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Short-Term Effects of India's Employment Guarantee Program on Labor Markets and Agricultural Productivity

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Abstract

This paper uses a large national household panel from 1999/2000 and 2007/08 to analyze the short-term effects of India's Mahatma Gandhi National Rural Employment Guarantee Scheme on wages, labor supply, agricultural labor use, and productivity. The scheme prompted a 10-point wage increase and higher labor supply to nonagricultural casual work and agricultural self-employment. Program-induced drops in hired labor demand were more than outweighed by more intensive use of family labor, machinery, fertilizer, and diversification to crops with higher risk-return profiles, especially by small farmers. Although the aggregate productivity effects were modest, total employment generated by the program (but not employment in irrigation-related activities) significantly increased productivity, suggesting alleviation of liquidity constraints and implicit insurance provision rather than quality of works undertaken as a main channel for program-induced productivity effects.

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Short-Term Effects of India's Employment Guarantee Program on Labor Markets and Agricultural Productivity

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I. Introduction

India's Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) is, with a budget of US$ 7.8 billion in 2011/12 alone, the world's largest workfare program. It offers unskilled employment in works to provide local productivity-enhancing infrastructure for up to 100 days per year to households who expressed interest in such work by acquiring a 'job card'. Wages are statutorily set and equal between men and women yet, it is hoped, not attractive enough to prevent self-targeting. MNREGS can affect agricultural productivity in three ways. First, although MNREGS is designed to minimize impacts on agricultural labor markets by not offering employment in the main growing season, it is likely to directly or indirectly affect labor supply and demand. In the short term, this would affect wage rates and employment levels while in the medium to long term investment in mechanization may alter capital/labor ratios. Second, by providing implicit insurance against downside risk, resource transfers and predictable wage payments may allow poor farmers to increase investment or adopt crop portfolios with higher risk and expected return. Finally, local infrastructure (e.g. for water management or roads) constructed under MNREGS can directly increase returns to land and labor, the main assets of small farmers and the rural poor.

Not surprisingly given its size and ambition, MNREGS has attracted considerable scholarly interest. While non-random roll-out poses challenges, many studies explore program impacts on consumption smoothing, wages, welfare, and socioeconomic outcomes. By and large these studies find that resource transfers by the program significantly increased consumption and welfare by the poor, especially in the dry season, leading to wage growth and female empowerment. Impacts of newly established productive infrastructure on agricultural productivity, although a defining characteristic of MNREGS as compared to, say, a simple cash transfer scheme, have been less well studied. In fact, critics argue MNREGS may displace existing jobs rather than generate new ones; that poor quality of assets built under the program may undermine its contribution to higher productivity; and that program-related labor demand may push up agricultural wage rates, undermine mobility, and encourage premature mechanization. In a worst case scenario, this could depress rural labor demand and create dependency on the program not as an employer of last resort in crises but as a permanent feature of rural India's institutional landscape.

To explore short-term effects of MNREG on labor markets, risk taking, and agricultural productivity, we use unique national panel data from 1999/2000 and 2007/08 that offer three advantages. First, as they cover the same households in 1999, i.e. before the program had been conceived, and in 2007/08 when some but

not all of them had received the program, we can use a difference in difference approach with household fixed effects. As the household panel goes back to 1982, we can also test for parallel pre-treatment trends in key outcome variables between treatment and control group. Second, data on labor supply and wages at individual level allow us to explore heterogeneity by gender and initial land ownership. Finally, we estimate a production function and use administrative data on the intensity of MNREGS implementation for a subset of villages to go beyond average treatment effects and make inferences on potential transmission channels.

With respect to labor markets, we find that in the short term MNREGs contributed to wage growth and employment diversification, especially for females and those with limited land endowments. Based on our estimates, the program increased wages by 10 points and reduced hired agricultural labor demand by 8.3 days, mainly in the pre-harvest period, a decrease that was more than outweighed by more intensive use of family labor (by a total of 18 days). The program triggered more intensive use of machinery (by 5.5 points), irrigation (by 7.9 points), and fertilizer (by 11.7 points) and contributed to an increase in the number of crops grown (by 0.17 in the first and 0.41 in the third season). Together with a shift from rice and wheat towards high value crops for small farmers, this points towards program-induced diversification of income sources and productivity growth.

To explore if this can be attributed to productive assets or resource transfers through MNREGS, we use, for a subset of villages, the amount of days spent on all and irrigation-specific MNREGS works. The elasticity of agricultural output with respect to the former is, at an estimated 7.1 to 10.3 percentage points, larger and more significant than the estimated coefficient on MNREGS time spent on irrigation-related works. We take this as suggestive of short-term productivity impacts of the program being largely due to resource transfers rather than improvements in local productive infrastructure and discuss ways in which potential heterogeneity and longer-term impacts in this respect could be explored.

The paper is structured as follows: Section two describes program characteristics and methodologies used to evaluate it, presents studies that assessed its impacts, and uses this to pose the empirical questions to be answered here and the strategy for doing so. Section three describes data, presents descriptive statistics, and discusses the identification strategy as well as its justification in terms of pre-program parallel trends between treatment and control group. Section four presents and discusses estimated impacts of MNREGS -overall and by gender and farm size- on wage levels and labor supply and agricultural labor demand; input demand, technology choice, and crop diversification; and productivity of agricultural production. Section five concludes by drawing out implications for future research and policy.

2. Program characteristics and evidence of impacts

To motivate our analysis, we describe MNREGS characteristics and implementation arrangements, noting that it could affect socioeconomic outcomes directly, i.e. by project works enhancing productivity and returns to land and labor by the poor, or indirectly -by wage payments helping to smooth consumption and, if the program is expected to exist in the long term, providing implicit insurance and encouraging investment in physical and human capital. A brief review of methodological approaches and results suggests that most existing studies focused on impacts of wage-related resource transfers rather than effects on agricultural productivity and that consumption and production impacts have been analyzed largely in isolation from each other.

2.1 Program characteristics and potential impact pathways

India's Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) is one of the largest programs of its kind globally. Building on India's long tradition of food-for-work schemes (Dutta *et al.* 2012; Subbarao 1997),[1] it guarantees employment of up to 100 days per year to households who registered locally to obtain a job card.[2] Unskilled labor made available in this way is used to build productive assets (access roads, water harvesting structures, etc.) in a way that explicitly encourages female participation by paying equal wages to men and women and by imposing a gender quota that requires that one-third of the work be performed by women. While overall responsibility for implementation is with states, many functions are delegated to the village/panchayat level.[3] A range of controls, including use of IT and social audits, were put in place to minimize abuse, adjust to wide variations in capacity across states, and ensure the program is implemented transparently.

The program's legislative basis is the 2005 National Rural Employment Guarantee Act. A total of 200, 130, and 285 districts started to implement the program in February 2006, April 2007, and April 2008, respectively, with roll-out in three phases from the poorest to the least poor districts, based on a poverty index by India's Planning Commission. To deal with issues arising from non-random expansion, three main strategies to assess program impact have been used in the literature, namely (i) difference in difference (DID) estimates, mostly at district level, that use data from NSS's household surveys (possibly aggregated to form a pseudo-panel) or administrative data from other sources; (ii) regression discontinuity (RD) designs using the discontinuity in the Planning Commission index of poverty level in districts in a state that

[1] The work requirement differentiates MNREGS from programs such as PROGRESA (Attanasio *et al.* 2012) or Bolsa Escola (Glewwe and Kassouf 2012) that focus more on education.
[2] Applicants are eligible to receive a job card containing photos of all adult household members free within 15 days of application. Job-card holders' indicative work demand lead to elaboration of an annual plan which, once ratified by the village assembly, is transmitted for consolidation at district level although in practice a more top-down process is often followed, based on central budget allocations.
[3] Village governments (*gram panchayats*) and their staff are responsible to match job seekers to jobs throughout the year. These include preparation of a list of projects in reasonable distance from the village, measures to ease female participation (e.g. child care), supervision of ongoing projects, worker identification and assignment to specific sites, and financial management including wage payment.

determined roll-out; and (iii) household panels, often limited to specific states, with data from before and after the intervention for those entering the program at different points in time.

In theory, MNREGS could affect agricultural productivity and rural welfare in the short term via three channels. First, although the program offers less work during the main agricultural season to minimize competition with agricultural labor supply, it is likely to affect wage rates and labor supply and demand. Second, by predictably transferring wages income to individuals in times of need, e.g. if hit by shocks or during the dry season, MNERGS can help smooth consumption and reduce vulnerability.[4] For agents who had earlier been risk-rationed or credit-constrained, access to the program may affect portfolio choices and investment decisions. This may result in adoption of activities, e.g. crop choice and use of inputs with higher risk-return profiles and investment in agricultural technology or human capital and health (e.g. keeping kids in school) that could put individuals on a permanently higher growth trajectory. Finally, the nature and quality of local infrastructure (e.g. for water management or roads) constructed by MNREGS would be expected to increase returns to land and labor, the main assets of small farmers and the rural poor.

2.2 Evidence of labor market and socioeconomic impacts

Implementing MNREGS in a country the size of India with often clientelist structures was bound to give rise to unique challenges. It is thus not surprising to find evidence of mis-targeting (Dutta *et al.* 2014; Liu and Barrett 2013), corruption, or distribution of benefits along party lines (Das 2015). In Orissa, payments to 'ghost workers' were found to have accounted to 75-80% of total program cost although expectation of an ability to extract rents in the future may also limit theft according to a 'golden goose effect' (Niehaus and Sukhtankar 2013b). Exploiting exogenous wage variation suggests that the marginal rate of corruption was close to 100% (Niehaus and Sukhtankar 2013a).

Where these implementation challenges were dealt with, descriptive accounts suggest that the program had positive impact.[5] Several studies find it improved consumption by the poor. NSS data point towards large season-specific effects for scheduled castes and tribes (SCs and STs) but not the general population who, as a result of MNREGS were able to smooth consumption across seasons (Klonner and Oldiges 2014).[6] In Andhra Pradesh, one of the better performing states, panel data suggest MNREGS was well targeted and affected food consumption and asset accumulation by the poor (Deininger and Liu 2013), with impacts on food security, savings, and health outcomes (Ravi and Engler 2015). Beyond consumption, MNREGS was

[4] Productivity shocks have been shown to cause larger changes in wages when supply is inelastic, e.g. because workers are poorer, less able to migrate, or more credit-constrained. These changes generally hurt workers and benefit land owners (Jayachandran 2006).
[5] Recent IHDS data suggest that MNREGS increased income and wages for unskilled, reducing poverty by up to 32% and preventing 14 million from falling into poverty (Desai *et al.* 2015).
[6] A back-of the envelope cost benefit analysis suggests that consumption smoothing benefits for the SC/ST population would have been sufficient to justify the wage outlays incurred by MNREGS (Klonner and Oldiges 2014). Of course conclusions from such an evaluation might change if the disutility of the work to be performed under the program is taken into account (Alik-Lagrange and Ravallion 2015) and posing the right counterfactual is important (Baird *et al.* 2011).

found to have increased female empowerment (Afridi *et al.* 2013), reduced gender-based violence (Amaral *et al.* 2015), increased school participation by children in primary school age (Islam and Sivasankaran 2015), leading to better school outcomes, i.e. grade progression and achievement scores (Mani *et al.* 2014).[7]

Given the importance of casual labor for India's poorest groups, wide inter-temporal fluctuations of rural labor demand, and prevalence of gender discrimination in rural labor markets, wage impacts of MNREGS have been a key focus of study. A Difference-in-Difference design using NSS data points towards a program-induced wage increase of about 5% that was, with 8%, significantly higher for females (Azam *et al.* 2012). NSS data point towards program-induced wage increases of some 5 points overall and 9 points in states with good program implementation. No gender-specific effects are found but estimates' plausibility is increased by the fact that the increase is confined to the dry season although net effect on employment was zero (Imbert and Papp 2015b). Monthly wage data for 2000-2011 suggest that MNREGS increased growth of real agricultural wages by 4.3% during the peak season in some states with gender wage gaps and skilled wages remaining unaffected (Berg *et al.* 2014).[8] Evidence of positive wage effects is not universal, however: a RD for the transition from phase II to III, using 64th round NSS data, suggests limited or no impact on labor market outcomes or on closing of the gender wage gap, leading to authors to conclude that MNREGS may have performed an insurance or safety net function (Zimmermann 2015a) but not contributed to generation of new employment.

Levels of temporary migration may be affected if MNREGS increases local labor demand. Case studies do indeed suggest that the program reduced short-term 'distress' migration by unskilled workers in the dry season, in addition to directly and indirectly enhancing the returns to small and medium farmers' assets through water-conservation structures and improving liquidity without affecting long-term migration by the higher-skilled (Reddy *et al.* 2014). Econometric evidence from data specifically collected for this purpose supports the notion of a program-induced reduction in short-term dry-season migration but no effect on long-term migration (Imbert and Papp 2015a).[9] While anecdotes in the press highlight potentially negative MNREGS effects on agricultural labor supply, a causal relationship beyond general wages increases is unlikely as program rules rule out program work in the agricultural peak season, a restriction which, based on the evidence, seems to have been mostly adhered to in practice.

2.3 Program effects on agricultural productivity

[7] The program is also shown to have affected election outcomes (Zimmermann 2015b) and local violence (Khanna and Zimmermann 2014).
[8] A 2005-10 district panel that combines NSS data with information on rainfall and MNREGS-induced asset generation suggests that, partly due to the assets generated by MNREGS, the sensitivity of wages to rainfall shocks decreased by some 10 points (Shah 2013).
[9] Given the negative impacts of short-term migration on migrants' children (Coffey 2013), this is likely generate significant benefits in terms of human capital.

Beyond the short-term consumption benefits from program-related resource transfers, the predictable nature of such labor demand could affect agricultural outcomes and productivity in two ways. On the one hand, MNREGS could increase investment and intensity of cultivation, allowing farmers to use input levels that are closer to the optimum, or to adopt crop portfolios with higher risk-return profile. On the other hand, assets created through MNREGS works, especially if related to irrigation or other types of land improvement, should increase productivity and reduce production risk directly. Evidence on production-related impacts of MNREGS is limited, partly due to data challenges.[10] As a key feature of the program, in contrast to, for example, a straight cash transfer scheme, is the construction of productive infrastructure, this is a central issue for assessing its impact.[11]

One category of studies assesses the extent to which availability of the program allows farmers to take on higher levels of production risk. For example, district level Agricultural Input Survey (ACIS) data with a RD framework between phases I and II suggest MNREGS-induced wage increases increased the likelihood of mechanization by 10-20 points in the short term (Bhargava 2014). This could raise the possibility that, in the longer term, program-induced wage increases may prompt a reduction in labor demand. Repeated cross sections based on national NSS data with a RD design suggest that farmers exposed to NREGS make riskier crop choices (Ragunathan and Hari 2014). Panel data from AP point towards a modest MNREGS-induced shift from traditional towards commercial crops such as cotton (Gehrke 2014).

To assess whether higher levels of risk-taking are due to farmers expecting MNREGS to continue in the foreseeable future or a reduction in risk due to program-related works (e.g. in irrigation), data on the amount, type, and quality of the structures constructed under the program are needed. The only study that, to our knowledge, links outcomes to nature and quality of MNREGS works, finds higher that quality of works under MNREGS led to significant, though quantitatively small (0.5 to 0.8 points) increases in the share of cash crops grown (Shah 2013).

To explore this further, we complement, for a subset of the villages in our sample, household-level data on production and labor supply with information on the quantity of MNREGS employment overall vas that in irrigation which would be expected to yield benefits in the short term. A coefficient on the latter that is at least as large and significant as the former would provide circumstantial evidence for infrastructure constructed by MNREGS having a significant short-term productivity effect whereas an insignificant or small effect would point towards observed productivity effects being driven by resource transfers instead.

3. Estimation strategy and descriptive statistics

[10] Desai *et al.* (2015) report completion rates of at most 51%. To our knowledge the only study exploring this aspect in more detail is Shah (2013).
[11] Ideally, assets (e.g. small irrigation) generated under the program would simultaneously reduce the risk of moving into higher value crops.

To analyze short-term labor-market and productivity effects of MNREGS and the underlying channels, we use 1999-00 and 2007-08 ARIS-REDS panel data that include member-level labor supply, and details on agricultural production as well as information on the total amount of employment generated by MNREGS in a subset of villages. A Difference-In-Difference (DID) design with household fixed effects is used to control for time invariant unobservables and 1982 data to test for pre-treatment parallel trends between treated and control groups.

3.1 Data and analytical approach

Our primary data source is the 1981/82, 1999/00, and 2007/8 rounds of ARIS-REDS, a nationally representative panel survey first conducted in 1971 that provides comprehensive information for more than 4,000 panel households in 232 villages from 17 Indian states.[12] The survey contains detailed information on labor supply and wage receipts by each household member and inputs and outputs from agricultural production. To assess MNREGS impacts, we draw primarily on the survey's labor and agricultural modules to assess impacts of the program being available on labor markets and agricultural productivity.

When the 2007/8 round was administered, MNREGS had been implemented in phase I and II districts (our treated group) but not yet in those to be covered under phase III of the program, allowing us to use the latter as a control.[13] Letting i denote households, d district, and t time (with t=0 for the 1999/2000 and t=1 the 2007/08 round), we use the REDS panel data to estimates the impact of MNREGS on various outcome variables using a regression framework of the form

$$Y_{idt} = \beta_0 + \beta_1 MNREGS_{dt} + \beta_2\, MNREGS_{dt}\, X\, Post_{id} + \beta_3 Post_t + \lambda X_{idt} + \mu_i + \varepsilon_{idt} \qquad (1)$$

where Y_{idt} is the outcome variable of interest $MNREGS_{dt}$ is an indicator variable that equals 1 if district d was part of phases I or II of the MNREGS roll-out and zero otherwise; $Post_t$ is a time dummy; $\boldsymbol{X}$ is a vector of time varying controls at individual (sex, age, age square, education, education square, marital status), household (land ownership, marital status size, female shares in different age categories, head's gender and age) and village (population, share of SCs and STs, share of agricultural households, availability of paved road, distance to next town) level; μ_i a household fixed effect; and ε_{idt} an error term.[14] Our main interest is in β_2, the estimated impact of MNREGS exposure and we also introduce an additional interaction with

[12] The sample includes all of a household's descendants who still reside in the village in case of a split.

[13] As discussed above, for Andhra Pradesh, Bihar, Chattisgarh, Haryana, Madhya Pradesh, Maharashtra, Rajasthan, and Tamil Nadu, we were also able to obtain administrative data on employment generated by MNREGS overall and for irrigation-related activities, mainly cleaning and rehabilitating canals. If implemented in an effective manner, the latter would quickly improve agricultural productivity even for non-participants while program-induced wage payments would affect risk coping mainly by direct beneficiaries. Due to delays with implementing the survey in Kerala, all of the state's districts had been covered by MNREGS at the time the survey was administered, forcing us to drop observations from this state. Our final analysis sample thus includes 16 of the original states.

[14] For households who split between our two periods, successor households resident in the same village are included with the same id in the second period. In practice, dropping them does not affect the substantive results.

gender or household land endowments as individual or hosuehold characteristics (X_{idt}) to explore potential heterogeneity of effects in these dimensions. Standard errors are clustered at household level throughout.

In all cases, availability of panel data allows us to use household fixed effects to control for unobservable effects that are time invariant. But households in control and treatment districts may follow different growth paths even in the absence of the intervention. To see if this is a concern, we use the 1982 data to test for pre-program parallel trends in variables of interest by estimating (1) for the 1982 to 1999 period (i.e. t=0 for the 1982 and t=1 for 1999/2000). Results for individuals' main occupation, agricultural output value, and input use in table 1 suggest that, except non-farm self-employment where coefficients are marginally significant (though suggesting lower rather than higher growth in treatment areas), the hypothesis of pre-program parallel trends between treatment and control cannot be rejected.

To make initial inferences on potential transmission channels, we introduce MNREGS exposure as a productivity shifter in a standard Cobb-Douglas production function of the form

$$YM_{idt} = \alpha_0 + \alpha_1 MNREGS_{dt} + \alpha_2 MNREGS_{dt} \, X \, Post_{id} + \lambda \mathbf{X}_{idt} + \mu_i + \varepsilon_{idt} \quad (2)$$

where, beyond the variables discussed earlier, YM_{idt} is monetary output by farm i in t, $\mathbf{X}_{idt}$ a vector of inputs m used by i, μ_i a farm-specific fixed effect for farm i, and ε_{idt} a white noise error term, and the αs and λ are coefficients or coefficient vectors to be estimated. To ensure robustness of results, we estimate not only the panel regression with household fixed effects but also an equivalent cross sectional equation that includes villages with positive treatment only.

Moreover, for the subset of villages where such information is available, we replace the zero/one indicator of program availability ($MNREGS_{dt}$) with the number of days of total or irrigation-related MNREGS works in a village. As the share of the latter varies significantly across villages and effects of irrigation-related infrastructure would be felt more quickly than those of other types of local public goods (drought-proofing or land improvements), differences in estimated coefficients' significance or magnitude between the two would indicate the relative importance of quick-maturing irrigation-related work: A figure for the latter much larger or more significant than that on total labor would suggest that water-related infrastructure built by MNREGS drives productivity effects while the opposite (i.e. the coefficient on total MNREGS-work being larger or more significant than that on water-related improvements) would point towards program-induced resource transfers as a the main transmission channel.

3.2 Descriptive statistics

Table 2 presents data on key household and individual characteristics in 1999/00 and 2007/08 for treatment and control. Significant declines in household size, from 6.9 to 5.7 members on average, go hand in hand with increases in per capita income or consumption from 10,141 to 23,252 and 5,087 to 8,164 respectively

and a marked decline in the poverty headcount from 0.43 to 0.31. Partly as a result of subdivision in the course of succession, the mean land endowment declined from 5.6 to 4.7, with a modest increase in the incidence of irrigation. The sharp increase in the share of land that inherited (from 82% to 95%) illustrates that limited importance of land markets in reallocating land from less to more productive farmers.[15] Control areas are characterized by higher levels of income and consumption, lower levels of poverty, a higher share of irrigated land, and marginally higher access to bullocks or tractors.

The period was characterized by significant increases in wages, from Rs 46 to Rs. 53 per day (for male it was 51 to 58 Rs per day and for female it was 36 to 41 Rs per day). The higher growth rate in non-agriculture compared to agriculture suggests that part of this increase may be MNREGS-induced although wage levels were higher in the control than the treatments. In terms of time use, we find a drop in those who did not work (15% to 11%) or attended to domestic duties only (26% to 24%). This was accompanied by increases in the share of self-employment in agriculture (28% to 33%) as well as non-agriculture (3% to 4%) as well as casual workers in agriculture (10% to 11%) and non-agriculture (6% to 10%) that may again be program-induced and a slight decrease in the share of those in salaried work (5% to 4%).

To compensate for the lack of information on MNREGS implementation at household level and allow us to make at least initial inferences on whether the consumption or the production channel is the most relevant channel for project impacts to materialize, we complement household-level with administrative data on the total number of days of employment provided under MNREGS, in total and for irrigation-related activities that could be expected to have an immediate productivity-enhancing impact. Summary statistics for these data, which unfortunately were available only from Andhra Pradesh, Bihar, Chhattisgarh, Haryana, Madhya Pradesh, Maharashtra, Rajasthan, and Tamil Nadu, in panel C. With 38.8 days of employment generated per household in treated villages (vs. 6.5 in control villages, pointing to some contamination), the program's size is not inconsequential. Also, with 17.1, almost half this employment was in irrigation-related activities which, if effectively implemented, should have an almost immediate impact on agricultural production.

Information on agricultural production outcomes in table 3 points towards modest increases in value of output (from Rs. 4,129 to Rs. 4,746/ ac.) and inputs (from Rs. 1,072 to 1,339/ac.) as well as profits from agricultural cultivation (Rs. 3,057 to 3,407/ac.). The incidence of irrigation increased markedly, from 38% to 56%, possibly reflecting MNREGS-related investment. While total number of hired labor used increased from 30 to 42 days, family labor use decreased from 91 to 79 days. Intensity of hired labor was much higher in treated areas than in controls while more family labor was used in control compared to treatment areas.

[15] Functioning of rural land sales markets is affected by land ceilings imposed to facilitate land reforms. Rental markets are outlawed in many states, leading to static efficiency losses (Deininger *et al.* 2008) and depressing investment (Deininger *et al.* 2013b). Ill-functioning land markets have also been linked to significant inefficiencies in the industrial context (Duranton *et al.* 2014).

4. Econometric results

We find evidence of significant program-induced wage increases but no support for claims of MNREGS having crowded out private employment; in fact, although casual labor moves from the farm to the non-agricultural sector, lower casual labor demand in agriculture is more than outweighed by higher family labor input, especially at harvest, pointing towards a program-induced increase of labor use in agriculture. Together with evidence on higher intensity of fertilizer, irrigation and machinery use and some diversification away from rice and wheat, this suggests that program-induced resource transfers affected outcomes both directly and indirectly. This is reinforced by our finding of a significant productivity increase due to the program, mostly as a result of increased income rather than efficiency in water use.

4.1 Labor supply and wage effects

Labor market outcomes available from the survey are, for every household member, the number of days spent in salaried employment and wages received in casual work or self-employment in farm- and non-farm sectors. The latter includes detail on the number of days devoted to crop cultivation by male and female family members and hired workers at the pre-harvest (i.e., land preparation, sowing/transplanting, weeding) and harvest stage.[16] These allow us to assess MNREGS impacts on three sets of outcomes, namely (i) casual wages in agricultural and non-agriculture; (ii) changes in labor supply to self-employment or casual work in different sectors; and (iii) for farmers use of family and hired labor across different seasons. We explore heterogeneity across males and females and by land ownership. The survey provides evidence on total value of output, use of purchased inputs and machinery or irrigation, and number or type -high value vs. paddy and wheat- of crops grown. We use these to test for productivity effects that may have been triggered by program-induced risk-reductions, noting that, as the program targets the poorest groups, direct program effects should be most pronounced for small farmers.

Table 4 reports estimated impacts on wages received, overall (panel A) and allowing for heterogeneous program effects by gender (panel B). We find MNREGS-induced wage increases of some 10%, well above what is reported elsewhere. Most of this increase can be attributed to wages in the agricultural sector which are estimated to have increased by 11%, compared to a positive but insignificant coefficient for wages in the non-farm sector. Gender disaggregation suggests that program-induced wage increases affected males and females more or less equally though estimated rates were marginally higher for females who also seem to have experienced a marginally significant increase in non-agricultural wages.

[16] While the data are extraordinarily rich, they suffer from two shortcomings. First, lack of information on the source (i.e. public or private) of non-farm work makes it impossible to distinguish work performed under MNREGS from other types of non-farm casual employment. Second, as data on on-farm labor supply in 1999/2000 was not disaggregated by season, a direct test of the hypothesis that MNREGS-induced increases in dry season labor demand were key to smoothing consumption (Imbert and Papp 2015b; Klonner and Oldiges 2014) is not possible.

Regressions for labor market participation in table 5 allow us to explore the extent to which wage changes affected labor supply and demand. In the aggregate, we find insignificant impacts on the incidence of agricultural wage work but a significant increase (by 3.4 points) in non-farm casual work including NREGS jobs. There is evidence of a program-induced 5 point increase in on-farm self-employment, either to substitute for lower availability of wage labor or as a result of intensification that may partly be attributed to a greater ability to bear risk by households who, in program areas, can rely on the implicit safety net provided by the program. Allowing heterogeneity of effects by gender (panel B) points towards an increase of labor supply to the agricultural sector by males but a shift away from farm to non-farm employment and to some extent even the salaried sector, by females. Allowing for heterogeneity of program impacts by size of households' land endowment (panel C) suggests that increases in labor supply to the non-farm sector are concentrated among the landless and small or medium sized farmers who are the MNREGS' main target group. While the landless increase supply of labor to the farm as well as the non-farm sector, significant increases in labor supply to agricultural self-employment emerge only for small and to some degree medium farmers, possibly because some MNREGS-investment can be performed on farm. We also find evidence of a reduction of non-farm self-employment and an increase in salaried work by the largest land owners.

To appreciate MNREGS' effects on agricultural labor markets and to assess particularly if concerns about program-induced wage increases having caused labor shortages and prompted premature mechanization are supported by the evidence, we explore data on labor demand and supply. Estimates of program impacts on the number of hired (panel A) and family worker days (panel B) used in agricultural production by the about 3,200 farmers in the sample in table 6 lead to a number of conclusions. First, the program is estimated to have prompted a significant reduction of hired labor use which is estimated to have dropped by 8.4 days (col. 1), mainly due to reduced use of pre-harvest compared to harvest labor (-5 *vs*. -3 days). This reduction is driven by a shift from the farm- to the non-farm sector by females. Absence of significant differences by farm size class (panel A1) suggests it affected farms of different sizes equally. Panel B illustrates that lower hired labor demand was more than compensated for by more intensive use of family labor -with point estimates of 18, 11, and 6 for total, male, and female days. Disaggregating by stage in the production cycle suggests that the program did not affect pre-harvest labor demand but led to a significant increase in labor days used for harvesting, with estimates of 12, 7, and 4 for total, males, and females, respectively. While MNREGS led to reduced use of hired labor, this was more than compensated for by higher intensity of family labor, indicating a positive program effect on agricultural labor use overall.

4.2 Impacts on agricultural input use and crop or technology choice

To assess potential impacts on productivity and diversification, evidence of MNREGS effects on total output value and use of fertilizer and machinery as well as crop composition and the share of irrigated area

is provided in tables 7 and 8, both for the entire sample (panel A) and with heterogeneity by farm size class (panel B). Results with respect to the first set of variables suggest that MNREGS had no significant impact on the value of total or per acre output. At the same time, it is estimated to have led to a marked increase in the use of machinery, with a point estimate of 5.5%. As would be expected with direct effects of MNREGS affecting mainly the poor, such effects were more pronounced among small and medium farmers (estimated coefficients of 8.5% and 9.3%). Increases, of 10% and 6% respectively, of organic and chemical fertilizer by small producers suggests that program-induced alleviation of liquidity may have helped small producers move closer to the optimum level of variable input use although output and yields are not (yet) affected significantly. We also note that, in addition to irrigation-related spending, which increased by some 8% overall due to the program, MNREGS is estimated to have led to an increase in the share of cultivated area irrigated by some 6% overall and by 10% among small farmers. Physical works, in particular cleaning of canals to rehabilitate infrastructure and establishment of new small-scale water conservation structures under MNREGS is a plausible contributing factor that may have helped create the preconditions for more intensive land use, in particular planting of a second or third crop beyond wheat or paddy which normally depends on availability of sufficient soil moisture for plants to survive.

While higher returns to farming require diversification of output beyond rice and wheat, the non-traditional crops involved are not covered by government-imposed floor prices and more vulnerable to climatic shocks, both of which would increase price and production risk. Assessing if MNREGS helped to increase the number of crops grown and the share of area devoted to non-traditional higher value crops can thus serve as a proxy for the extent to which it increased the ability of different types of farmers to manage risk. Results in table 8 suggest that MNREGS did indeed increase the number of crops grown, with the largest effect (0.41 vs. 0.17 and 0.19 in the first and second season) in the third season (cols. 1-3). Again, this is most pronounced among small and to some extent medium sized farmers who are directly targeted by resource transfers through MNREGS wages. Adding information on the share of area devoted to irrigation and different crops in cols. 4-7 suggests that MNREGS is estimated to have triggered a 5.7 percentage point increase in irrigated area -possibly by alleviating capital constraints to operate necessary equipment- as well as a 3.5 point increase in the share of high value crops that was compensated by an equivalent decrease in the area planted to paddy. In all cases, effects are most pronounced among small and medium-sized farmers, supporting the hypothesis of them being linked to direct MNREGS effects.

Estimating the production function specified in (2) with indicators of program implementation as shifters in a standard production function allows us to explore if or to what extent MNREGS affected productivity and we report results for the panel with household fixed effects (cols. 1-4 and 7) and the cross-section of villages where MNREGS was implemented only (cols. 5-6 and 8). The positive but insignificant MNREGS

dummy (table 9, col. 1), suggests little effect on agricultural productivity overall, consistent with the negligible output effect obtained earlier, although we cannot reject the hypothesis of a small and marginally significant (a point estimate of 12% significant at 10%) positive impact on the smallest farmers (col. 2). Things changes if, for villages with information on the amount of MNREGS-related work, we include the number of days of employment generated by the program as an indicator of the intensity of program implementation. In this case, the estimated coefficient on the elasticity of productivity with respect to MNREGS employment is 0.071 and highly significant for the panel and 0.104 for the cross section.[17]

Compared to the highly significant estimated coefficients on total MNREGS labor time, including time on irrigation-related work only (col. 7 and 8 for panel and the cross-section, respectively), yields insignificant, though positive coefficients. This suggests that, for our sample and study period, the main channel FOR MNREGS to affect agricultural production in the short term was not by helping to construct irrigation infrastructure but by transferring resources and reducing risk.

5. Conclusion and implications

This paper was motivated by limited evidence on MNREGS effects on agriculture, including concerns about the program actually having had undesirable effects. Using unique data and a robust method to assess short-term program impacts on rural wages, labor demand, and agricultural production structures, we find that, in the short term, MNREGS led to a marked increase of agricultural wages, higher levels of non-farm casual work, and on-farm self-employment and program-induced reductions in casual agricultural labor demand more than outweighed by more intensive use of family labor. MNREGS led to more intensive use of irrigation and greater diversification of crop portfolios, especially by small farmers, to include more risky crops beyond rice and wheat. In 8 states for which such data are available, the intensity of treatment (i.e. the amount of MNREGS labor days) is estimated to have increased productivity with an elasticity of 0.07 to 0.10, largely by alleviating liquidity constraints and improving access to insurance.

The failure to find impacts from time spent on program-constructed irrigation infrastructure suggests that improving the quality of such works might be one way to quickly improve program effectiveness. Exploring the extent to which productivity effects vary with implementation quality would be of great interest to help ensure MNREGS delivers on its potential to not only provide a safety net and to improve the productive capacity and welfare of rural areas. Beyond this, long-term effects will differ from those ascertained here for a variety of reasons, most importantly the scope for changes in labor demand due to mechanization. More rigorous exploration of these issues will be of relevance well beyond India.

[17] Interestingly, we cannot reject equality of the estimated impact between small, medium, and large farms.

Table 1: Test of parallel trends pre-reform for key outcome variables

	Self-employed		Casual	Agric. output		Agricultural input use			
	Farm	Non-farm	Labor	Total	Per acre	Labor	Fertilizer	Machinery	Irrig.
Pre trend	0.012	-0.036***	0.012	-0.169	0.151	-0.032	0.031	-0.064	0.007
	(0.013)	(0.011)	(0.009)	(0.169)	(0.153)	(0.031)	(0.032)	(0.04)	(0.037)
No. obs.	44,142	44,142	44,142	4,956	4,956	4,956	4,956	4,956	4,956
R-squared	0.224	0.42	0.271	0.726	0.732	0.634	0.732	0.558	0.616

Notes: Household and year fixed effects as well as controls included throughout but not reported. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 2: Key household and individual characteristics

	Total	1999/2000	2007/08	Control	Treated
			Panel A: Household characteristics		
Characteristics					
Household size	6.35	6.94	5.71	6.35	6.34
Head female	0.06	0.04	0.07	0.05	0.06
Head married	89.32	89.81	88.8	89.65	89.09
Head's age	51.41	50.68	52.19	50.98	51.71
Head's education	4.07	4.16	3.97	3.88	4.2
Max. education	6.98	7.61	6.31	6.98	6.99
Welfare & assets					
Inc. p.c. (Rs./a)	12746	10141	15553	14292	11655
Cons. p.c (Rs/a)	5649	5087	6256	6271	5210
Poverty ratio	0.37	0.43	0.31	0.31	0.41
Land owned in acres	5.18	5.6	4.72	5.35	5.06
of which irrigated	58.3	57.17	59.52	63.63	54.54
of which inherited	88.13	82.07	95.09	89.06	87.46
Owns any bullocks	95.58	94.16	97.11	95.48	95.65
if yes value	9540.43	7971.59	10999.49	8801.93	9941.73
No. of observations	6,468	3,356	3,112	2,677	3,791
			Panel B: Wages and individual characteristics		
Wages (if working)					
Average wage	50.03	46.07	53.98	57.05	45.57
Male	55.34	51.60	58.69	63.24	49.96
Female	37.88	35.52	40.94	40.68	36.36
agricultural	42.92	41.12	44.71	46.92	40.68
Male	47.19	46.12	48.15	51.89	44.46
Female	36.12	34.17	38.41	38.48	34.88
nonagricultural	61.77	55.89	65.86	71.90	54.64
Male	64.17	59.45	67.13	74.30	56.60
Female	47.28	41.24	55.09	52.71	44.69
Characteristics					
Female	48.96	48.15	49.76	48.37	49.44
Age	35.27	34.4	36.11	35.08	35.42
Educ. (years)	4.34	4.68	4.01	4.27	4.4
Engaged in					
Agric. self-empl.	30.6	28.38	32.78	32.75	28.85
Non-ag. self-empl.	3.67	2.97	4.36	3.67	3.67
Agr. casual labor	10.44	9.66	11.21	8.81	11.77
Non-ag. casual	8.25	6.07	10.39	7.71	8.7
Salaried work	4.12	4.69	3.57	4.46	3.85
Domestic work	24.76	25.63	23.91	24.66	24.85
School/college	9.21	7.46	10.93	9.9	8.65
Unemployed/not in labor force	12.81	15.15	10.53	12.23	13.29
No. of observations	38,714	19,147	19,567	17,398	21,316
			Panel C: Village level characteristics (8 states only)		
No. of households	508		508	704	400
MNREGS. days total/hh	21.39		21.39	6.53	38.79
MNREGS spdg tot (Rs/hh)	5762		5762	2312	9734
MNREGS. days irrig/hh	9.34		9.34	2.72	17.11
MNREGS spdg irr. (Rs/hh)	2347		2347	1278	3513
No. of obs.	94		94	40	54

Source: Own computation from REDS 1999/00 and 2007/08. Village level data are available for 2007-08 only.

Note: Irrigation related days are those relating to work related to irrigation facilities (including micro and minor irrigation works); renovation of traditional water bodies (including de-silting of tanks); water conservation and water harvesting (digging/maintenance of ponds, watersheds, etc.); and drainage works (cleaning and digging of new main and field drains). Works not included were those for drought proofing (including afforestation and tree plantation); land development/improvement activities; flood control or protection; rural connectivity (all-weather access); and building/maintenance of school buildings or community centers.

Table 3: Key characteristics regarding agricultural labor demand and production

	Total	1999/2000	2007/08	Control	Treated
Output and Inputs					
Output value (Rs.)	18187.62	17368.24	19070.38	21243.88	16031.15
Output value (Rs./ac)	4425.81	4128.86	4745.73	4859.04	4120.12
Input cost (Rs./ac)	1200.64	1072.13	1339.1	1287.98	1139.02
Profit (Rs./ac)	3225.16	3056.73	3406.63	3571.06	2981.1
Use org. fertilizer	84.93	85.04	84.82	84.76	85.06
if yes value (Rs./ac)	94.21	71.77	118.38	97.23	92.08
Used chem. fertilizer	95.94	97.02	94.77	95.22	96.44
if yes value (Rs./ac)	345.3	367.99	320.86	358.6	335.92
Used mechanized mach	88.39	78.49	99.07	90.47	86.93
if yes value (Rs./ac)	256.63	159.25	339.75	290.99	231.40
Used other mach.	73.10	85.07	60.19	75.23	71.59
if yes value (Rs./ac)	92.07	69.35	126.66	110.70	78.26
Used irrigation.	46.99	38.44	56.21	48.71	45.78
if yes value (Rs./ac)	658.93	494.89	779.78	652.10	664.06
Total labor days					
Hired all	35.99	30.42	42.00	32.67	38.34
Hired male	23.39	19.47	27.6	21.01	25.07
Hired female	12.61	10.94	14.4	11.66	13.28
Family all	85.09	90.58	79.18	95.42	77.8
Family male	59.68	62.11	57.07	65.36	55.67
Family female	25.41	28.47	22.11	30.06	22.13
Share hired	0.29	0.27	0.31	0.26	0.31
Pre harvest days					
Hired all	20.14	17.75	22.72	17.97	21.67
Hired male	13.8	11.85	15.9	12.22	14.92
Hired female	6.34	5.9	6.81	5.75	6.75
Family all	52.5	56.26	48.45	55.45	50.42
Family male	39.1	40.94	37.13	40.5	38.12
Family female	13.4	15.32	11.33	14.95	12.3
Share of hired labor	0.26	0.25	0.26	0.22	0.28
Harvest labor days					
Hired all	15.85	12.67	19.28	14.69	16.67
Hired male	9.59	7.62	11.7	8.79	10.15
Hired female	6.27	5.04	7.58	5.9	6.52
Family all	32.59	34.32	30.73	39.97	27.38
Family male	20.58	21.17	19.94	24.86	17.55
Family female	12.01	13.15	10.79	15.11	9.83
Share of hired labor	0.34	0.31	0.36	0.31	0.36
No. of observations	6,468	3,356	3,112	2,677	3,791

Source: Own computation from REDS 1999/00 and 2007/08.

Table 4: Estimates of program effects on agricultural and nonagricultural wages

	Total	Agricultural	Non-agric.
		Panel A: All workers	
MNREGS * post	0.103***	0.111**	0.112
	(0.027)	(0.041)	(0.089)
R-squared	0.786	0.782	0.811
Observations	8,488	5,663	3,212
		Panel B: Allowing for heterogeneity by gender	
MNREGS * post * male	0.093***	0.099**	0.105
	(0.027)	(0.048)	(0.091)
MNREGS * post * female	0.127***	0.117**	0.185*
	(0.035)	(0.050)	(0.105)
R-squared	0.786	0.778	0.813
Observations	8,488	5,771	3,212

Notes: Household and year fixed effects as well as controls included throughout but not reported. Standard errors, clustered at household level, in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 5: Estimates of program effects on labor supply

	Self-employment		Casual work		Salaried
	Farm	Non-farm	Farm	Non-farm	
			Panel A: All workers		
MNREGS * post	0.050***	-0.009	0.009	0.034***	-0.003
	(0.013)	(0.006)	(0.011)	(0.008)	(0.005)
Obs.	38,714	38,714	38,714	38,714	38,714
R-squared	0.504	0.333	0.504	0.390	0.286
			Panel B: Male vs. female		
MNREGS * post * male	0.071***	-0.012	0.042***	0.047***	-0.015**
	(0.013)	(0.009)	(0.013)	(0.012)	(0.007)
MNREGS * post * female	0.031**	-0.004	-0.021*	0.025***	0.008*
	(0.015)	(0.006)	(0.011)	(0.007)	(0.005)
F-statistics	8.908	0.893	34.83	3.376	11.35
P-value	0.00285	0.345	3.81e-09	0.0662	0.000758
Observations	38,714	38,714	38,714	38,714	38,714
R-squared	0.505	0.334	0.506	0.396	0.287
			Panel C: Size of landholding		
MNREGS * post * landless	-0.002	-0.007	0.057**	0.037**	-0.006
	(0.014)	(0.012)	(0.023)	(0.017)	(0.008)
MNREGS * post * small	0.051**	0.005	-0.021	0.043***	-0.009
	(0.023)	(0.010)	(0.020)	(0.015)	(0.008)
MNREGS * post * medium	0.039*	-0.014	-0.017	0.026**	-0.009
	(0.022)	(0.010)	(0.018)	(0.012)	(0.008)
MNREGS * post * large	0.008	-0.019**	-0.013	0.015	0.019**
	(0.025)	(0.010)	(0.014)	(0.011)	(0.008)
Observations	38,714	38,714	38,714	38,714	38,714
R-squared	0.541	0.308	0.475	0.361	0.260

Notes: Household and year fixed effects as well as controls included but not reported. Standard errors, clustered at household level, in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 6: Estimates of program effects on hired labor and family labor demand in agricultural production

	Total			Pre harvest			Harvest		
	Total	**Male**	**Female**	**Total**	**Male**	**Female**	**Total**	**Male**	**Female**
Panel A: Hired labor, entire sample									
MNREGS	-8.368**	-4.946	-1.588	-5.155*	-3.224	-1.330*	-3.061*	-1.293	-0.618
* post	(4.201)	(3.504)	(1.270)	(2.888)	(2.542)	(0.729)	(1.751)	(1.289)	(0.695)
Observations	6,468	6,468	6,468	6,468	6,468	6,468	6,468	6,468	6,468
R-squared	0.730	0.709	0.748	0.712	0.690	0.749	0.731	0.726	0.738
Panel A1 :Hired labor by farm size									
MNREGS *	-4.533	-1.743	-0.950	-3.181	-0.754	-1.269*	-2.070	-0.576	-0.149
post * small	(3.544)	(2.911)	(1.157)	(2.618)	(2.293)	(0.664)	(1.424)	(1.018)	(0.638)
MNREGS *	-8.774	-3.989	-2.817	-5.875	-3.825	-1.422	-2.735	-0.174	-1.224
post* med.	(6.900)	(5.840)	(2.015)	(5.210)	(4.659)	(1.187)	(2.443)	(1.631)	(1.107)
MNREGS *	-6.388	-5.724	0.928	-4.433	-3.933	-0.560	-1.026	-1.180	0.739
post * large	(11.143)	(9.002)	(3.628)	(7.214)	(6.085)	(2.097)	(4.948)	(3.657)	(1.918)
Observations	6,468	6,468	6,468	6,468	6,468	6,468	6,468	6,468	6,468
R-squared	0.734	0.712	0.751	0.713	0.691	0.750	0.737	0.732	0.742
Panel B:Family labor, entire sample									
MNREGS	18.091***	11.048**	5.943**	6.162	3.652	1.156	12.193***	7.443***	4.274***
* post	(6.965)	(4.939)	(2.806)	(5.011)	(3.817)	(1.846)	(3.104)	(2.075)	(1.404)
Observations	6,468	6,468	6,468	6,468	6,468	6,468	6,468	6,468	6,468
R-squared	0.674	0.661	0.724	0.662	0.649	0.711	0.689	0.668	0.744
Panel B1:Family labor by farm size									
MNREGS *	18.450*	11.774	7.395*	9.141	5.263	2.963	8.848**	5.892**	3.209*
post * small	(10.129)	(7.613)	(3.924)	(7.648)	(6.373)	(2.617)	(4.444)	(2.940)	(1.901)
MNREGS *	10.095	4.596	3.775	0.411	-0.710	0.327	10.261*	5.909	4.003
post* med.	(12.217)	(7.995)	(5.152)	(8.156)	(5.647)	(3.259)	(5.762)	(3.646)	(2.599)
MNREGS *	25.573*	18.527*	5.954	8.299	6.887	-0.160	17.882***	11.670***	5.412*
post * large	(14.245)	(9.933)	(5.765)	(10.291)	(7.454)	(3.873)	(6.078)	(4.238)	(2.789)
Observations	6,468	6,468	6,468	6,468	6,468	6,468	6,468	6,468	6,468
R-squared	0.675	0.662	0.724	0.663	0.649	0.711	0.690	0.669	0.745

Notes: Household and year fixed effects as well as controls included but not reported. Standard errors, clustered at household level, in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 7: Estimates of program effects on agricultural productivity and input use

	Output		Value of fertilizer used		Used technology	
	Total	**Per acre**	**Organic**	**Chemical**	**Machinery**	**Irrigation**
			Panel A: Overall impact			
MNREGS	-0.044	-0.044	0.117***	-0.001	0.055**	0.079**
* post	(0.054)	(0.054)	(0.031)	(0.017)	(0.027)	(0.037)
Observations	6,468	6,468	6,468	6,468	6,468	6,468
R-squared	0.892	0.787	0.640	0.652	0.641	0.655
			Panel B: Heterogeneity by farm size class			
MNREGS *	0.124	0.124	0.097*	0.057**	0.085**	0.102
post * small	(0.091)	(0.091)	(0.055)	(0.028)	(0.042)	(0.064)
MNREGS *	-0.078	-0.078	0.052	-0.023	0.093**	0.063
post* medium	(0.088)	(0.088)	(0.050)	(0.029)	(0.047)	(0.060)
MNREGS *	-0.100	-0.100	0.165***	-0.045	0.007	0.019
post * large	(0.102)	(0.102)	(0.050)	(0.031)	(0.052)	(0.064)
Observations	6,468	6,468	6,468	6,468	6,468	6,468
R-squared	0.894	0.792	0.645	0.654	0.644	0.658

Notes: Household and year fixed effects as well as controls included but not reported. Standard errors, clustered at household level, in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 8: Estimates of program effects on, crops grown and composition

	No. of crops grown			Irrigated	Area devoted to		
	Season I	**Season II**	**Season III**	**area (%)**	**Paddy**	**Wheat**	**High value**
				Panel A: Overall impact			
MNREGS	0.166***	0.192***	0.413***	0.057**	-0.035*	0.005	0.035***
* post	(0.039)	(0.061)	(0.093)	(0.025)	(0.018)	(0.011)	(0.009)
Observations	6,468	6,468	6,468	6,468	6,468	6,468	6,468
R-squared	0.679	0.810	0.844	0.849	0.897	0.877	0.839
				Panel B: Heterogeneity by farm size class			
MNREGS *	0.202***	0.302***	0.480***	0.101**	-0.018	0.026	0.031*
post*small	(0.054)	(0.082)	(0.119)	(0.040)	(0.031)	(0.020)	(0.016)
MNREGS *	0.172**	0.096	0.334**	0.024	-0.050*	-0.008	0.043***
post* med.	(0.069)	(0.108)	(0.158)	(0.042)	(0.030)	(0.019)	(0.016)
MNREGS *	0.114	-0.026	0.027	0.088*	-0.011	0.010	0.029*
post * large	(0.086)	(0.132)	(0.201)	(0.047)	(0.030)	(0.020)	(0.017)
Observations	6,468	6,468	6,468	6,468	6,468	6,468	6,468
R-squared	0.682	0.820	0.857	0.852	0.898	0.878	0.839

Notes: High value crops include oilseeds, pulses, and cotton. Household and year fixed effects as well as controls included but not reported. Standard errors, clustered at household level, in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 9: Estimates of program effect on agricultural productivity using implementation data

	All states		8 states with implementation data					
	MNREGS dummy		Labor days spent on all MNREGS works				MNREGs water only	
MNREGS	0.021		0.071***		0.103**		0.127	0.242*
* post	(0.043)		(0.025)		(0.044)		(0.179)	(0.142)
MNREGS *		0.121*		0.071***		0.104**		
post* small		(0.071)		(0.024)		(0.042)		
MNREGS *		-0.017		0.066**		0.088*		
post* medium		(0.070)		(0.026)		(0.051)		
MNREGS *		-0.025		0.079***		0.124**		
post* large		(0.078)		(0.026)		(0.051)		
Log of land	0.602***	0.566***	0.606***	0.585***	0.631***	0.621***	0.610***	0.663***
	(0.043)	(0.047)	(0.061)	(0.063)	(0.056)	(0.057)	(0.061)	(0.061)
Seed	0.110***	0.114***	0.075***	0.076***	0.026	0.026	0.070***	0.019
	(0.020)	(0.020)	(0.021)	(0.021)	(0.022)	(0.022)	(0.022)	(0.022)
Fertilizer	0.159***	0.151***	0.211***	0.206***	0.311***	0.309***	0.216***	0.291***
	(0.026)	(0.026)	(0.043)	(0.044)	(0.059)	(0.059)	(0.043)	(0.064)
Bullock	0.021***	0.020***	0.033***	0.032***	0.007	0.006	0.035***	0.011
	(0.007)	(0.007)	(0.010)	(0.011)	(0.009)	(0.009)	(0.010)	(0.009)
Machinery	0.020***	0.018***	0.011	0.010	0.023**	0.022**	0.009	0.019*
	(0.006)	(0.006)	(0.010)	(0.010)	(0.011)	(0.010)	(0.010)	(0.011)
Labor	0.017**	0.016**	0.016*	0.015	0.033***	0.032***	0.014	0.032***
	(0.007)	(0.007)	(0.009)	(0.009)	(0.009)	(0.009)	(0.010)	(0.010)
Other	0.009	0.011*	0.022**	0.023**	-0.007	-0.008	0.022**	-0.001
	(0.006)	(0.006)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Observations	6,468	6,468	2,484	2,484	1,165	1,165	2,484	1,165
R-squared	0.937	0.938	0.943	0.943	0.856	0.857	0.944	0.852
Fixed effect	HH	HH	HH	HH	State	State	HH	State
Year FE	Yes	Yes	Yes	Yes	No	No	Yes	No

Note: Standard errors are clustered at household or state level. *** p<0.01, ** p<0.05, * p<0.1. The eight states for which employment data are available are Andhra Pradesh, Bihar, Chattisgarh, Haryana, Madhya Pradesh, Maharashtra, Rajasthan, and Tamil Nadu. As explained in the text, the relevant MNREGS variable in cols 1 and 2 is a MNREGS dummy while in cols. 3-6, it is the number of days of work provided under MNREGS in the village since the program was put in place. Outcome variable is log of agricultural output in all colomns.

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