DEMOGRAPHIC IMPACT of AGRICULTURAL TECHNOLOGY USE in NEPAL[1]

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Abstract

Using longitudinal panel data from western Chitwan Valley of Nepal, this study investigates the impact of labor-saving modern farm technologies use on fertility behavior - numbers of babies born. Including this setting, there is ample evidence that modern farm technologies substitute human labor and save labor. In rural agricultural settings where the demand for farm labor is believed to be the driver of persistent high fertility, the use of such labor-saving technologies ought to lower fertility. However, little attention has been given to potential role the modern technologies use may play on fertility decline. The data allowed unique opportunity to link a household's labor-saving inputs use to subsequent demographic behaviors - numbers of births in those households. The results of our multivariate analysis show significantly lower births in households that used tractor, and pumpset and farm implements. Implications are advanced.

The Issue

In agrarian societies of developing countries, human labor contribution to household production activities is substantial. The value of child labor, therefore the demand for children, is high due to their labor contribution in performing various farm and non-farm activities. This high value of child labor is considered one of the explanations driving the persistent high fertility among individuals of agrarian societies (Rosenzweig 1977; Rosenzweig and Evenson 1975; Stokes and Schutjer 1984; Stokes, Schutzer, and Bulatao 1986; Filmer and Pritchett 1997; Loughran and Pritchette 1997).

Nepal is not an exception, where the economy is largely agriculturally based. Human labor, including child labor is widely used in carrying out various activities (Bhandari 2006; Bhandari et al. 1996; Chitrakar 1990; Filmer and Pritchett 1997; Karan and Ishii 1996; Kumar and Hotchkiss 1988; Loughran and Pritchette 1997). The labor needed for performing most agricultural activities to a large extent comes from within the household. To maintain a regular supply of laborers, farm households may pursue alternative strategies that include use of hired labor, produce more babies, and use of labor-saving farm technologies wherever possible.

In the Chitwan valley, the setting for this study, some farm households use labor-saving modern mechanical (tractors, pumpsets and implements) as well as bio-chemical (chemical fertilizers and pesticides) technologies for agricultural production. Since these technologies are labor-saving (for example, Boserup 1965; Rauniyar and Goode 1996), the availability of family labor inversely influences the decision to adopt technology in agriculture (Feder et al. 1985; Karablieh and Salem 2003; Schutjer and Van der Veen 1977). Previous study from this study setting provides such evidence (Bhandari 2006). Conversely, the use of such labor-saving technologies on farm production may reduce the demand for human labor including child labor, thus reducing the number of births.

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With this background in view, this study aims at answering: *to what extent does the use of labor-saving modern mechanical and biochemical inputs in agriculture influence the numbers of farm births in an agricultural setting of Nepal?* To our knowledge, studies that has examined the possible inverse effect of the use of farm technologies on births as proposed by Rosenzweig (1977), however, is virtually absent in developing countries including Nepal particularly because of the lack of appropriate data. The longitudinal panel data collected by the Chitwan Valley Family Study utilized here allows unique opportunity to answer this question.

Theoretical framework

Although various explanations exist to explain fertility transitions in developing countries, Rosenzweig (1977) and Stokes and his colleagues (for example, Stokes and Schutjer 1984; Stokes, Schutzer, and Bulatao 1986) provide theoretical frameworks for studying fertility behaviors of individuals in agricultural households. Rosenzweig (1977) considers psychic and productive roles of children as important factors contributing to the demand for children. While Stokes and his colleagues (for example, Stokes and Schutjer 1984; Stokes, Schutzer, and Bulatao 1986) offer two hypotheses: the land-labor demand hypothesis and the land-security hypothesis. According to the land-labor demand hypothesis, the greater accessibility to cultivated land requires more laborers, which ultimately increases the demand for children. Conversely, according to the land-security hypothesis, land ownership provides old-age security to farmers and thus inversely affects number of births.

This study builds upon the demand framework for agricultural households proposed by Rosenzweig (1977). Rosenzweig (1977:124) pointed out two important roles of children in an agrarian household– "as durable commodities which yield psychic income and productive laborers…" He particularly focused on the roles of children in performing various economic activities in household production and resulting high fertility among individuals due to the greater demand for them. Using the aggregate U.S. farm population cross-sectional data from 1939-1960, he observed that the decline in birth rates was associated with the reduction of value of children in farm households as a result of the application of capital-biased technical change. The use of technologies decreased the value of child labor and hence reduced the pecuniary returns from children within agriculture sector ultimately declining farm birth rates.

We utilize this explanation to examine the effect of technology use in farm production on numbers of child births using data from an agrarian setting of Nepal. In most agrarian settings, households are both a production and a consumption unit. Farm households are the primary units of decision making (Ellis 1993; Feder and Umali 1993). Human labor (including child labor) is widely used in carrying out various household activities including farming (Bhandari 2006; Bhandari et al. 1996; Chitrakar 1990; Filmer and Pritchett 1997; Karan and Ishii 1996; Kumar and Hotchkiss 1988; Loughran and Pritchette 1997; Rosenzweig 1977). The labor needed for performing most agricultural activities such as plowing fields, applying manure, carrying out intercultural operations, weeding, transplanting, and harvesting exclusively come from within the household. Because of the absence of labor markets for most household production activities, some households strategically use child labor to perform daily reproduction or maintenance activities. Other households use labor-saving farm technologies as an alternative strategy.

In the Chitwan valley, the study setting, some farm households use modern mechanical (tractors, pumpsets, farm implements) as well as bio-chemical (chemical fertilizers and pesticides) technologies for agricultural production. Uses of labor-saving modern farm inputs may reduce the value of human labor including child labor. For instance, in Nepal, land preparation for crop cultivation is generally performed by using human and animal labor. It is understood that the use of tractors in agriculture replaces farm labor (Agarwal 1983; Schutjer and Van der Veen 1977). In one study in India, the use of a tractor required only one-fifth the labor that was needed when using a bullock (Agarwal 1983). In her study, Agarwal found that there was a considerable replacement of human labor by tractor power. Similar findings were reported by Bartsch (1977).

Use of rainfall and canal water (gravity flow) is the common method used in irrigating crop fields in Asia. Nepal in general and Chitwan Valley in particular are not exceptions to this situation. In the Chitwan Valley, crop fields are usually irrigated by using canal water during the monsoon (rainy) season. However, where canal water cannot be delivered to the field, a pumpset is used. Water is lifted either from the canal or from the deep wells with the help of a pumpset and then applied to the field crops. However, during dry seasons (winter and summer), the irrigation canals are generally dry and the pumpset is the only source for regular and assured supply of water. Evidence is limited on whether the use of a pumpset is a labor-saving or a labor-using technology as compared to gravity irrigation. However, there are findings that traditional methods such as the use of the Persian wheel (an animal powered wheel with pots) and *charsa* (use of bullocks for lifting water from the well), commonly used methods in India, are labor-intensive as compared to pumpset irrigation (Bartsch 1977).

Among the other implements used by the farmers of the Chitwan Valley are corn shellers, sprayers and chaff cutters. Corn shellers are used for loosening grains from corn, whereas sprayers are used for spraying chemicals such as pesticides and herbicides. A chaff cutter is used for cutting straw or dried fodder into small pieces to be used for livestock. Loosening of corn grains is commonly a manual job in the Valley. Although female labor is generally used for this purpose, male labor is equally used whenever needed. A corn sheller also is increasingly being used by some farm households for the purpose. It is relatively easier and faster to use a corn sheller. Similarly, a chaff cutter saves males' time as compared to those of females. The use of a sprayer generally increases male labor and saves female labor by reducing their time for weeding or removing diseased plants from the field. But its use is infrequent in Nepal.

Farmyard manure (FYM) or compost (also called organic manure) is the commonly used soil nutrient replenishing material. Recently, the use of chemical fertilizer is increasing, however. Techniques of fertilizer application vary in Asia, for example, farmyard manure application by hand, green manure application right in the field by cutting green plants, and plowing them into the soil, and chemical fertilizer application by hand or using a scoop and basket (Bartsch 1977). In some countries, fertilizer drills, seed drills, and row planter equipment by tractors are used to apply chemical fertilizers. In Nepal, manual application by hand is a commonly used technique.

Comparative studies on labor requirements by various methods of manure application are scarce. Moreover, the available evidence is not conclusive. In Swaziland, the use of chemical fertilizer is considered to be a labor-intensive technology, where it is frequently used as basal-dose and top-dressing (Rauniyar and Goode 1996). Arnon

(1987) also reported that the application of fertilizers may increase labor demand due to the need for more frequent and intensive weeding. In India, Bartsch (1977) also indicated similar findings. However, these studies have not compared labor requirements of chemical fertilizer application with traditional application of manure.

In the Nepalese context in general, and the Chitwan Valley in particular, the application of FYM demands a much higher level of human labor as compared to the use of chemical fertilizers. This is because a household is required to keep livestock to produce manure for the field, which demands regular supply of labor for the care and management of animals. Second, the barn has to be cleaned and compost has to be prepared. Third, prepared compost has to be carried out to the field in baskets or carts and has to be applied in each and every field. It requires a significant amount of labor as compared to buying, storing, and applying of chemical fertilizer in the field.

The application of herbicides and insecticides also replaces manual labor. Herbicides are used for controlling weed growth in the crop fields, whereas insecticides and pesticides are used for controlling insects and diseases. Manual weeding of unwanted plants is a common practice in the Valley and the task of weeding is specifically performed by women. Therefore, the use of herbicides particularly replaces female time. For example, Rani and Malavia (1992) reported that one acre of land required 12.42 days for manual weeding by women in India. When herbicides were applied to control weeds, the time required decreased to 0.42 days per acre.

There is ample evidence of the labor replacement effects of most farm technologies. The labor replacement effect of modern technology may reduce the value of children as farm laborers, ultimately reducing the numbers of births. Therefore, this study aims at testing the hypothesis that *the use of modern labor-saving technologies such as tractors, improved farm implements, chemical fertilizers, and pesticides reduces the numbers of births.*

Significance

This study has important theoretical and practical significance. Most studies have primarily focused on socio, economic and cultural factors to explain fertility transitions in developing countries. Theoretically, this study, however, examines the role of labor-saving farm inputs used by a farm household on demographic behavior - numbers of child births. By analyzing the household-level panel data, this study affords the unique opportunity to understand this relationship. Practically, this finding may be of significance in agricultural settings of other countries of South Asia (for example, Bangladesh and India) and other regions where population is growing rapidly and food production is barely matching the needs of fast-growing populations. In addition, the findings may be useful in countries, for example Nepal, where use of inputs has not been increased despite government's efforts to increase food production by encouraging the balanced use of green revolution technologies.

Data

This study used the household-level data from multiple surveys collected by the Chitwan Valley Family Study from the western Chitwan Valley of south central Nepal. The main purpose of the research was to examine the influence of rapidly changing social contexts on demographic processes including timing of marriage, childbearing and contraceptive

use. The research was also designed to investigate the reciprocal relationships between family formation (marriage, childbearing, and migration) and the environmental outcomes such as land use. We used the 1996 household census data, the 1996 baseline agriculture data (also called Time 1 data), and the on-going household registry data (1996-2001) for 54 months. The survey included all the households that were present inside the neighborhoods or clusters (see Barber et al. 1997 for detail). The multiple surveys being carried out in the valley utilize the same study population over time.

The 1996 household census collected information on age and gender of each person living in a household. This survey included all the individuals who ate and slept in a given household during the past six months. The 1996 baseline agriculture data, the first round of household interviews (Time 1 survey), in general, recorded information on farming activities. Of particular interest to this study, the survey recorded information on the use of various technologies in crop production such as tractors, pumpsets, chemical fertilizers and pesticides (insecticides and herbicides), farm implements, and other information such as size of cultivated holding, land ownership, and livestock holdings. The data were collected using a face-to-face interview technique featuring a carefully designed interviewer assisted structured schedule. The response rate was 100 percent.

The on-going household registry monitors demographic events such as marriage, child bearing, migration and deaths for every month since 1996. In this study we utilized number of babies as the outcome variable updated from the household registry over a period of 54 months (4.5 years). Other control variables such as number of services available in the community and distance to largest market center of Narayangarh used come from neighborhood level data (see Axinn et al. 1997 for additional detail).

Unit of analysis

A farm household (that farmed in 1996 agriculture survey) is the unit of analysis. A farming household is defined as a "household in which at least one member (not necessarily the head, the reference person or the main income earner) is operating a holding" as defined by the FAO (1986:144). Specifically, the survey has defined a household as farming if it is engaged in any kind of crop cultivation activities on at least 10 *dhurs* (20 *dhurs* = 1 *kattha* = 0.034 hectare) of land during the survey period. The variable was operationalized partly through responses to the yes/no question "Does your household do any farming?" The survey also asked the actual size of land under various crops during the survey year. The validity of the response on farming status was confirmed by determining whether the actual amount of land the household was cultivating during the survey period was 10 *dhur* or more. The same operational definition was used in the 2001 household survey.

Every household had been given a unique household identification number in 1996 that was retained and assigned to the household in 2001. Therefore, it is easy to identify and compare the status of a household by using this unique identifier in different surveys. Using this unique identifier, a household's farming status recorded in 1996 can be linked with any other variables measured over a period of time.

Setting

The Western Chitwan Valley situated in the southern plain of central Nepal is the setting for this study. Before the 1950s, the Valley was mainly inhabited by indigenous Tharu

ethnic group. It was covered with dense forests and was infamous for malarial infestation. The government, with the assistance from the USA, initiated a rehabilitation program in the Valley during the 1950s by clearing the dense forests. Since then, the Valley has witnessed a rapid inflow of migrants of diverse ethnic groups. Further, Chitwan's central location and relatively well-developed transportation network have been the catalytic forces for turning it into a hub for business and tourism. This has resulted in a rapid proliferation of government services, businesses, and wage labor jobs in the district (Shivakoti et al. 1999).

Farming is the main source of livelihood of people in the Valley. Although agriculture is experiencing rapid modernization, it is largely subsistence in nature. A large majority of farmers practice mixed-farming with highly integrated crop and livestock production systems. A household survey conducted in 1996 indicated that of the total 1,805 sample households, over 80 percent of them were growing some crops and about three-fourths of them were keeping livestock such as cattle, buffalo, sheep and goats.

In the Chitwan Valley, people were attracted by the free distribution of land for agricultural purposes at the beginning of the settlement and development of modern amenities and services in recent decades. The Valley is inhabited mostly by in-migrants, especially from *pahad*, i.e., the Hill and the high Hill and other Terai districts including India. There is a wide variation in ethnic composition ranging from the High Caste Hindus (for example, Brahmin and Chhetri), Low Caste Hindus (for example, Kami, Sarki, and Damai), Newar, Hill Tibetoburmese (for example, Gurung, Magar, Tamang) and Terai Tibetoburmese (for example, Tharu, Kumal and Darai).

Variables and their measurement

Dependent variable

Number of babies born to individuals living in farm households over a period of 54 months (4.5 years) after 1996 is the dependent variable used in this study.

Independent variables

Technology use in agriculture. Technology use in crop production by a farm household in 1996 is the major explanatory variable used to explain the amount of childbearing. Use of tractors, pumpset and farm implements, chemical fertilizers, and pesticides by farmers in producing crops are the technology use variables considered.

The data allows us to track the same household so that data collected in 1996 can be linked to each household over a period of study period. This makes the study unique per se. On top of this, the independent variables were measured in 1996 and the dependent variable child bearing is measured in subsequent months. Therefore, it is logical to assess the causal link between technology use and its effect on subsequent demographic behaviors at the household level.

Tractors use. In the Chitwan Valley, tractors are commonly used by farmers for land preparation, specifically for the first tillage operation. Tractors are also used for other purposes like threshing and transportation of grain and straw. In this study, tractor use was measured with a survey item that asked "Did your household use a tractor to plough the land for planting ….. crop?" The variable is coded "1" if that household used a tractor in plowing the land and "0" otherwise.

Use of pumpset and farm implements. Canal water is commonly used to irrigate crop fields during the monsoon season in the Valley. However, where crop fields are inaccessible to canals, a pumpset is used to lift water from the canals or wells to irrigate the fields. In the Valley, irrigation water is not distributed through canals during the winter season. Therefore, the use of a pumpset increases when canals are dry.

It is assumed that a household that owns a pumpset or any other farm implements uses them in farming. Ownership of a pumpset, in this study, is used to measure the access to and use of well-controlled irrigation even during the dry season. In the survey, information on the ownership of a pumpset by farm households was obtained by asking "Do you have a pumpset for irrigation?" The variable was coded "1" if the answer is yes and "0" otherwise. Similarly, ownership of other farm implements such as a thresher, chaff cutter, sprayer, corn sheller, or other implements is also considered as an indicator of improved technology use on the farm. To measure this variable, the survey asked "Does your household have a thresher, chaff cutter, sprayer, corn sheller, or any other kind of farm tools?" The response was recorded as "1" if a household owns any of these implements and "0" otherwise.

We constructed a summated index of the ownership of a pumpset and farm implements. The dichotomously coded responses of these two mechanical implements were simply added together, which grouped farmers into three categories: (a) a farmer owned none of them (coded 0), (b) a farmer owned any one of them (coded 1), and (c) a farmer owned both of them (coded 2). We then regrouped these farmers into two categories as (a) a farmer used none of them (coded 0), and (b) a farmer owned at least one of them.

Use of chemical fertilizers and pesticides/herbicides. The survey collected information on the use of chemical fertilizers and pesticides/herbicides by asking whether a household used any chemical fertilizers and pesticides/herbicides in the past three years. The question was: "Did you use chemical fertilizer in the past three years?" A similar question was asked for pesticide/herbicide use. The answers were recorded as "1" if a household did so and "0" otherwise.

Index of technology use. A summated index of the technology use variable is constructed using the dichotomously coded responses of the use of tractor, pumpset and farm implements, chemical fertilizer, and pesticide. Each of these variables were added together. The index ranged from 0 to 4; 0 being a farmer used none of these inputs and 4 being a farmer used all four of them. This variable is used as a continuous variable in the analysis.

Controls

Number of females of childbearing age is measured as the total number of women 15-45 years of age living in a household at the time of survey in 1996.

Organization of agricultural production, particularly the size of cultivated holding and the ownership of land influence individual fertility behaviors in an agricultural setting (Stokes and Schutjer 1983; Stokes, Schutjer and Bulatao1986). It is expected that households with large size of cultivated land holdings may demand more labor for cultivating the land thus motivating them for supplying more children (the land-labor demand hypothesis). In addition, in many societies, children are considered as risk insurance or a source for old-age support (Mason 1987; Caldwell 1982). In an

agricultural setting, for landowners, the owned land can serve as collateral against loans or as a means of financial support in old age (Stokes and Schutjer 1983). This may influence landowner's decision in limiting fertility. Tuladhar et al. (1982) and Gajurel (2001) provide evidence of the land-labor demand hypothesis from Nepal.

The total cultivated land is the total of *bari* and *khet* land cultivated by a farm household during the survey year. In the Chitwan Valley, two types of farm land are available – *bari* and *khet*. The *bari* is upland, usually un-irrigated, and generally not suitable for rice cultivation. The *khet* is low lying area and can be irrigated during monsoon season and is good for rice planting. The *khet* is considered good quality land in terms of production and price compared to the *bari*. The 1996 household survey first confirmed whether a household has farmed any *bari* or *khet* land. A separate question was asked "Do you farm any *bari* land where you cannot grow rice?" and for *khet* "Do you farm any *khet* land?" The response was recorded as "yes" or "no." Upon confirmation, the next question asked the size of *bari* and *khet* land. The amount of land was recorded in the local unit, *bigha* (1 hectare = 1.5 *bigha*) and *kattha* (1 hectare = 30 *kattha;* 1 *bigha* = 20 *kattha*). Then, the amounts of both *khet* and *bari* land in *kattha* were added to find the total cultivated size of holding.

Land ownership is measured as full owner-cultivators, owner plus sharecroppers (part-owners), and sharecroppers. The 1996 household survey revealed information about the ownership of *bari* and *khet* land separately by asking "Does your household own the land, is it sharecropped, is it mortgaged, is it on contract to you, are you the tenant of the land or are there some other arrangements?" Based on the information provided to each category, I recoded the responses and categorized them as (i) full owners, (ii) owner plus sharecroppers (part-owners), and (iii) sharecroppers.

In Nepal, farming and livestock keeping are closely integrated. One of the purposes of keeping livestock is for farmyard manure. Application of farmyard manure or compost is a common practice in Nepal as well as in the Valley. Since buying and selling of manure is virtually absent, a household with animals is assumed to use manure rather than chemical fertilizers in crop fields. In addition, male cattle and buffaloes are used for plowing the land. Care for animals demands substantial amount of human labor. Therefore, it is expected that the demand for children may also be associated with livestock keeping. In this study, total numbers of large animals, cattle and buffaloes is used.

Effect of education on fertility is widely studied and these are found to be negatively associated (Becker 1981; Easterlin and Crimminis 1985). Similar findings have been reported by Pearce (2000) and Gajurel (2001) in this study setting. An individual's education is measured as the number of years of schooling at the time of survey. Employment of an individual also influences individual fertility behavior.

Education has a negative effect on fertility (Becker, 1981; Easterlin and Crimminis, 1985). Educated individuals may have good skills, and thus good employment. Education may also increase individual's socioeconomic status that negatively affects fertility behaviors. Moreover, educated persons may have a good knowledge of advantages and disadvantages associated with contraceptive use and may have different attitudes toward contraceptives as compared to their illiterate or less educated counterparts. Several studies conducted in the Chitwan Valley setting also reported a negative association between education and fertility preferences (Pearce, 2000;

Gajurel, 2001). This study controls the education of the elderly (male or female) member of the household.

The Chitwan valley is resided by people of various ethnic groups such as High Caste Hindu (for example, Brahmin and Chhetri), Low Caste Hindu (for example, Kami, Damai, Sharki), Newar, Hill Tibetoburmese (for example, Gurung and Magar) and indigenous Terai Tibetoburmese groups (for example, Tharu, Kumal and Darai). Previous studies in this research setting observed a variation in fertility behaviors of individuals by ethnicity (Axinn and Barber 2001; Biddlecom et al. 2000; Gajurel 2001; Pearce 2000). Individuals belonging to the local indigenous or Terai Tibetoburmese ethnic groups preferred significantly larger family sizes compared to other ethnic groups. Therefore, the effect of ethnicity has been adjusted for.

As is often used by other researchers in this setting (for example, Axinn and Barber 2001), households are grouped into High Caste Hindu (for example, Brahmin and Chhetri), Low Caste Hindu (for example, Kami, Sunar, Damai, Sarki), Newar, Hill Tibetoburmese (for example, Gurung, Magar, Tamang), and local indigenous Terai or Terai Tibetoburmese (for example, Tharu, Kumal and Darai) groups. High caste Hindu group is considered as the reference category.

In the Chitwan Valley, the Agricultural Development Bank and other banks such as the Nepal Commercial Bank (Nepal Vanijya Bank) and Nepal Bank Limited provide credit to farmers for agricultural purposes. Similarly, access to agricultural cooperatives is also an important source of chemical fertilizers and pesticides. Access to a road increases the access to markets for inputs as well as outputs. It affects technology use in agriculture by decreasing the costs of inputs and increasing the accessibility to product markets. Access to transportation also increases access to other off-farm employment opportunities, thus increasing the likelihood of shifts out of farming. Other services included are the access to schools, health services, and employment opportunities. The employment opportunities include factories, schools, government offices, hotels, and banks that can be walked from the neighborhood. In the survey, all these variables are measured as the time to walk in minutes to the nearest service from the neighborhood.

Since most of these services are likely to be concentrated in one place, there could be a high correlation between access to banks, cooperatives, bus services, schools, health services, and employment opportunities. Therefore, an index was constructed to measure the degree of accessibility to these services. To create an index, first, the time to walk to the given service was recoded as “less than or equal to 10 minutes” coded as “1” and “more than 10 minutes” coded as “0” as used by Gajurel (2001). Then, these re-coded variables were added together to obtain the number of services within a 10-minute walk. This is the measure of the degree of accessibility to various services. The services included are the access to banks, bus services, cooperatives, schools, health services, and employment opportunities. The index ranges from 0 to 6; 0 implying presence of no services at all to 6 implying presence of all six services considered. These indexes were used as continuous variables in the analysis.

Small Farmer Development Program (SFDP) of the Agricultural Development Bank provides necessary inputs, credit, and advice to small farmers in two Village Development Committees, namely, Jagatpur and Meghauli in the study area. SFDP has also a community development component in its program. The presence of the small

farmer development program in the neighborhood is coded “1” if a SFDP group member is present and “0” if not.

Narayanghrh is the urban center and the headquarters of the Chitwan District. This is the main outlet for agricultural produce in the Valley. This is also the important source of information. Moreover, off-farm opportunities are also available in the urban center and its vicinity. The distance to Narayangarh in Kilometers from the neighborhood is used as a continuous measure.

In the Chitwan Valley Study, the 2001 household survey reported that some of the households that were farming during the 1996 survey left their occupation and followed non-farm activities by 2001. I defined such a shift in occupation between 1996 and 2001 as occupational mobility (farm exit) for purposes of this study. The 1996 household survey confirms the farming or non-farming status of a household by asking, “Does your household do any farming?” Similarly, the 2001 household survey also asked this same question to the household that was surveyed in 1996. This survey also followed the same definition of farming household, cultivating 10 *dhur* (0.5 *kattha*) or more land as described elsewhere in this chapter to identify a household’s farming status and followed the same procedure to collect the information. Some other households that moved out after 1996 survey were not followed for agricultural survey. Therefore, a separate variable was created to net out the effect of this changed context.

Data analysis

Univariate, bivariate and multivariate statistical tools were used. First, the variables used in the study were described using descriptive statistical tools such as mean, standard deviation, range and percent (Table 1). Then, differences in child bearing by technology use groups were assessed using the one-way ANOVA (Table 2).

Pearson’s correlation was used to examine the correlation between variables as well as to diagnose potential multicollinearity problems in the data (Menard 1995; Schroeder et al. 1986; Walsh 1990). Collinearity diagnostics, the tolerance statistics, provided in the linear regression analysis of the SPSS program were also used to identify possible collinearity problems. The tolerance statistics reflect the variance in each independent variable not explained by all other independent variables (Menard 1995; Norusis 1990). According to Menard (1995), a tolerance statistics “less than 0.20 is the cause for concern and a tolerance of less than 0.10 almost certainly indicates a serious collinearity problem” (p. 66).

Since the dependent variable, the number of babies born to individuals living in farm households is continuously measured; ordinary least square (OLS) technique has been used as a multivariate tool to examine the net effects of independent variable on the dependent variable.

Results and discussion

(Yet to be written)

TABLES

Table 1. Descriptive Statistics of Variables (N=1,262)

Variables	Descriptive Statistics			
	Mean	SD	Min	Max
Dependent variable				
Total number of babies born in 4.5 years (after 1996)	0.59	0.92	0.00	6.00
Major independent variables				
Tractor use in 1996 (Yes=1)	0.77	0.42	0	1
Pumpset and farm implements use in 1996 (Yes=1)	0.16	0.36	0	1
Chemical fertilizer use in 1996 (Yes=1)	0.82	0.38	0	1
Pesticide use in 1996 (Yes=1)	0.23	0.42	0	1
Index of technology use	1.98	0.91	0	4
Controls				
Number of females of age 15-45 years in the household	1.25	0.87	0	8
Total cultivated (khet and bari) land (kattha)	24.71	23.50	0	200.00
Land ownderhip: (Ref: Own cultivated land)				
Share crop or other arrangements	0.08	0.27	0	1
Own and share crop cultivated land	0.20	0.40	0	1
Total number of cattle and buffaloes	2.59	2.14	0	14
Ethnicity (reference=high caste Hindu)				
Low caste Hindu	0.11	0.32	0	1
Hill Tibetoburmese	0.16	0.37	0	1
Newar	0.06	0.24	0	1
Terai Tibetoburmese	0.18	0.38	0	1
Number of services within 10 minutes of walk	2.22	1.48	0	6
Presence of small farmers group in the community (Yes=1)	0.20	0.40	0	1
Farming status: (Ref: Continued farming between 1996 and 2001)				
Shift of farm occupation between 1996 and 2001 (Yes=1)	0.07	0.26	0	1
Other: unknown farm status between 1996 and 2001(Yes=1)	0.04	0.19	0	1
Distance to main market center of Narayangarh (Km)	9.06	3.71	0.04	17.7

Note: 30 kattha = 1 hectare

Table 2. Average Number of Children Born to Farm Households by Technology Use (N=1,262)

Variables	Number of babies born to farm households by 54 months after 1996		
	N (Percent)	Mean	SD
Mechanical technology			
Tractor			
Did not use	293 (23.22)	0.74***	1.01
Used	969 (76.78)	0.54	0.89
Pumpset and farm implements			
Did not own	1065 (86.77)	0.58	0.92
Owned	197 (15.61)	0.61	0.96
Bio-chemical technology			
Chemical fertilizer	224 (17.75)	0.69+	0.98
Did not use	1038 (82.25)	0.56	0.56
Used			
Pesticides/herbicides			
Did not use	968 (76.70)	0.61	0.94
Used	294 (23.30)	0.51	0.85

One-way ANOVA F *** = p<.001; ** = p<.01; * = p<.05; + = <.10

Table 3. Unstandardized OLS Regression Estimates Predicting the Effect of Technology Use in Crop Production on Child Bearing (N=1,262)

Variables	1	2	3	4	5
Independent variables					
Tractor use in 1996 (Yes=1)	-0.148*	-	-	-	-
Pumpset and farm implements use in 1996 (Yes=1)	-	-0.161*	-	-	-
Chemical fertilizer use in 1996 (Yes=1)	-	-	-0.098	-	-
Pesticide use in 1996 (Yes=1)	-	-	-	-0.093	-
Index of technology use	-	-	-	-	-0.104***
Controls					
No. of females of age 15-45 years in the household	0.105***	0.105***	0.108***	0.107***	0.107***
Total cultivated (bari and khet) land (kattha)	0.002	0.003	0.002	0.002	0.003*
Land ownership: (Ref: Own cultivated land)					
Share crop or other arrangements	0.000	-0.005	-0.005	0.001	-0.025
Own and share crop cultivated land	0.009	-0.008	0.007	0.001	-0.005
Total number of cattle and buffaloes	0.060***	0.068***	0.067***	0.066***	0.064***
Ethnicity (reference=high caste Hindu)					
Low caste Hindu	0.359***	0.373***	0.370***	0.376***	0.335***
Hill Tibetoburmese	0.149*	0.148*	0.150*	0.154*	0.141+
Newar	-0.021	-0.010	-0.018	-0.019	-0.034
Terai Tibetoburmese	0.500***	0.518***	0.509***	0.518***	0.472***
Number of services within 10 minutes of walk	-0.005	-0.007	-0.005	-0.005	-0.005
Presence of small farmers group (Yes=1)	-0.063	-0.061	-0.053	-0.060	-0.070
Farming status:					
(Ref: Continued farming between 1996 and 2001)					
Shift away from farming between 1996 and 2001 (Yes=1)	0.108	0.141	0.120	0.132	0.116
Other households (Yes=1)	0.212*	0.223+	0.214	0.223+	0.215
Distance to main market center of Narayangarh (Km)	0.005	0.006	0.005	0.004	0.007
Intercept	0.169	0.036	0.124*	0.065	0.226*
Model F	8.953***	8.826***	8.672***	8.697***	9.389***
Regression degrees of freedom	15	15	15	15	15
Residual degrees of freedom	1246	1246	1246	1246	1246
Adjusted R-square	8.6%	8.5%	8.4%	8.4%	9.1%

Note: 30 kattha = 1 hectare

*** = p<.001; ** = p<.01; * = p<.05; + = p<.10

Summary and Conclusion
(Yet to be written)

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