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Population Change in the Wake of Agricultural Improvement: Lessons for Pakistan

STEPHEN A. VOSTI and MICHAEL LIPTON

I. INTRODUCTION

Since the early 1960s, the mandates of agricultural researchers have been rooted in a "neo-Malthusian" theory of "demographic transition". Population increase in rural South Asia, in particular, had by 1960–63 reached the point where food supply per person could no longer be maintained simply by increases in cultivated area. Food supply was therefore to be raised through higher-yielding varieties of staples. Such *HYVs* were to increase food availability enough to keep ahead of population increase. Extra food availability per person was supposed to reduce population-induced risks of undernutrition and famine, creating a "breathing space" while general socioeconomic development brought about lower fertility.

HYVs have raised food output substantially in many parts of Asia and Latin America, and many advocate HYVs as the main approach to agricultural development in Africa. Surely, many poor people's lives have been saved by the extra employment income, and perhaps by the cheaper food, generated by HYVs. Yet the incidence of poverty in South Asia has probably not changed much since 1960, and the underpinnings of the original HYV strategy have been largely discredited.

It is no longer believed, for example, that population growth is *the* major cause of hunger, nor that accelerated food production (in and of itself) will suffice to reduce poverty in rural areas. In addition, the implicit independence between HYV technologies and the "breathing space" they were intended to generate is

Stephen A. Vosti and Michael Lipton are associated with the International Food Policy Research Institute, Washington D. C., USA.

being challenged. Do HYV technologies affect fertility in ways that extend or lessen this "breathing space"? Do particular types of modern agricultural technologies have different effects on fertility patterns?

This paper examines the impact of several types of modern agricultural technologies since the early 1960s on fertility-based demographic transitions between 1971 and 1981 at the District level in rural India. We begin with an estimation of total fertility rates in Section II, followed by a brief District-level characterisation of agriculture in Section III. Section IV presents the results of empirical estimation. Section V concludes the paper.

II. ESTIMATION OF DISTRICT-LEVEL TOTAL FERTILITY RATES – 1971 AND 1981

Our aim is to quantify the effects, at District level, of agricultural change on population change. Total fertility rates (TFR) were selected as our measure of population change, and TFRs were estimated for 1971 and 1981 using the following equation:

$$TFR2s = 5\Sigma_5 f_{as} * {}_5N^o(t)/\Sigma(\ ({}_5W_a(t)\ {}_5f_{as}(t)*5Lo/lo_s)*5);$$

where ${}_5f_{as}$ is State-level age-specific fertility rate (as above); ${}_5N^o$ is the number of children aged 0-5 years in the District; (t) is the year (1971 or 1981); ${}_5W_a$ is the number of women per child-bearing (5-year) age group in the District; and $5Lo/lo_s$ is State-level child 'survivability', incorporating child mortality into the equation.[1]

District-level estimates of TFR for 1981 were subtracted from TFR estimates for 1971, yielding a TFR difference (labeled TFRDIF)[2]. Virtually all values of TFRDIF were positive, i.e., total fertility rates fell in almost all Indian Districts over the 1971–81 period. There was, however,, substantial variability *across* Districts as to the swiftness with which TFRs fell, as depicted in Diagram 1.

[1]Child survival rates were computed in turn from 1971 and 1981 Census and other data giving survival probabilities up to age 5 for each State, using the formula: $5Lo/lo_d = 0.2+1.3*p(1) + p(2)+p(3)+p(4)+0.5*p(5)$; where $p(1)$ is the State level probability of surviving to age 1, $p(2)$ to age 2, etc..

[2]Reliable State-level evidence of *TFR* based on inter-census estimates suggest that demographic transitions began in India in the mid-to late-1960s (Rele, 1987). We believe our 1970-71 starting point captures most of the reliably detectable decreases in total fertility rates.

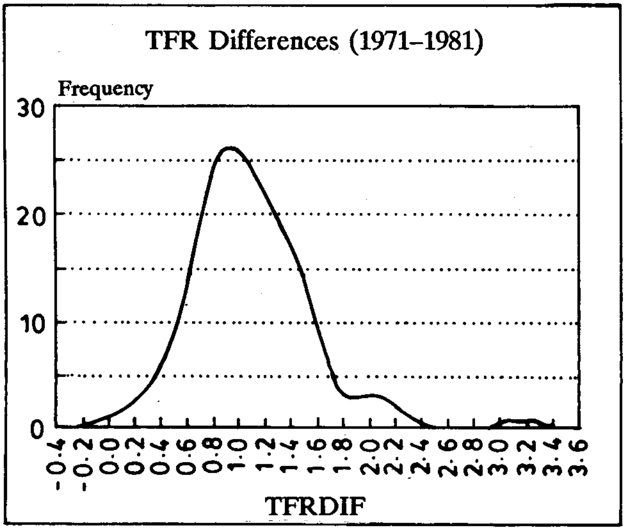

Diagram 1

III. CHARACTERISATION OF DISTRICT-LEVEL AGRICULTURAL CHANGE–1961–80

(a) Objective

Our purpose is to characterise agriculture and agricultural change at the District level over the 1960–61 to 1979–80 period, with particular emphasis on the use of modern agricultural technologies. District-level differences in stocks and flows of key agricultural inputs and outputs are calculated for the 131 Districts included in this study.

(b) Agricultural Change at the District-Level[3]

There have been substantial changes in agricultural yields, production techniques, and modern input use over the 1961-80 period at the District level, both across and *within* States.

Table 1 provides a brief description of the variables used in subsequent analysis. Table 2 presents descriptive statistics that highlight differences across Districts, and over time, in the levels and composition of output generated and modern inputs used. For example, on average, HYV seeds were used on 35 percent

[3]Important innovations in the area of high yielding varieties, irrigation, and agricultural mechanisation were clearly available to, and adopted by, farmers in India beginning in the mid-1960s. Our 1960-61 starting point will capture most of the initial stage of agricultural transformation.

Table 1

Description of Agricultural and Demographic Variables

		Variable Descriptions[a]
DUM66	:	Dummy variable for start of HYV planting (1966=1, 1967=0).
DCUL *A*	:	Difference in percentage of agricultural workers listed as
DCUL *B*	:	cultivators from: *A*, the 1961 to 1971 censuses; *B*, the 1971 to 1981 censuses.
DPGLABR *A*	:	Difference in percentage of Total Workers listed as rurally based.
DPGLABR *B*	:	Rural Workers from: *A*, the 1961 to 1971 censuses; *B*, the 1971 to 1981 censuses.
DTOP3 *A*	:	Difference in diversity measure (percentage of Gross Cultivated
DTOP3 *B*	:	Area concentrated in the top three area crops) from: *A*, 1961 to 1971; *B*, 1971 to 1981.
GCA1	:	Total Gross Cultivated Area (1000's of ha) in 1961.
GIA1	:	Gross Irrigated Area (1000's of ha) in 1961.
NCA1	:	Net Cultivated Area (1000's of ha) in 1961.
NPK1	:	Sum of the quantities of Nitrogen, Phosphate, and Potassium fertilizers (tonnes) applied in 1961.
PAGLBR71	:	Percentage of total workers listed as rurally based rural workers in 1971.
PHYV	:	Percentage of the area to top-area crop in 1980 that was planted to HYV (in 1980).
PREDF19	:	Percent of rural females aged 15-19 listed in the 1971 Census as having attended primary school.
PREDF 24	:	Percent of rural females aged 19–24 listed in the 1971 Census as having attended primary school.
PRFCUL71	:	Percentage of agricultural workers listed as cultivators in the 1971 census.
PRFTRB71	:	Percentage of total rural population belonging to scheduled tribes in 1971.
PRWID44	:	Percent of rural females aged 40-44 listed in the 1971 Census as widows.
QLABOR1	:	Agricultural Labourers plus Cultivators, multiplied by the average number of days worked in the State by farm workers, in 1961.
QTRACT1	:	Number of four wheel machines in use in 1961.
R____*	:	Exponential growth rate of the variable from 1961–80.
RLWAGE1	:	Annual wages of a male ploughman or field labourer in 1961.
SRS___P	:	Sum of the (___P, positive; and absolute value of ___N, negative)
SRS__N	:	residuals of the projected (using exponential growth rate) vs. actual values of the variable from 1961–80.
TFRDIF	:	Estimated 1971 Total Fertility Rate minus estimated 1981 Total Fertility Rate – in most cases, a positive number.
TFR5E71	:	Estimated 1971 Total Fertility Rate.
TOP1	:	1961 yield (1000's of metric tonnes over 1000's of hectares) of the top area crop in 1980.
TOP3__7	:	Percentage of formed area dedicated to the top 3 crops (in terms of area) in 1971.
VTO1	:	Value of total output per capita for rural population in constant 1960-61 Rupees.

[a] All variables are at the District level.
*RTOP, RNPK, and RVTO were calculated using two-year averages as endpoints to control for year to year fluctuations away from the trend.

Table 2

Descriptive Statistics for Agricultural and Demographic Variables

N=131 Variable	(Unit)	Mean	Std. Dev	Range	Minimum	Maximum
Technology Block						
PHYV	(Proportion)	.35	.31	1.00	.00	1.00
GIA1	('000 Has.)	72.15	87.16	414.40	1	415
RGIA	(Growth Rate)	.04	.04	.18	–.04	.14
NPK1	(Tonnes)	901.61	1343.77	8551.00	6.00	8557.00
RNPK	(Growth Rate)	.16	.04	.21	.07	.28
QTRACT1	(4-Wheel Mach.)	66.13	85.22	564.00	1	565
RTRACT	(Growth Rate)	.23	.05	.27	.06	.34
TOP1	(Tonnes/Ha.)	.75	.44	1.90	.03	1.94
RTOP	(Growth Rate)	.01	.02	.15	–.08	.07
Other Agricultural Block						
NCA1	('000 Has.)	515.70	276.51	1363.50	82	1445
RNCA	(Growth Rate)	.002	.01	.03	–.01	.02
GCA1	('000 Has.)	563.27	293.90	1367.50	97	1464
RGCA	(Growth Rate)	.004	.01	.04	–.02	.02
QLABOR1	(Man-days)	56946167	34650913.6	219436669	8487738	227924407
RLABOR	(Growth Rate)	.02	.01	.10	–.02	.08
RLWAGE1	(1960/1 Rupee/Day)	1.54	.66	4.47	.61	5.08
RRLWAGE	(Growth Rate)	.00	.02	.13	–.08	.05
PAGLBR71	(Proportion)	.70	.12	.62	.28	.90
DPAGLBRA	(Growth Rate)	–.004	.05	.33	–.11	.22
DPAGLBRB	(Growth Rate)	–.03	.03	.18	-.14	.04
PRFCUL71	(Proportion)	.61	.14	.65	.27	.92
DCULA	(Growth Rate)	–.13	.05	.36	–.39	–.03
DCULB	(Growth Rate)	.004	.04	.18	–.09	.08
TOP3_7	(Proportion)	.61	.15	.80	.12	.93
DTOP3A	(Growth Rate)	–.01	.03	.16	–.16	.00
DTOP3B	(Growth Rate)	–.004	.10	.53	–.26	.27
Income Block						
VTO1	(1960/1 Rupees) Inhabitant	137.52	50.48	292.84	43.12	335.95
RVTO	(Growth Rate)	.005	.01	.09	–.04	.06
Sociodemographic Block						
PRWID44	(Proportion)	.15	.04	.21	.06	.26
PREDF34	(Proportion)	.23	.16	.91	.04	.95
TFR5E71	(Rate)	5.28	.73	5.07	3.2	8.3
PREDF19	(Proportion)	.27	.16	.73	.05	.78
PREDF24	(Proportion)	.19	.12	.65	.04	.69

Table 3

Within-State, District-level Descriptive Statistics for Agricultural and Demographic Variables

	Low Population Pressure			High Population Pressure		
	Gujara			Tamil Nadu		
	1961	1971	1980	1961	1971	1980
		Mean (Std. Dev.) (Range)	N=16		Mean (Std. Dev.) (Range)	N=9
GCA–POP (Has./Person)	0.77 (0.30) (0.34-1.41)	0.64 (0.26) (0.29–1.16)	0.54 (0.22) (0.25–0.91)	0.28 (0.06) (0.14-0.36)	0.25 (0.06) (0.12-0.32)	0.19 (0.05) (0.09-0.24)
GIA–POP (Has./Person)	0.06 (0.05) (0.01-0.23)	0.08 (0.03) (0.02-0.12)	0.11 (0.05) (0.02-0.20)	0.12 (0.04) (0.06-0.18)	0.11 (0.04) (0.06-0.18)	0.09 (0.03) (0.04-0.14)
NPK–GCA (Metric Tonnes/.000 Has.)	5.30 (0.95) (3.91-7.14)	9.68 (1.88) (6.40-13.44)	18.20 (3.77) (12.81-26.58)	7.49 (7.76) (3.47-27.99)	13.60 (14.02) (6.43-50.62)	31.05 (31.36) (15.12-113.68)
TRC–GCA(4-Wheel Machines/ .000 Has.)	0.19 0.16 (0.04-0.69)	0.48 (0.45) (0.05-1.77)	12.86 (13.34) (1.07-49.00)	0.22 (0.24) (0.20-0.74)	0.36 (0.34) (0.07-1.14)	10.83 (8.88) (1.68-28.31)
RLWAGE (1960-61 Rupees)	2.16 (1.24) (1.02-5.08)	2.30 (1.32) (1.08-5.42)	2.68 (1.54) (1.26-6.32)	1.41 (0.35) (1.06-2.09)	1.40 (0.33) (1.15-2.11)	1.74 (0.36) (1.18-2.38)
VTO–GCA (1960-61 Rupees/ 000 Has.)	0.28 (0.15) (0.10–0.58)	0.37 (0.20) (0.16-0.79)	0.35 (0.19) (0.14-0.77)	0.27 (0.19) (0.10-0.76)	0.30 (0.18) (0.13-0.72)	0.29 (0.12) (0.11-0.48)

of gross cultivated area dedicated to Districts' top area crop in 1980, but this average conceals geographic (and crop-specific) variation in HYV use, which ranged from 0 percent to 100 percent. Similarly, growth in NPK use averaged 16 percent over the sample period – with some Districts registering up to 28 percent growth rates and others only 7 percent increases.

Moreover, States facing extremely different population densities contained Districts that varied widely in input use and output generated. Table 3 presents data for Gujarat and Tamil Nadu which (in 1980) displayed the highest and lowest levels of gross cropped area per rural inhabitant, respectively. Clearly, the mean levels of land availability (and *changes* in land availability) varied dramatically across these States. More importantly, *ranges* of indicators of population pressure varied widely *within* States, as well. Substantial overlap in ranges for some variables across States highlights the shortcomings of State-level stratifications; a clear signal of the potential for the type of District-level study undertaken here.

IV. INTERRELATIONSHIPS BETWEEN AGRICULTURAL CHANGE AND POPULATION CHANGE

The central question to be addressed in this research project is the extent to which the stock of technologies and/or changes in technologies employed in agriculture affect changes in total fertility rates in the medium term. At first glance, one would expect the impact of agricultural technologies on TFR to be either direct (for example, the impact of technical change on demand for female labour, affecting the costs of bearing children), or indirect, via changes in the level of income available to farm households. Moreover, it is quite possible that particular *types* of agricultural technologies might have different (perhaps even opposite) effects on medium-term changes in TFR. We attempt to identify and quantify these relationships.

1. General Test of the Impact of Technical Change in Agriculture on Demographic Transitions

A first step towards sorting out the impact of technical change on TFR change is to examine the direct (technology → TFR) and indirect (technology → income → TFR) links in the data.[4] Agricultural and income blocks of variables (1960-61–1979-80) were tested for their collective statistical explanatory power as regards changes in TFR (1970-71–1980-81).[5] Several regression equations were estimated,

[4]An endogeneity test was performed and statistically confirmed the absence of a causal relationship running *from* changes in TFRs *to* changes in agriculture.

[5]We experimented with the lag structure linking the two data series. Agricultural change over the *1960–70 period* was chiefly responsible for determining the statistically significant interrelationships in population change over the *1970-71–1980-81 period*.

and the collective significance of the variables included in the technology and income blocks was assessed using F-tests.

Diagram 2 reports the results of these F-tests. The technology block (see

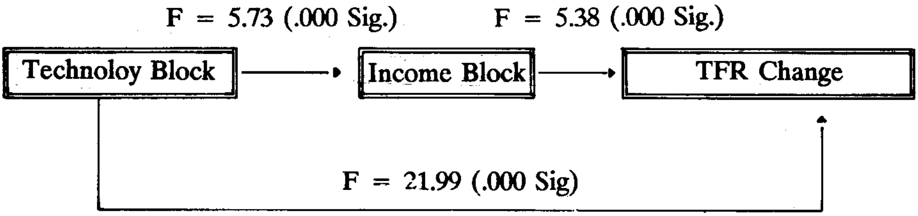

Diagram 2

Tables 4 and 2 for details) was found to have a highly significant *direct* impact on TFR change ($F=21.99$). In addition, this technology block was found to have a significant, independent impact on income derived from annual crop production ($F=5.73$), which in turn was found to have a significant impact on demographic transition ($F=5.38$).

These preliminary results confirm the direct influence of modern technologies on changes in total fertility rates, and suggest that options may exist for selecting particular types of technologies (and technology policies) to simultaneously induce agricultural change *and* swifter medium-term declines in TFRs. These options will depend on the specific influences of particular types of technologies on TFR changes.

2. Tests of Specific Hypotheses Linking Technological, Other Agricultural, Income-related, and Sociodemographic Factors to Changes in Total Fertility Rates

No composite indicator of technological change can capture the vector of factors that characterise agricultural transformation. We focus on and quantify different aspects of technical change in agriculture from 1961–80, and assess the independent impacts of each on 1971–81 changes in TFR by including these measures as explanatory variables in a regression equation with changes in TFR as the dependent variable.

What follows is a summary of the impacts of specific technological, other agricultural, income-related, and sociodemographic factors on the degree to which District-level TFR declined over the 1971–81 period. Results of the Ordinary Least Squares regression appear in Table 4.

Table 4

Factors Influencing Speed of Total Fertility Rate Declines
O.L.S. Estimates

Dependent Variable = TFRDIF

Variable Name	Est. Coeff.[a]
Technology Block	
PHYV	.02
GIA1	−6.65E-5
RGIA	−.99
NPK1	−2.34E-5
RNPK	.15
SRSNPKP	9.42E-6
SRSNPKN	2.34E-6**
QTRACT1	−1.64E-3***
RTRACT	−1.06*
TOP1	−.40***
RTOP	−5.48***
SRSTOPP	.04
SRSTOPN	.07***
RICE[b]	.46***
BAJRA[b]	.18
JOWAR[b]	.20**
OTHCROP[b]	−.09
DUM66	−3.34E-3
Other Agriculture Block	
NCA1	8.87E-4
RNCA	−8.32
GCA1	−1.01E-3
RGCA	12.48
QLABOR1	2.08E-9
RLABOR	−1.02
RLWAGE1	−.14
RRLWAGE	4.49***
SRSRLWAGEP	.02
SRSRLWAGEN	−.07***
PAGLBR71	−.47
DPAGLBRA	−.59
DPAGLBRB	−1.73*

Variable Name	Est. Coeff.[a]
Other Agriculture Block (Cont'd)	
PRFCUL71	.15
DCULA	−.87
DCULB	−.57
TOP3_7	−4.05E-3
DTOP3A	.47
DTOP3B	.81**
PRFTRB71	.37**
Income Block	
VTO1	1.06E-3
RVTO	5.09*
SRSVTOP	−7.04E-5
SRSVTON	7.40E-4***
Sociodemographic Block	
PRW1D44	−1.50*
PREDF34	1.45**
TFR5E71	.52***
PREDF19	3.14***
PREDF24	−3.98***
Constant	−1.53***
$\bar{R}^2 = .72$	N = 131

[a] Absolute value of t-ratio, with *,**,*** signifying significance levels of 15 percent, 10 percent, and 5 percent, respectively.

[b] Dummy variables for top area crops in 1980, with wheat as the excluded variable – OTHCROP represents all non-HYV top area crops.

(a) Technology Block

The relative presence of HYV technologies in 1980 (measured in terms of the percentage of top area crop area in HYV seeds), did *not* influence changes in total fertility rates. In addition, neither the stock of gross irrigated area in 1961, nor the rate of growth in irrigated area over the 1961–80 period, had a significant effect on TFR changes.

While neither the level of NPK use in 1961, nor the rate of growth of NPK used over the 1961–80 period, had an influence on changes in total fertility rates, increases in *down-side* variation in NPK use from the established growth trend *accelerated* declines of total fertility rates.

Districts with above-average *levels* of farm mechanisation in 1961 experienced *slower* declines in total fertility rates, as did Districts that registered above-average *increases* in farm mechanisation over the sample period.

Controlling for the type of crop identified as most important, the *more successful* the most important crop (cross-sectionally, in terms of yields in 1961), or the faster its growth rate in yields over the study period, the *slower* the demographic transition. TFR declines were slower in Districts specialising in wheat production *vis-a-vis* those Districts specialising in rice or jowar. Finally, Districts displaying large down-side variations in rates of growth in yields for the top crop displayed significantly *faster* rates of change in total fertility rates.

(b) Other Agriculture Block

Stocks of, and changes in gross and net cropped area were not statistically linked to changes in total fertility rates. However, *increases* in the percentage concentration of gross cropped area in the top 3 crops over the 1971–80 period led to *swifter* declines in total fertility rates.

The total stock of labour used in agriculture in 1961, and the rate of growth in labour use over the 1961–80 period (controlling for area under plow) both failed to significantly affect changes in total fertility rates. However, weak statistical evidence suggests that Districts with above-average wage rates in 1961 had somewhat lower decreases in total fertility rates. More importantly (and statistically more robust), Districts in which *real wages increased* at above-average rates tended to have much *faster declines* in total fertility rates. Interestingly, Districts with relatively *low down-side variations* in wage rates experienced much *faster* demographic transitions.

Districts with rural labour comprising above-average percentages of total District labour force in 1971 had somewhat slower declines in total fertility rates. A more significant, negative relationship surfaced between *changes* in the percentage of rural labour in total District labour force over the 1971–81 period and changes in total fertility rates.

(c) Income Block

Growth in crop-derived income over the 1961–80 period had a positive impact on declines in total fertility rates. Cross-sectional variations in base-year, crop-derived income levels did not affect total fertility rates. Districts experiencing lower levels of *down-side* variations in income growth tended to have *slower* demographic transition.

(d) Socio-demographic Block

Above-average levels of education among females in the 19–24 and 24–34 age groups in 1971 tended to hasten demographic transitions substantially. Increased education among women in the 20–24 age group, however, tended to retard decreases in total fertility rates, perhaps owing to delayed child-bearing in this particular age group. Increased levels of widowhood in 1971 among rural females aged 40–44 tended to slow demographic transitions. Higher total fertility *rates in 1971* prompted faster *declines* in total fertility rates over the 1971–81 period.[6]

V. CONCLUSIONS AND POLICY IMPLICATIONS

Empirical results strongly support the *direct* and *indirect* impacts of agricultural technologies on TFR declines at the District level in rural India. Moreover, the results suggests that the impacts of different *types* modern agricultural technologies on medium-term total fertility rate declines are by no means uniform. Increases in both agricultural mechanisation and the growth rate of yields of major staple crops were found to *decrease* the rates at which TFR decline. On the other hand, increases in irrigation, NPK use, and the percentage of area dedicated to modern HYV seeds were demographically neutral.

Intertemporal variability for each District associated with the use and impact of modern technologies also influenced the rate at which total fertility rates declined. Increases in *down-side risk* associated with NPK use, growth rates in yields of the major crops, real wage rate increases, and increases in income derived from annual crop sources were all associated with *faster* TFR declines.

[6]A regression equation was estimated to control for the State-level fixed effects. The results (not reported here) confirmed the importance of the District-level interrelationships previously identified; no important (statistically significant) changes were generated, and *none* of the coefficients on the Sate-level variables were different from zero.

Increases in District-level concentration of output in the top three crops was also shown to speed up TFR declines.

Finally, Districts experiencing above-average growth in real wage rates tended to have faster declines in total fertility rates. Likewise, Districts with above-average growth rates in crop-derived income experienced faster TFR reductions.

The policy implications associated with these general research conclusions cost some doubt on the ability of modern agricultural technologies in the medium term to simultaneously feed the world's poor while at the same time bringing about reductions in the overall number of rural inhabitants depending on that increased food supply. Increased mechanisation and crop-specific yields (particularly for wheat), and a general reduction in intertemporal variability in input use and output have been key issues to which agricultural research and policies have been addressed. Our research suggests that improvement in these critical areas, while undoubtedly increasing the total stock of food available *and* the growth rates in agricultural output, have generally tended to *retard* demographic transitions in the medium term. Policies and/or technologies conducive to District-level (and by extension, farm-level) output diversification are likely to retard demographic transition. On the other hand, policies aimed at increasing rural incomes, particularly rural wages for females (we suspect), will probably promote swifter demographic transitions.

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Comments on
"Population Change in the Wake of Agricultural Improvement: Lessons for Pakistan"

This paper is a meticulous empirical investigation of the relationship between agricultural change and population change in India. It grapples with a large data set in neat stages. I think we need to reconsider some of the theory given in the paper, and therefore the results and policy implications.

Received theory gives the authors 4 determinants of fertility behaviour. The most important determinant here is given by the Chicago/Columbia school: that there is a demand for children (Dc) for their future income.

From this the authors imply:

(i) Agrarian technical change causes an increase in income, and a consequent decrease in the total fertility rate (TFR);

(ii) If technical change is labour using, Dc will increase, so the TFR will increase.

I disagree with the authors on (ii). Let us begin with the Chicago school proposition that children are demanded for their future income. Clearly this does not apply across all income classes. Rich parents are unlikely to rely on children's future income. So it applies to poor parents. And the lower the household income, the higher Dc is likely to be. Then the authors theory that if technical change is L using Dc will increase, may not hold because of a counter tendency.

(iii) If technical change is labour saving, employment is decreasing, household income is low or decreasing, there will be a greater need to rely on children's future income, so Dc will increase, and TFRs will increase.

The difference between the authors and myself is that they stress that observed high probabilities of employment will raise Dc. I hold that observed low incomes are a stronger tendency inducing reliance on children's future employment. In fact I will argue on the basis of some of my work on child labour in Pakistan the following model.

At a micro level the poor household is faced with low levels of adult employment at an adult wage rate. To increase the household income, child employment is offered in the labour market at a lower children's wage rate. At the micro level this gives the household a lower wage higher employment niche in an otherwise sticky labour market. At the macro level the introduction of child labour allows employers to reduce wages for children in a sticky labour market for adult labour.[1]

This theoretical oversight leads to some important results which the authors cannot explain. They find:

(a) A significant, strong, negative relationship between tractorisation in 1961, or growth of tractorisation on the one hand, and the decline in TFRs across districts on the other. They expected according (ii) that increased mechanisation, and lower employment would decrease TFRs, because of the probability of employment effect;
 But this result is in keeping with my argument (iii) that increased mechanisation, and lower employment will increase TFRs, because of the lower household income and greater Dc for their future incomes.
 My income effect argument is supported by two more results obtained by the authors.
(b) The increase in real wages is significantly and strongly positively correlated to a decrease in TFRs; and
(c) The growth rate of crop derivable income was significantly and strongly positively correlated to decrease in TFRs. So the income effect on TFRs is clearly predominant, and theory needs to be modified here.

I think that these results have very important policy implications for our population and growth planners in Pakistan.

(1) The increasing landlessness and unemployment in the agrarian sector is disastrous for future growth. We do not want skewed growth; and
(2) The increasing landlessness and unemployment in the agrarian sector may well account for the high levels of TFRs found in Pakistan because of the predominate income effect observed in India. So we need to even out the skewness of agrarian income and assets to bring down TFRs.

Moazam Mahmood

Pakistan Institute of
Development Economics,
Islamabad.

[1]Mahmood, M. (1992) Why children do not go to school in Pakistan (ongoing project at PIDE).