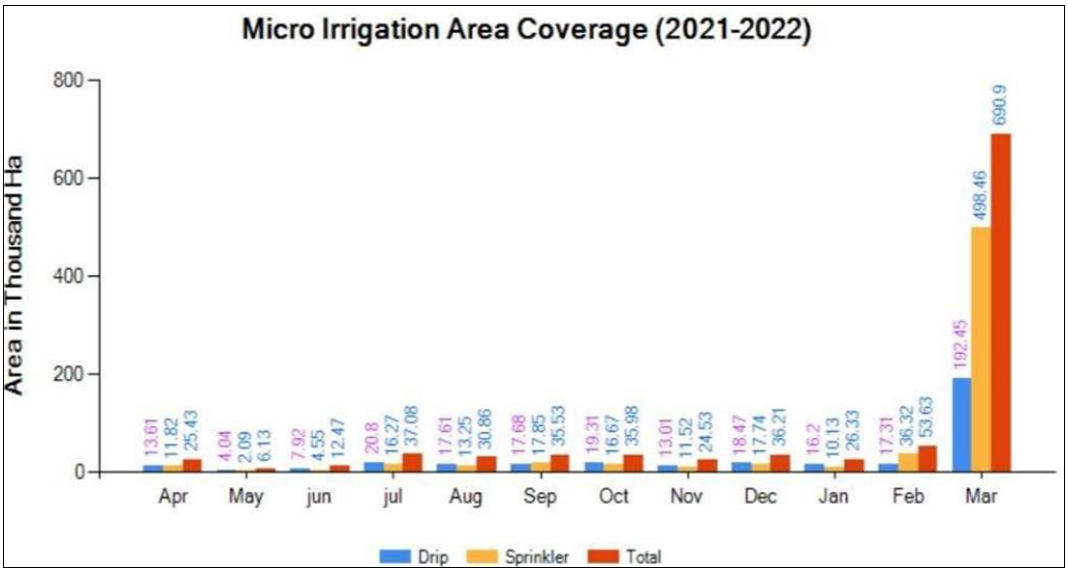
Labor-Based Explanation: Sen proposes that smaller holdings benefit from the lower opportunity cost of family labor. Additionally, farmers with smaller holdings can employ better production methods that may be impractical to implement on larger farms. Smaller farms also require fewer complementary inputs, such as irrigation and capital. Managerial efficiency is higher in smaller farms due to a greater stock of capital per acre, leading to a higher marginal product of labor compared to larger farms.

Fertility-Based Explanation: Sen argues that soil fertility is inversely related to the size of land holdings. Fertile soil generates greater income, incentivizing larger family sizes, which leads to further subdivision of land among descendants over time. This creates an inverse relationship between soil fertility and land size.

Regression analysis using NSSO 77th round data on Agriculture in India confirms the negative relationship between land size and productivity in recent years. This trend is evident, as smaller farmers do not lag in adopting improved technologies or fertilizer use compared to their larger counterparts. Marginal and semi-medium farms, in particular, make the most effective use of available inputs.

Indian small holdings challenge the theory that modern technologies and economies of scale negatively impact farm performance. Larger plots encounter managerial issues, as farmers' labor productivity declines when other inputs are held constant. This is due to the increased effort required to cover larger areas, as well as the higher investment needed in inputs to achieve good yields.

In the current era of population explosion, climate change, and water scarcity, micro-irrigation emerges as a crucial method for sustainable agriculture. Agriculture remains the largest consumer of water in India. Since 2015-16, the Department of Agriculture and Farmer's Welfare (DA&FW) has implemented the Per Drop More Crop component under the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY-PDMC) across all states of the country.



Source - Ministry of Agriculture and Farmer's Welfare, Government of India

Fig 3: Micro Irrigation Area Coverage

Under the Per Drop More Crop component, a target was set for 6,00,000 farmers to adopt micro- irrigation in 2020-21; however, only 2,67,000 farmers adopted the method. This underachievement, even after five years of the scheme's implementation, highlights the lack of adaptability among Indian farmers to new and innovative technologies. Similarly, while the scheme aimed to cover an area of 16 lakh hectares under micro-irrigation, only 9.38 lakh hectares were achieved.

The primary reason for farmers' limited support for micro-irrigation methods, such as drip and sprinkler systems, was the insufficient number of scientific knowledge dissemination and awareness campaigns (training) conducted in 2020-21. Although the schemes are designed to address challenges in agriculture, their success depends on effective implementation and the optimal utilization of resources to achieve the desired outcomes.

b) Irrigation Coverage and Productivity

Studies by various researchers have concluded that farming in India is not profitable, primarily because farmers do not receive the prices they deserve. This occurs due to the lower bargaining power of farmers compared to other market agents. It is believed that the government can provide relief to farmers by adopting direct measures to address this power asymmetry.

However, implementing such measures is fraught with social, economic, and political complexities. Therefore, an alternative solution that avoids affecting the voting base of political parties is proposed.

The solution lies in increasing *per hectare production*, i.e., improving yield. This approach focuses on enhancing the productivity of the land, thereby increasing the output for the same fixed cost and, to some extent, variable cost incurred by farmers. As a result, the average revenue per hectare of land, and overall revenue, would rise.

The rationale is based on the structure of the cost function, C(x). The costs incurred by farmers are largely dependent on the land under cultivation rather than the output produced. For instance, irrigation, fertilizer usage, and labor employment are all directly related to the area of land rather than the quantity of output. By improving yield, farmers can maximize the return on their existing resources, effectively addressing the issue of low profitability without requiring structural changes that could lead to political or social pushback.

Therefore, the profit for farmers is as follows:

Profit = P*Y - C(x)

Where

Y: Yield P: Price

If various methods can increase yield (YYY), farmers can achieve higher profits or larger profit margins overall. However, the critical question remains: *how to increase yield?*

The answer lies in the concept of *"Observing the Obvious!"* Irrigation, as the lifeline of agriculture, holds the key to enhancing productivity. With a proper and focused study, irrigation can serve as a vital link to improving yield.

This section aims to analyze and study how farmers' income can be increased despite challenges such as adverse price movements and unfavorable market conditions by focusing on yield improvement. Since productivity is at the core of this study, the emphasis will be on measuring and understanding the magnitude of relationships. The following relationships between irrigation and yield will be established:

- How does subsidy affect Yield - Irrigation relationship?
- How method of irrigation that uses Electricity affects the Yield-Irrigation relationship?
- How Fertilizer affects Yield - Irrigation relationship?

The Threat of Over-Irrigation.

But before that, a simple approach using the polynomial regression equation is undertaken. This approach not only provides the marginal impact of irrigation but also reveals

how the marginal impact is affected. The results are presented below.

```
Call:
lm(formula = data2$Yield ~ data2$AreaIrrigated + I(data2$AreaIrrigated^2))

Residuals:
     Min       1Q   Median       3Q      Max
-213.505  -33.039    5.998   40.005  138.015

Coefficients:
                          Estimate Std. Error t value     Pr(>|t|)
(Intercept)             226.59260   59.73843   3.793     0.000325 ***
data2$AreaIrrigated      13.55764    3.12117   4.344 0.0000493514 ***
I(data2$AreaIrrigated^2)  0.24078    0.03691   6.524 0.0000000113 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 62.33 on 66 degrees of freedom
Multiple R-squared:  0.9862,    Adjusted R-squared:  0.9858
F-statistic:  2354 on 2 and 66 DF,  p-value: < 0.00000000000000022
```

As suggested by the results, the marginal impact of irrigation is positive. For every 1-hectare increase in the irrigated area, yield (per hectare productivity) is increased by 13.5 kg. Although the marginal effect is positive, an uncontrolled increase in irrigation is not desirable, as it may lead to the problem of over-irrigation, adversely affecting both crop yield and soil quality in the long run. Additionally, for every 1-hectare increase in the irrigated area, the impact on yield change rises by 1.24 This indicates that the slope increases at an accelerating rate. This observation suggests that the current level of irrigation is significantly low, to the extent that even with further increases, the issue of over-irrigation is unlikely to arise, and the marginal effect remains positive.

It can be confidently recommended that the government should implement measures to enhance irrigation facilities through dams, rivers, canals, rainwater harvesting, and similar initiatives without concern for over-irrigation.

How Does Subsidy Affect Yield-Irrigation Relationship?

The subsidy is a highly discussed issue in agriculture, both for governments and international trade bodies such as the WTO. An assessment of the impact of subsidy on yield, alongside irrigation, is undertaken in this study.

To evaluate this, the Matching Technique is employed, which compares the after-treatment effect of the treated group with its appropriate counterfactuals. The propensity score model is utilized for matching, and the Average Treatment on Treated (ATT) is calculated.

Note: To estimate yield without subsidy, an OLS regression of yield on subsidy was conducted, and predicted values were subtracted from yield for specific years. Therefore, the validity of this study should be interpreted with caution. The results are presented as follows:

```
Estimate...  183.7
SE.........  33.856
T-stat.....  5.426
p.val......  0.000000057635

Original number of observations..............  69
Original number of treated obs...............  10
Matched number of observations...............  10
Matched number of observations  (unweighted).  10
```

- The results indicate that, in comparison to farmers who do not receive subsidies, those with subsidies observe an increase of 183.7 kg/hectare in yield.
- With a total mean yield of 1,235.73 kg/hectare, the observed effect of the subsidy on yield appears to be substantial. Additionally, the given p-value allows for the confident rejection of the null hypothesis that the subsidy has no significant impact on the yield-irrigation relationship.
- Consequently, it is evident that the subsidy serves as a strong complementary factor to irrigation in enhancing yield.

How Method of Irrigation that Uses Electricity Affects Yield-Irrigation Relationship?

Another key question is which type of irrigation method should be preferred by individuals. While various irrigation methods exist, the data clearly shows that tube wells and pumps account for nearly 50% of the irrigated areas, with electricity being used for their operation.

Electricity consumption does not directly affect yield; rather, it impacts yield indirectly through its influence on irrigation from pumps and tube wells. Electricity consumption meets most of the criteria for an Instrumental Variable (IV), as it does not directly affect the outcome variable (yield) but is strongly correlated with the independent variable (irrigation).

Instrument Exogeneity	Correlation between Residuals and Electricity consumption.	0.06 which is close to zero
Instrument Relevance	Correlation between Electricity Consumption and Irrigation should be High.	96.46%

Thus, using the two-step least squares (2SLS) estimation, the following results are obtained:

```
Call:
ivreg(formula = data3$Yield ~ data3$AreaIrrigated | data3$AreaIrrigated +
    data3$ElcCons)

Residuals:
     Min       1Q   Median       3Q      Max
-109.734  -35.303    1.898   33.163  140.198

Coefficients:
                  Estimate Std. Error t value             Pr(>|t|)
(Intercept)       -321.959     62.841  -5.123            0.0000128 ***
data3$AreaIrrigated   37.294      1.156  32.267 < 0.0000000000000002 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 57.48 on 33 degrees of freedom
Multiple R-Squared: 0.9693,     Adjusted R-squared: 0.9683
Wald test:  1041 on 1 and 33 DF,  p-value: < 0.00000000000000022
```

The above result demonstrates that the impact of irrigation on yields has increased almost threefold when an instrumental variable (IV) is used. Therefore, it can be concluded that irrigation has a positive impact on yield, particularly when a more efficient method of irrigation is employed.

How Fertilizer Affects the Yield-Irrigation Relationship?

Fertilizers play a crucial role in enhancing productivity. In this section, we aim to study how the impact of irrigation increases with the use of fertilizers. Similar to the previous analysis, we will employ the matching method to assess this relationship.

```
Estimate...  891.11
SE.........  60.952
T-stat.....  14.62
p.val......  < 0.000000000000000222

Original number of observations..............  69
Original number of treated obs...............  38
Matched number of observations...............  38
Matched number of observations  (unweighted).  38
```

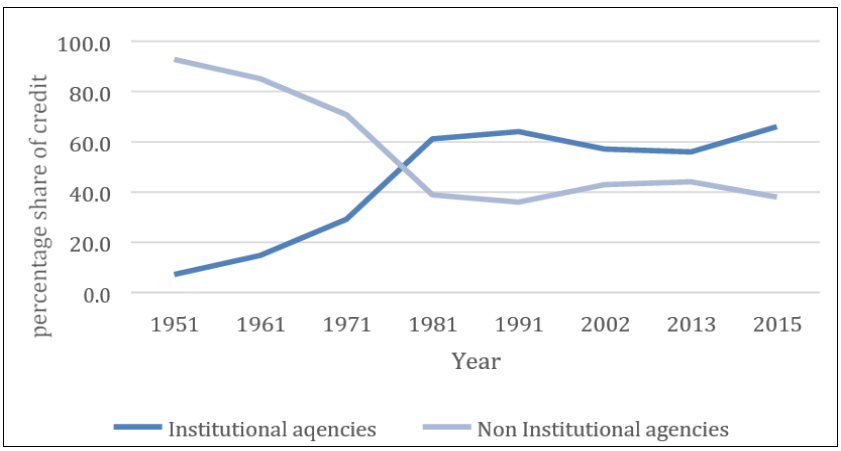
The results indicate a highly significant effect, where farmers who used fertilizers yielded 891 kg (about 1964.32 lb.) more than those who did not use fertilizers. While the results align with expectations, the magnitude of the impact is worth highlighting.

- This section serves as a study that encourages the government to provide a comprehensive support package for farmers.
- Given the magnitude of impact, the government should offer fertilizers, electricity, and electronic pumps for irrigation at subsidized rates to enhance productivity.
- With this approach, farmers with higher productivity can eventually overcome power asymmetry, leading to social and economic upliftment.

c) Agricultural Credit and Productivity

Credit in Agriculture is considered of immense importance, required for crop production and allied activities. Since inadequate financial resources are possessed by most of the farmers, borrowing is forced upon them. The two major sources of borrowing are identified as Institutional and Non-Institutional. Institutional Source of Credit is comprised of loans from Commercial Banks, Co-operative Societies, and the Government, while Non-Institutional Sources are comprised of moneylenders, landlords, traders, commission agents, relatives, and friends.

Non-Institutional credit is associated with demerits due to its intrinsic feature of improper documentation; this allows money lenders to charge exorbitant interest rates. Unjust practices are followed during the giving of loans and their recovery, constraining farmers from adopting emerging mechanization, as, after repaying loans, little money is left for reinvestment in agriculture. Many small and marginal farmers fail to repay either the interest rate or loan amount, or both, ultimately pulling them into a debt trap and causing their livelihoods to perish. Institutional sources of credit are seen as a powerful alternative to eradicate the evils of non-institutional credit. Thus, access to credit from institutional sources is recognized as an important determinant of the health of the agriculture sector in any economy, especially in India, where non-institutional credit had previously dominated.



Source: RBI dataset

Fig 4: Institutional v/s Non-institutional credit

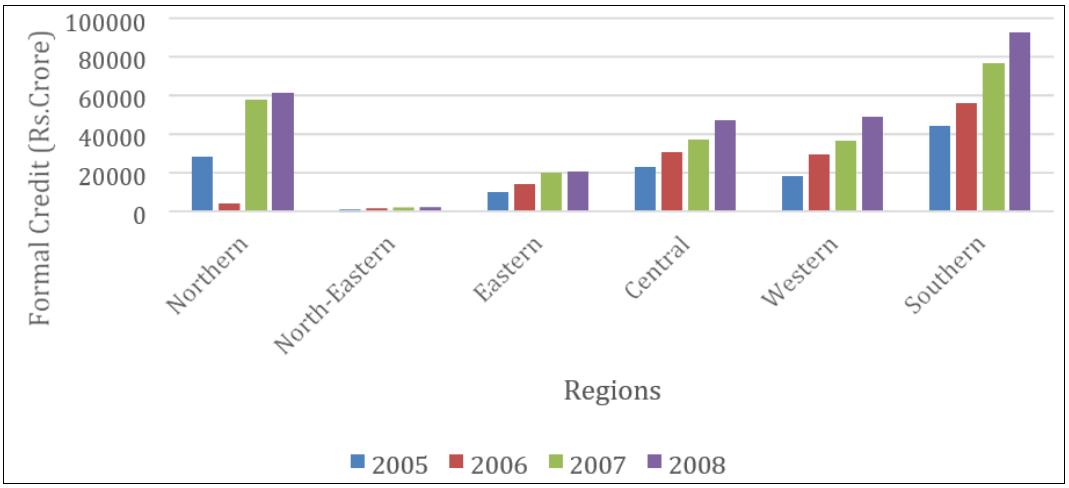
The above graph is shown to depict the percentage of credit from institutional and non-institutional sources from 1951 to 2015. In 1951, the non-institutional sources of credit were dominant, with 90% of farmer households' outstanding debt being accounted for by them. The remaining 10% share was held by institutional sources. Over time, a declining trend in non-institutional sources and a corresponding increasing trend in institutional sources of credit have been observed, due to the various government initiatives enabling farmers' access to the former.

Access to formal credit and agriculture development in different Indian states

As per the NABARD report 2021, despite institutional credit sources accounting for 70% of all agriculture credit in 2019, diversity exists between Indian states in terms of access to formal credit. In states such as Kerala, Uttarakhand, Himachal Pradesh, and Maharashtra, more than 80% of rural credit supply is sourced from formal sources, whereas non-institutional sources account for 50% of rural credit in Andhra Pradesh, 56% in Jharkhand, and 57% in Telangana. This demonstrates that non-institutional credit remains prevalent in large parts of the country.

Not surprisingly, the literature on agriculture development states that the southern region of India corresponds with a relatively faster development of the agricultural sector. Shankar, in India's agricultural development, conducted an analysis of agricultural productivity, the value of production, and other variables for India's agrarian regions at three-time points: 1962-1965, 1980- 1983, and 2005-2008. Their results indicate that the southern region was a consistent winner for all three mentioned periods.

The above assertions made by NABARD are also supported by plotting formal credit access to various regions of the Indian economy for the years 2005-08, which corresponds to the period studied by Shankar. It is observed that formal credit availability is greater in the Southern Region compared to other regions.



Source: RBI

Fig 5: Formal Credit Access

It can be inferred that more access to formal credit played a crucial role in the southern region standing out in terms of agricultural development. These results are consistent with the study of Rao, 1994. Less credit availability constrained the ability of farmers to adopt emerging technology and investments, hindering their productive capacity and ultimately pushing them to non- institutional sources.

Access to Formal Credit Based on Land size: It was observed that households with smaller land sizes had a greater share of loans from non- institutional sources in comparison with larger land-size households during the period 2015-2016. It can be inferred that small and marginal farmers depend more on the expensive source of credit than large farmers. Thus, heterogeneity in terms of landholding is further translated to a seemingly higher proportion of credit from non-institutional sources by the already deprived ones as compared to the richer farmers.

Table 1: Average Loan Taken by the Agricultural Households between July 2015 to June 2016

Land Class Size (Ha)	Formal Sources (%)	Informal Sources (%)
<0.01	70.9	29.1
0.01 0.40	58.8	41.2
0.41 1.00	69	31
1.01 2.00	79.9	20.1
> 2.00	78.2	21.8
Total	**72.3**	**27.7**

Source: NABARD (2018)

Importance of institutional credit in agricultural development

The relationship between agricultural productivity and credit from institutional sources, specifically commercial banks, was assessed by performing a panel data regression on the Indian States over the time period 2004-2021 for GVA added by agriculture, which is the measure of the value of goods and services produced by the agriculture sector, and 2004-2017 for yield, which is output per unit of input, using the fixed effects method. The methodology was particularly adopted by Narayanan in 2016 [12]. The literature shows that formal credit affects other variables with a lag of one period. Hence, the following regression model was used:

$log(GVA)it=\alpha i + \beta log(FormalCreditit-1) + \varepsilon it$

$log(Yield)it=\alpha i + \beta log(FormalCreditit-1) + \varepsilon it$

```
Oneway (individual) effect Within Model

Call:
plm(formula = logGVA ~ logcredit, data = dataframe, model = "within")

Balanced Panel: n = 33, T = 17, N = 561

Residuals:
     Min.   1st Qu.    Median   3rd Qu.      Max.
-1.219470 -0.318821  0.054049  0.290424  1.297717

Coefficients:
           Estimate Std. Error t-value  Pr(>|t|)
logcredit 0.251500   0.019289  13.039 < 2.2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Total Sum of Squares:    139.37
Residual Sum of Squares: 105.38
R-Squared:      0.24391
Adj. R-Squared: 0.19656
F-statistic: 170.007 on 1 and 527 DF, p-value: < 2.22e-16
```

```
Oneway (individual) effect Within Model

Call:
plm(formula = logyield ~ logcredit, data = dataframe, model = "within")

Unbalanced Panel: n = 20, T = 5-13, N = 248

Residuals:
       Min.     1st Qu.      Median     3rd Qu.        Max.
-0.23129925 -0.03227605  0.00094841  0.03111717  0.33659769

Coefficients:
           Estimate Std. Error t-value  Pr(>|t|)
logcredit 0.067775   0.012918  5.2465 3.551e-07 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Total Sum of Squares:    1.3434
Residual Sum of Squares: 1.1982
R-Squared:      0.10814
Adj. R-Squared: 0.029567
F-statistic: 27.5256 on 1 and 227 DF, p-value: 3.5515e-07
```

It was found that if there is an increase in formal credit of 10%, then the contribution of agriculture to gross value added increases by 2.51% and yield increases by 0.6%. These results are consistent with those found in Narayanan (2016) [12].

The above two results are an outcome of greater input usage enabled by improved access to formal credit. This assertion is supported through a panel data regression on selected states of the Indian economy for the time period 2005-2020.

log(Input)it=αi + βlog(FormalCreditit-1) + εit

```
Call:
plm(formula = logf ~ logcredit, data = dataframe, model = "within")

Unbalanced Panel: n = 20, T = 2-16, N = 295

Residuals:
      Min.    1st Qu.     Median    3rd Qu.       Max.
-0.6856626 -0.0572379  0.0040632  0.0651018  0.3825599

Coefficients:
           Estimate Std. Error t-value  Pr(>|t|)
logcredit  0.53965    0.01895  28.478 < 2.2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Total Sum of Squares:    14.914
Residual Sum of Squares: 3.7663
R-Squared:      0.74746
Adj. R-Squared: 0.72903
F-statistic: 810.983 on 1 and 274 DF, p-value: < 2.22e-16
```

```
Oneway (individual) effect Within Model

Call:
plm(formula = logi ~ logcredit, data = dataframe, model = "within")

Unbalanced Panel: n = 20, T = 2-16, N = 288

Residuals:
     Min.   1st Qu.    Median   3rd Qu.      Max.
-2.214030 -0.183105  0.023688  0.202094  1.216327

Coefficients:
           Estimate Std. Error t-value  Pr(>|t|)
logcredit  0.48672    0.07142   6.815 6.251e-11 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Total Sum of Squares:    58.956
Residual Sum of Squares: 50.22
R-Squared:      0.14817
Adj. R-Squared: 0.084366
F-statistic: 46.4442 on 1 and 267 DF, p-value: 6.2506e-11
```

Three inputs were considered: Fertilizers and Insecticides. The results obtained show that a 10% increase in credit raises fertilizer usage by 5.39% and the use of insecticides by 4.8%. A slightly different model was used for assessing the impact of credit on capital usage.

$(Capital)it=\alpha i + \beta(FormalCreditit-1) + \varepsilon it$

```
Oneway (individual) effect Within Model

Call:
plm(formula = Capital ~ FormalCredit, data = dataframe, model = "within")

Unbalanced Panel: n = 20, T = 2-16, N = 295

Residuals:
     Min.   1st Qu.    Median      Mean   3rd Qu.      Max.
-3.34e+08 -5.30e+07 -1.64e+06  0.00e+00  5.61e+07  4.48e+08

Coefficients:
                 Estimate Std. Error t-value  Pr(>|t|)
FormalCredit 6.0450e-04 3.0843e-05  19.599 < 2.2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Total Sum of Squares:    1.0111e+19
Residual Sum of Squares: 4.2094e+18
R-Squared:      0.58367
Adj. R-Squared: 0.55328
F-statistic: 384.128 on 1 and 274 DF, p-value: < 2.22e-16
```

Results indicate that if credit is increased by Rs. 1000, then expenditure on capital is increased by Rs. 6. Although this value is considered small, it is noted that capital is durable and expensive, and recurring expenditure on it is preferred not to be incurred by farmers.

The aforementioned points clearly highlight the importance

of formal credit for agricultural development. Summarizing the above analysis, major challenges imposed by credit in Indian agriculture revolve around the accessibility of formal sector credit: (a) It is indicated that states with greater access to formal credit are more developed in terms of agriculture, (b) It is indicated that out of 30% of non-institutional credit in agriculture, around 70% is availed by small and marginal farmers, who are in a more vulnerable position in the economy. This dependence on small and marginal farmers is suggested to reflect gaps in financial inclusion and pose a challenge to agricultural productivity in India. It is indicated that access to formal sector credit is one of the major challenges impacting Indian agriculture.

In order to determine the financial behavior of households, a survey was conducted by NAFIS in 2016, which inferred that around 3/4th of loans were preferred to be taken from informal sources. The major reason for this preference was indicated as easy availability (76.2%). Other reasons stated included leniency in repayment, no documentation, trust in friends and family, and no fear of legal entanglement.

While the major reason for not taking a loan from institutional sources was indicated as high- interest rates (38.5%), other reasons cited included the requirement of collateral, lengthy process, short maturity period, high cost, uncertainty, and lack of awareness.

To improve accessibility to institutional credit, various schemes have been introduced by the government over time, such as:

- **Kisan Credit Card (KCC) Scheme (1998):** Cash can be easily withdrawn for production or purchase of agricultural inputs such as fertilizers, machinery, seeds, etc., using KCC. A credit limit of Rs. 10,000 to Rs. 50,000 is provided to marginal farmers based on the crops they grow, land size, and credit requirements for warehouse storage.
- **Agriculture Debt Waiver and Debt Relief Scheme (ADWDRS) 2008:** Distress of the farming community is alleviated, and institutional credit channels are cleared, allowing new credit to be obtained by farmers.
- **Interest subvention to farmers (2006-07):** Short-term agricultural credit of up to Rs. 3 lakhs at 7% rate of interest is provided to farmers by banks.

Other steps have been taken by the government for this cause. Additional recommendations include:

- Credit pricing should be done without intervention, i.e., based on Adam Smith's theory of the invisible hand, to ensure equitable credit flow for all agricultural communities. The focus should shift to ensuring timely and adequate credit at a reasonable price, especially in areas of weak credit delivery, instead of focusing only on subsidizing.
- Credit monitoring should also cover related activities funded by financial institutions such as NABARD. Credit usage from the stage of input to the final output should be closely overseen for optimum utilization.
- Strengthening of cooperatives should be done to provide credit delivery and skill enhancement. Primary Agricultural Co-operative Societies (PACs), which contribute to rural credit distribution, can be linked with commercial banks.

Micro-insurance should be strengthened, particularly for small farmers, to assist them adequately at the time of natural disasters, which disproportionately affect these farmers. An institutional mechanism is required to manage marketing and storage risks.

Conclusion

The whole study shows that India's approach to restructuring is untenable. Land boundaries are negatively affecting India's agricultural labor productivity levels of growth, giving rise to broader and deeper inequities and wage stagnation. Advancement of resources has resulted in substantial gains in productivity in India over the last several years, enabling the nation to reach cereal safeguards and ensure current reserves in odd moments of necessity. Consequently, the intensity of resources has led to significant environmental pressures. One such appears to result in kind of a negotiation between enhancing productivity while also boosting adaptive capacity. A conceptual framework for Indian agriculture has been proposed in this paper in terms of the commitments wellness of India's agricultural industry and, as a matter of fact, the markets.

We will conclude with the following remarks about our major challenges:

- In retrospect with Land size and productivity, we can see from a regression on the NSSO 77th round data on Agriculture in India that there is a negative relationship between land size and productivity in India, and this trend has been very visible in recent years. When compared to their larger counterparts, small farmers do not fall short of adopting improved technologies or using fertilizer, with marginal and semi-medium farms making the best use of the inputs. Indian small holdings contradict the basic underlying theory that the introduction of modern technologies and the scale of production factors have a negative impact on farm performance. With larger plots, we face managerial issues in that the farmer's total labor productivity suffers when all other inputs are held constant because they must travel a greater distance to cover overall crops and must invest more in inputs to ensure a good yield.
    - Considering the results of Irrigation are as expected but the magnitude is something we wanted to highlight, the section should come as a study that motivates the government for a complete package for the farmers. With reference to the magnitude of impact, the government should provide Fertilizers Electricity, and electronic pumps for irrigation at a subsidized rate to enhance productivity. With this higher productivity, farmers can eventually stand against the power asymmetry and uplift themselves both socially and economically.
    - Credit accessibility can help enhance agricultural productivity. Instead of focusing solely on subsidizing, the emphasis should shift to timely and adequate credit at reasonable prices, particularly in areas of poor credit delivery. For optimum utilization, credit usage must be closely monitored in all stages of agricultural production. Strengthening Cooperatives and Micro-insurance will help greatly is required to encourage farmers to take formal credits and assist them. A strong institutional mechanism is needed to be developed to manage marketing and storage risk. Creating awareness

about the same is also crucial to ensure the farmers in actual need can avail the benefit.

This study has constructed that India's restructuring is not just partial but also follows an unsustainable path. In India, a reorientation to sustainable farming beliefs is actually needed. This must entail a transition from the resource intensification-based Indian agriculture presently. Instead of just visualizing our limited land ownership as an inadequacy, authorities should really actively seek to transform them into a willingness, notably because even though small farms were shown to be more efficient and versatile. Moreover, in terms of commitments wellness of India's agriculture sector in terms, the whole shift must protect the integrity of farm owners' revenues along with long-term handholding.

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