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The human fertility implications of food and agricultural policies in less-developed countries

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Among managers of foreign-assistance programs and those responsible for the design and implementation of agricultural and rural development policy is a growing interest in the relationship between agricultural policy and population change. In its crudest form, this interest is expressed by Paddock, and those of similar persuasion, as a plea for withholding agricultural technology from nations whose population growth is "not under control" (Aycock 1976). But the employment-oriented development strategies of Seers (1969) and Mellor (1976) and the AID requirement that loan applications include a population-impact statement are also manifestations of a growing recognition that rural welfare and production-oriented programs may not have the desired population impact.

Currently, the development of a rural policy that is sensitive to fertility issues is frustrated by the complexity of the issues involved. There is no comprehensive framework within which the relationships between agricultural and rural-development policy and population growth can be viewed. Agricultural and rural-development policies and policies designed to limit fertility may work together or they may work against each other. Which force dominates depends largely on a nation's stage of demographic development. It is therefore not surprising that a consistent strategy for the synthesis of agricultural policy and demographic policy has not emerged.

The purpose of this paper is to provide a framework for identifying the links between agricultural policy and fertility and to review the empirical literature regarding interaction between human fertility and policies designed to influence agricultural production in rural areas. The empirical evidence includes both published work and previously unpublished findings growing out of the Agricultural-Demographic Project of The Pennsylvania State University.[1]

THE PROCESS OF DEMOGRAPHIC DEVELOPMENT

Demographic development is the process whereby a nation, or a subpopulation, comes to control its human fertility. More specifically, a nation or subpopulation can be defined as having attained demographic development when actual fertility is limited by family-size desires rather than by biological factors (Schutjer 1978). In the case of human fertility, as with most human behavior, control is hard to define in the strict sense of the term. A substantial degree of control would mean that actual fertility conforms, more or less, to parental preferences in the typical case.

Three concepts of fertility are important for determining demographic development: natural fertility, desired fertility, and actual fertility (Easterlin 1972). Natural fertility refers to childbearing which is independent of any parity-connected voluntary control. That is, parents make no effort to control their fertility regardless of the number of children born. Desired fertility refers to the completed family size viewed as optimum at the time fertility decisions are being made; it reflects estimates of social obligations, resources available, and a range of socioeconomic considerations. Actual fertility represents the outcome of a series of discrete decisions, or nondecisions, as well as an adjustment for the actual and anticipated loss of children through premature mortality. Like natural fertility, actual fertility is sensitive to changes in nutrition and health standards. Unlike natural fertility, it reflects attempts of individuals to respond to their environment.

Using these concepts, the demographic development of a nation or of a subpopulation is defined as moving from a situation where actual completed family size is limited only by natural completed family size to a condition where the limit is desired family size. Similarly, a nation or subpopulation is defined as having attained demographic development when actual completed family size is limited by desired family size (Fig 1).

In the initial stage of demographic development, natural family size (fertility) is comparatively low, reflecting high rates of fetal wastage, infant and child mortality, and cultural constraints on childbearing. In the second stage, natural fertility rises in response to improvements in public health and nutrition brought about by improvements in agricultural productivity or direct intervention.[2] In the third stage of demographic development, natural fertility levels off, reflecting the difficulty of achieving further declines in mortality.

The level of desired family size is shown in Figure 1 as a faded line in Stage 1 to indicate the indeterminate nature of the concept at very early stages of demographic development. It is argued that desired family size is not well formulated at this stage. Awareness of the relevance of what is a desirable family size, and the recognition that limiting fertility may be advantageous, marks the entry of the population under consideration into the second stage of demographic development (Freedman 1979). The arrival of this "awareness point" can reflect a variety of conditions, but is likely to be closely correlated with land constraints.[3] In short, as long as traditional agricultural methods can be expanded to unused land of similar quality, the notion of limit-

[1]Publications and reports in the reference list resulting from the Agricultural-Demographic project are identifed by an asterisk.

[2]The increase in natural fertility occurs in the second stage of the traditional demographic-transition model.

[3]There is debate in the literature regarding the longer-term implications of declining man/land ratios. In classical theory the force limiting all economic progress is population growth and diminishing returns to labor (Peacock 1954; Baumol 1956). Boserup (1965) in turn argues that technological progress is a response to declining man/land ratios. In either case demographic awareness is the likely result of declining land availability; in the first instance because of declining real incomes and in the second because of the required change in agricultural techniques.

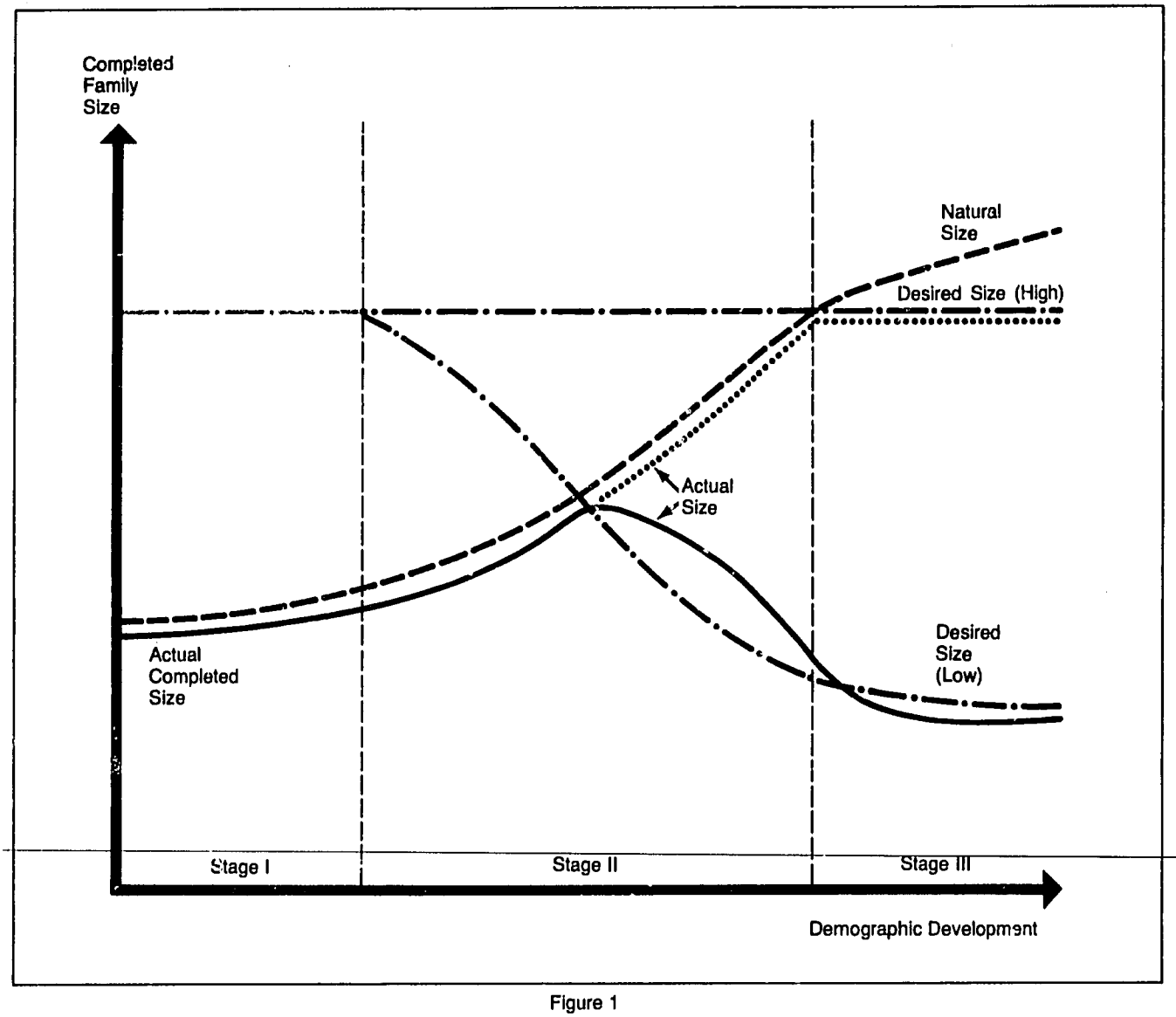

Figure 1

ing family size to a given number of children would appear to have little relevance to traditional farmers.

In the second stage of demographic development desired family size may decline, be constant, or rise. In Figure 1 only two possibilities are shown — constant and declining. In the case of declining desired family size, the desired family size falls below the natural family size in Stage 2 (Fig 1). At this point, actual completed family size begins to exceed the smaller desired family size — bringing about a reduction in actual completed family size as families adopt practices to bring family size in line with what is desired. If the desired family size remains at a high and constant level, the actual family size is not limited by the desired rate until the beginning of Stage 3.

Actual completed family size is shown in Figure 1 as limited by natural fertility until the desired size falls below the natural. Actual fertility can be constrained by the desired at a high or a low level of completed family size. Thus, demographic development does not necessarily imply low fertility; it implies only that the desires of each family operate as the major control on actual completed family size. It is also important to note that desired completed family size being below or equal to the natural size does not alone reflect demographic development — it is a necessary but not a sufficient condition. For example, in the case of a falling desired family size, the desired size dips below the natural size in Stage 2, but demographic development is not achieved until Stage 3 in which actual fertility falls to the level of desired family size.

DEMOGRAPHIC DEVELOPMENT POLICY

National policy can contribute to the process of demographic development through influence on natural, desired, and actual fertility. Which fertility rate is the appropriate target for policy action can be shown to depend upon the stage of demographic development.

In Stage I of demographic development, (successful) policies are likely to focus on raising natural fertility and promoting demographic awareness among the population.

Natural fertility includes two components: 1) strictly physiological factors such as fecundability, intra-uterine mortality, gestation period, temporary nonovulatory periods, and primary and secondary sterility; and 2) social customs affecting the likelihood of pregnancy such as increased age at marriage; ease of divorce, separation, and remarriage; sexual contacts outside marriage; breast-feeding practices; work-imposed separation of spouses; and taboos and other factors reducing coital frequency (Robinson and Schutjer 1980). Psychological factors and customs alike are possible policy targets, but the physiological component is amenable to agricultural and rural-development policy manipulation through changes in the quality of diet and health care available to the population.[1]

Demographic awareness in rural societies is likely to be primarily a function of land availability and crowding, but education programs and family planning activities can contribute. Specifically, family planning programs can play a major role in providing information required for families to define a desired family size (Freedman 1979). However, as noted in Figure 1, family planning programs likely will have a major fertility impact only after the desired fertility rate has fallen below the actual rate.

In Stage II, three policy foci influence further demographic development — 1) increases in the natural-fertility rate, 2) assistance to families in the attainment of their fertility desires, and 3) changes in the average desired number of children — in a direction consistent with national demographic objectives. In the final stage of demographic development, the relevant policy foci are a continued rise in the natural-fertility rate and support for families in maintaining their family size desires. If a change in desired family size is a national policy objective, that, too, becomes an appropriate policy focus for the third stage.

Changes in the natural-fertility rate result primarily from changes in biological and physical processes. Desired family size, however, primarily reflects behavioral patterns and as such is more amenable to economic analysis. Family size decisions based upon desired fertility have been the primary focus of micro-economic analyses of human fertility. Micro-level economic analysis of fertility began with Banks (1954), Leibenstein (1957), and Becker (1960), who sought to use the tools of micro-economic analysis to explain the effect of family income on family fertility decisions. A second set of micro-level theoretical models of family fertility behavior grew out of the work of Lancaster (1966), who argued that families seek to purchase a flow of services such as transportation, entertainment, and other consumer utilities by drawing upon the inputs available to the family in the form of human skills, time, and income. Within this framework, children are viewed as one input into the family utility package and are subject to the same income and price constraints as other goods requiring family time, financial resources, and human skill to produce.

A number of reviews of micro-level theoretical approaches to fertility are available (Schultz 1973; Leibenstein 1974; Cochrane 1975; Nerlove 1973). The Leibenstein review, which combines the more traditional work with that based upon the Lancaster approach, provides a useful input to a policy framework. The essence of the Leibenstein framework is the specification of the alternative utilities that children can provide a family: income utility (additions to family income), security utility (financial and emotional security in the parents' later years), and consumption or consumer-good utility. Thus, parents seeking to define a desired family size must compare the benefit associated with each of the utilities with the cost of obtaining the benefit.

The weights assigned to each utility will vary among societies and among individual families within a society. In Western nations, consumption utilities prevail and families experience negative family income effects, since the opportunity cost of parental time is greater than the income children generate during the period of time they live at home. Similarly, institutional mechanisms in most Western nations provide a degree of security to elderly people in the absence of support from children. Within a more traditional system, the range of utilities created by children is wider than in a Western system. Children do in fact generate income, provide old-age security, and generate consumption utility.

Within the proposed policy framework, actual completed family size is largely determined by natural and desired fertility rates. Thus, rural policy designed to influence human fertility must be examined for potential impacts on the components of natural fertility and the weights families assign to the utilities underlying desired fertility, as well as the costs and benefits of obtaining the utilities. As will be shown, food policy is likely to have a major impact on natural fertility, and agricultural policy can have a major impact on desired fertility.

THE STRUCTURE OF RURAL POLICY

Government investments and programs in rural areas include two broad categories — rural economic growth activities and rural-development activities. Following the work of Seers (1969), Cornman and Madden (1977), and others, rural economic growth consists of programs and policies designed to increase rural income through influence on returns to agricultural-production activities and/or the creation of nonagricultural employment opportunities in rural areas. Rural development encompasses the many activities which influence the quality of life other than improvement in income. Rural development includes improved access to public services and facilities for health, education, and welfare protection or enhancement of an area's natural and environmental resources; and the capacity of rural people, communities, and institutions to interact effectively, both locally and with the larger society, in identifying and attaining goals.

Rural economic growth and rural development are not completely separable. The introduction of a new crop may improve income through increased sales, but the institutions required to bring about the production of the crop may also serve to improve communication between farmers and government agencies on a broad range of issues more clearly in the domain of rural development. Similarly, nutrition and

[1]There is a related problem in that the natural fertility rate is likely to be a function of income at low levels of nutrition and health standards.

rural health programs may improve the quality of life in rural areas, but they may also increase the productivity of labor, and hence have a growth component.

Food and agricultural policies illustrate the rural development-rural growth dichotomy in the area of agricultural production and distribution. Food policy attempts to improve the quality of life through better diet while agricultural policy aims to increase output and improve efficiency among agricultural producers. Clearly, the interrelation of rural development and rural growth also holds in the case of food and agricultural policy.

The impact of food and agricultural policy on the demographic-development process is reviewed in the following section. The focus on these two dimensions of rural policy does not deny the importance of other aspects of rural policy in demographic development. Rural development policy in education and the provision of health services can play a major role in determining the rate of natural fertility. Similarly, rural-employment programs can increase income for rural families and increase the availability of off-farm employment opportunities for rural women, thus influencing desired family size. The discussion in this paper is limited, however, to food and agricultural policy.

IMPACT OF FOOD AND AGRICULTURAL POLICY ON NATURAL FERTILITY

Improving the rate of natural fertility is an appropriate demographic-development policy goal in each stage of demographic development. Food and agricultural policy can have an impact on natural-fertility rates primarily through improved nutrition and improved access to medical care associated with higher rural incomes. As noted earlier, natural fertility reflects physiological factors and social customs affecting the likelihood of pregnancy. Food policy will have its primary impact on the physiological component of natural fertility through improving diets, although breastfeeding practices — a component of the second set of factors — have also been affected by nutrition programs in some countries. Agricultural policy which results in improved efficiency at the farm level will contribute to improved natural fertility through greater food availability and through higher income leading to improvements in health.

Empirically, it is difficult to separate the nutritional impact on the physiological component of natural fertility from that associated with disease, since a close correlation exists between nutrition and susceptibility to disease — particularly infectious disease. Poor nutrition and disease together increase female fertility, fetal wastage, and child mortality. Isely et al. (1979) provide a comprehensive review of the literature on the fertility consequences of variation in health and nutritional status.

Maternal malnutrition appears to have its greatest independent effect on natural fertility through delayed menarche and duration of lactational amenorrhea (Bongaarts 1980). However, maternal height, as a measure of premenarcheal nutritional status, also correlates directly with the stillborn rate, fetal loss, and low birth weight (Isely et al. 1979, pp 59-61). The World Health Organization (1975) notes that chronic gonorrhea, pelvic tuberculosis, and pelvic schistosomiasis are all associated with infertility, while malaria, syphilis, certain viral bacterial rickettsial, and protozoan diseases affect pregnancy wastage.

Morley (1972) reported that approximately 25 percent of child and infant deaths in developing nations are directly due to malnutrition, while Puffer and Serrano (1973) found that in more than 50 percent of child and infant deaths, malnutrition is a contributing factor. The effects of poor nutritional status are pervasive. The infant born with a low birth weight for gestational age has in fact suffered *in utero* malnutrition. Following birth, infants in developing nations often do not have enough food, and suffer the effects of recurrent acute infections.

In short, it seems clear that food policy resulting in improved nutrition and related protection against infectious diseases along with agricultural policies that increase food output and income among farm families will have a positive impact on the level of natural fertility. It is also likely that nutritional improvements which decrease the infant mortality rate will have a secondary impact on natural and desired family size. The strong positive biological effect of child mortality on subsequent fertility, operating through shortening postpartum lactational amenorrhea, has been well documented (Knodel 1978; Cantrelle et al. 1978). The behavioral response which would affect desired family size through the parents' desire to replace lost children or assure a completed family of a given size is less certain and has undergone considerable revision in the past two decades (Rizk et al., forthcoming).

In 1963, Freedman posited that "known low mortality is one of the necessary conditions for an effective social policy for reducing fertility" (1968, p 164). As recently as 1972 a United Nations publication suggested that "evidence accumulates that the reduction of infant mortality may be a necessary prerequisite to the acceptance of family planning" (cited in Preston 1978, p 3). Preston noted that "The early 1970s was a period of almost unguarded optimism about the ability of reductions in child mortality to induce major declines in fertility through pre-existing social mechanisms" (1978, p 3).

These conclusions were based largely on evidence drawn from cross-sectional analyses of national or regional data, supplemented by some individual-level analyses. Findings from later individual-level research conducted in the late 1960s and throughout the 1970s were not as clear nor as consistent as in earlier aggregate studies. By 1976, Taylor et al. (1976, p 263) stated unequivocally that "it is not true that reduced child mortality is a precondition — a necessary but insufficient cause — for fertility reduction." These authors do not suggest that there is no link between the two; rather, they claim that the connections are less direct and straightforward than earlier studies had indicated.

Recent work in Egypt by Rizk et al. (forthcoming) supports the close relationship between infant deaths and fertility, but provides only limited insight into the relative importance of a biological versus a behavioral explanation for the relationship. Among the sample females, initial differences in birth intervals between women with and without child-mortality experience were largely eliminated when appropriate controls were introduced for variations in lactational amenorrhea. This finding is consistent with a growing body of research indicating little replacement effect or other behavioral responses to child mortality for birth intervals

when biological factors such as reduced lactation are controlled.

In contrast to the findings on birth intervals, individual experience with child mortality was significantly related to the number of additional children desired and to the use of contraception. In addition, community-level experience with child mortality was related to use of contraception. The findings suggest that child mortality does influence reproductive behavior, but the mechanisms through which such effects operate are more complex and less direct than has been assumed.

One conclusion emerging from recent work is that replacement effects of child mortality are likely to differ by the society's stage of demographic transition. In populations with very low rates of contraceptive use, and in which fertility is quite high, few effects of a child-replacement motivation are likely to be observed. In populations with very low or no use of contraceptives, pregnancy rates are already quite high. Thus, as Chowdhury et al. (1976, p 260) state: "even if women with child loss were to desire consciously to replace lost children and acted accordingly, it would be very difficult for them to achieve conception much more quickly than other women." Replacement strategies are more likely to be observed in populations farther along in the transition from high birth and death rates to low rates (Taylor et al. 1976, Chowdhury et al. 1976, Preston 1978). This conclusion suggests that effects on desired family size of food and agricultural policies which operate through a behavioral response to variation in infant and child mortality are likely to be associated with a falling desired family size in Stage II of demographic development.

FOOD AND AGRICULTURAL POLICY AND DESIRED FAMILY SIZE

Desired family size is hypothesized to vary according to individual families' estimates of the utility associated with additional children and the costs of obtaining those utilities. As noted above, desired family size can also reflect parental experience regarding infant and child mortality and hence is subject to influence through food policy designed to improve nutrition. The discussion below is limited to additional changes in desired family size resulting from the impact of agricultural policy on consumption utility, security utility, and income utility.

Agricultural Policy and Consumption Utility

The impact of agricultural policy on desired family size, operating through the consumption utility associated with children, may be found in the relationship between family income and fertility. At the farm-family level, children can be viewed as a consumption good, which permits the use of the family or household-demand-for-children framework, based upon the concepts of the "new household economics." In this framework "child services" are consumed by the household, and because children are not considered to be an inferior good, the demand for children increases with income and falls with rising prices.

Empirical measures of the income effect on the demand for children among farm families of developing nations are difficult to obtain. First, farm-family income is closely related to the use of family labor, including child labor, which tends to obscure the price-consumption relationship between income and human fertility. Second, the price effect operates primarily through increased opportunity costs of female time and through parental desires for more highly educated and healthier, better-nourished children. Both price effects are, of course, likely to be closely related to family income, i.e., higher female opportunity costs reflect a greater female contribution to family income, while higher income contributes to higher education and health expectations for children (Birdsall 1977, p 83).

The empirical literature provides no evidence of a consistent relationship between farm-family income and family size in developing nations — likely because of the links between family income, nutrition, and family labor utilization. There is limited empirical support for the notion that higher farm income can be expected to bring about consumption-utility-induced reductions in desired family size as farm families with greater income desire higher-priced (e.g., better-educated) children, and families "trade-off" higher-priced children for a smaller family size.

Studies of child costs in developing nations have tended to focus on education as the price factor over which parents have the greatest discretion. However, the results of the limited number of empirical studies that have looked carefully at the question of educational costs and fertility among rural families in the LDCs (less-developed countries) are mixed. Repetto (1976) notes that the results of the Rand studies of Chile and the Philippines show negative coefficients for school-enrollment rates. Similar results were found in the Rand Thailand study; however, that study used child schooling as a variable to measure child cost and used provinces as the unit of analysis, with the result that the magnitude of the negative coefficient was small (Maurer et al. 1973, pp 22, 24). In the Philippines, Paqueo used the quantity-price trade-off framework, and included provincial expenditures on education per student as a variable in regression to predict individual women's fertility. He found that although the signs of the coefficient of this variable for different samples and equations were "generally negative," they were statistically significant only for his "low education/rural subsample."

The Value of Children (VOC) studies of the East-West Center have carefully measured parental perceptions of costs of children's schooling. However, the results of comparisons of these perceived costs with fertility desires are not consistent. In the Philippines, where 85 percent of the parents expected their sons to finish college, the effect of the cost perception on additional children desired was insignificant once noneconomic "values" were accounted for (Bulatao 1975, pp 115, 136). However, cost perceptions were significantly related to ideal family size (Bulatao 1975, p 145). In Thailand, Buripakdi (1977, pp 62, 85) found no significant correlation between the expected cost of children and total number of children wanted; yet in the rural sample, 36 percent of the respondents would want more children if education through college were free. Educational aspirations for daughters were found to be negatively and significantly related to desired family size and, in general, "Thai respondents perceived the financial burden of having children to be high" (Buripakdi 1977, p 62).

An important study of the quantity-price trade-off among rural families in developing nations is that of Dyck (1979).

Drawing upon a sample of 436 farm households in the Central Plain region of Thailand, Dyck used a two-stage-regression technique to relate income, educational expectations for individual children, and fertility. Using a number of individual household and village-level variables, he explains 38 percent of the variation in the expected school level of individual children. Among the significant variables is family income, which is positively related to educational expectations for children. In the second stage of the analysis, the average educational expectations of each female for her children is combined with age of the female, marriage duration, and educational attainment of the female to predict total expected completed family size.

The resulting fertility equation explained 25 percent of the variation in total expected completed family size among the sample women. Other than female education, each variable was significant at the 1 percent level with the expected sign. Significantly, the negative impact of educational expectations was second only to that associated with marriage duration, suggesting a potentially important price effect on fertility expectations.

An extension of this work is represented by Ron (1980) who estimated a household-economic model using the same data used by Dyck in a less formal model. Roa's findings strongly support the existence of an income-induced education-family size trade-off among Thai rice farmers. Using the individual data, Dyck and Ron were able to demonstrate that, among farm families in the Central Plain Region of Thailand, income is positively associated with greater educational expectations for children (or higher-priced children), and that higher educational expectations for children were significantly and negatively related to fertility.

Clearly, more studies are required to confirm the results obtained under different cultural settings and with a wider variety of child-price factors. But the studies support the notion that agricultural policy designed to raise income among farm families may result in lower desired family size as families seek to provide greater educational opportunities for fewer children.

Agricultural Policy and Security Utility

The hypothesis that large families, particularly sons, result from parental desire for old-age security is attractive intuitively as well as theoretically. However, empirical tests of the hypothesis are limited in number and those available are at the aggregate level (Freedman 1963; Holm 1975). From a policy perspective, it appears critical that the level and certainty of future security to be obtained from children be empirically compared with those of alternative investments.[5]

Within the rural sector, the principal store of value is land. Land ownership can generate an income stream beyond the period during which the operator is receiving a management or labor return. Thus, conceptually it is likely that agricultural policies directed at broadening land ownership will reduce desired family size through reduction in the weight assigned to future parental security obtained from children. The limited literature regarding variation in family size among land owners, tenants, and landless laborers supports (in general) such a conclusion.

Three studies in the Philippines (Hawley 1955; Schutjer et al. 1980; and Hiday 1978) have investigated the influence of land tenure on fertility. Hawley found that farm tenants had higher fertility in all age groups of women except one — those 35 to 44 years of age. Schutjer et al. (1980), using a village-level sample in Luzon, found that the direct effect of land ownership on fertility was positive. More importantly, however, the indirect effects — operating through female education and village-level traditionalism — were negative. In addition, the indirect effects were stronger than the direct effects, resulting in an overall negative relationship between land ownership and fertility. Similar results were found by Hiday (1978) who reported a negative relationship between land tenure and fertility among farm families in two Mindanao communities. Owners and part-owners had the lowest fertility.

It has proved difficult to sort out empirically the impact of land ownership on fertility from the impact associated with farm size and access to land, and the institutions associated with ownership. Mamdani (1972) argued that among Indian farmers in the Punjab, high fertility (many sons) represented a means of acquiring land, holding on to land, and obtaining maximum benefits from the land through the elimination of hired labor. In such circumstances, concern over long-term security is only one of a number of motives for acquiring land.

Equally important is the work by DeVany and Sanchez (1977) in Mexico, where findings indicate that a negative relationship between land ownership and family size can be offset by pronatalist conditions governing land ownership. Specifically, they argue that the ejido system of granting rights to land on a usufruct basis creates a series of pronatalist incentives; incentives which raise fertility. These incentives include (DeVany and Sanchez 1977, pp 743-744):

> (1) *Production.* Children are productive at an early age; their direct labor services may augment those of the parents to increase the total product attainable from the family's small plot.
>
> (2) *Intertemporal Allocation.* The uncertainty of rights in the land, including the lack of salability, limits the degree to which the family will depend upon investment in its farm or in crops and other assets tied to land as a means of distributing present production forward to the future. (Further) uncertainty will make lenders reluctant to lend to ejidatarios, since the loan cannot be secured by the land.
>
> (3) *Land Retention.* Given the political nature of the ejido, a large family is an asset as a political base. The more members a family has who are of voting age or of an age to acquire more land, the larger is the coalition of families and allies who would block discretionary enforcement of the law that may deprive the family of its rights to its land or other resources of the ejido.

To test their hypotheses, DeVany and Sanchez examined the effects of the ejido system of land distribution on the fertility of women in 48 rural municipalities in the state of Mexico, which surrounds Mexico City. They found that a high ratio of ejidatarios per woman within a municipality

[5]Freedman (1963) and Holm (1975) provide support at the aggregate level for the security hypothesis.

was related to a greater incidence of marriage and higher fertility. Regardless of the measure of ejidatario effect used, all were positively related to fertility. DeVany and Sanchez (1977, p 761) suggest that reducing the uncertainty associated with ejido land, restoring the land market, and initiating steps to improve markets would reduce ejidatarios' incentives for higher fertility.

Recent analyses of fertility behavior among rural families in Thailand and Egypt more nearly capture the relationship between land ownership and fertility operating through security utility (Chalamwong et al. 1979; Stewart 1980). Both analyses employ multiple-regression techniques in an analysis of family-size variation among farm families with varying degrees of land ownership. In both cases, with cultivated area, income, and a set of demographic control variables included, land ownership as measured by the proportion of land cultivated which was owned by the family was negatively and significantly related to fertility. In fact, other than the demographic control variables of age and age at marriage, land ownership was the most important variable in explaining variation in total fertility among the sample families in Egypt and Thailand alike. Specific results were as follows:

	Standardized Betas	
Variables	Thailand	Egypt
Farm size	0.0476 (1.74)*	0.0571 (1.47)
Land ownership	-0.0814 (2.97)	-0.0858 (4.02)
Income	0.0149 (0.540)	-0.0301 (0.79)
Female education	-0.0316 (1.15)	0.0319 (1.51)
Female age	0.6358 (22.37)	0.7714 (36.32)
Age at first marriage	-0.3351 (2.07)	-0.2223 (10.57)
N	775	851
R^2	0.44	0.63

*Student t-value.

At a policy level, a program directed at increasing farm size through a land-redistribution scheme which includes ownership will likely have two contradictory impacts on family size. Land ownership will tend to reduce fertility by providing an alternative means of support to parents in old age and by encouraging greater investments in child education. Simultaneously, increases in average farm size will increase the demand for farm labor and hence, create pronatalist pressure.

Finally, it is important to note that although the two studies of land ownership reported above (which focus on the family or household as the unit of analysis) represent a significant improvement over most previous studies which have involved areal analyses, in some societies the security-fertility relationship may be an individual rather than a family issue. For example, Cain et al. (1979) found that in rural Bangladesh a lack of economic security for women provides considerable support for high fertility.

A number of unanswered questions remain — particularly, the importance of other forms of wealth as substitutes for land in providing parental security, and the relative importance of security versus current income and other variables in fertility decisions. Nonetheless, it does seem likely that agricultural policies directed at broadening land ownership and/or other continuing income streams will exert a downward pressure on desired family size among rural households through substitution of land for children as a store of wealth.

Agricultural Policy and Income Utility

Agricultural policy can also affect fertility by operating through the income utility generated by children. This effect depends upon 1) the impact of agricultural policy on labor income generated by children, and 2) the relationship between child-labor income and fertility. Thus, if high fertility among farm families is supported by the economic contribution of children, and agricultural-policy actions influence the demand for labor, it follows that agricultural policy may have an impact on family decisions regarding fertility because of its effect on the economic contribution of children to farm-family income.[6]

Empirical evidence appears to support the notion that family size is positively related to the economic contribution of children. Banskota and Evanson (1978) found a very strong positive relationship between fertility, the earning ability of children, and their contribution to family income in rural Philippine households. Rosenzweig and Evanson (1977) found similar evidence in India. A major empirical study of child contributions to family income in Thailand (Buripakdi 1977, pp 102-107), found that most Thai respondents answered a question regarding the advantages of having children as being 1) companionship and avoidance of loneliness, 2) economic and general help, especially in old age, and 3) continuity of the family name. In the rural portion of the sample, people mentioned economic help and the continuity of the family name most often. Buripakdi also found that expected help from children was positively associated with the number of children. Rural people were more likely than urban people to note the importance of economic help from their sons and daughters, such as help in the household, in the family business, in raising other children, and in the sharing of financial responsibilities.

In developing countries it is also quite common for sons or daughters to be employed in a nearby town or village while continuing to live on the family farm. Mueller (1976) argues that this off-farm employment from the rural sector may serve for a time to enhance the economic value of children and, hence, may justify high birth rates. But off-farm employment may also have repercussions which should tend to lower birth rates (Mueller 1976, p 328). Mueller explains that if the children work off the farm for a long time, this may cause a weakening of family ties; that is, the family becomes a collection of people with diverse individual

[6]Food policy, through increasing the productivity of family labor, can also potentially influence desired family size. Similarly, as noted by Schultz (1969), the potential contribution of a child to family income also depends upon social attitudes toward child-labor practices.

economic interests. The lack of family cohesiveness would weaken the expectation that children will share their income with parents. Moreover, having a large number of children may cease to provide influence, status, and security for the family, once it is recognized that sons can no longer remain in the village.

Empirical evidence also supports the proposition that agricultural policy can influence the demand for family labor of the type children can provide. Studies of the high-yielding variety (HYV) technology clearly indicate that increased labor requirements result from the adoption of the HYV package (Schutjer and Van Der Veen 1977, p 25). In addition, Merrill (1975, p 2) has shown that agricultural mechanization in developing nations may reduce the demand for family labor:

> "Mechanization which replaces animal power usually results in a reduction in labor inputs. The amount of reduction in labor inputs depends on the particular crops, farm size, and extent (as well as types) of mechanization. During the early stages of mechanization of grain production, labor requirements may be reduced by as much as 30 to 40 percent."

What is generally lacking in the literature, however, are studies which directly relate rural-policy actions to the demand for child labor and to subsequent fertility. Perhaps the set of literature which comes closest to dealing with the complete relationship is that relating land availability in rural areas to family size. Thus, land availability provides an indirect measure of the relative demand for labor, and hence of the potential income contribution of child labor. This relationship has been examined historically at the aggregate level where the major concern has been to explain the impact on fertility of settlement patterns and programs designed to increase the number of farm sites available. The historical studies of the United States, Canada, and eastern Europe suggest that in frontier areas the availability of easily accessible land was an important determinant of the high levels of fertility which characterized these regions during their settlement (Easterlin 1976; Forster and Tucker 1972; Leet 1976; Yasuba 1962). As frontier areas became more densely settled and land became increasingly scarce and expensive, fertility declined. The more recent work of Laidig et al. (1981), using historical data from Pennsylvania, clearly indicates however that it was the availability of land, rather than simply a frontier environment which accounts for high fertility during settlement.

Recent work on land availability in the less-developed countries is consistent with the historical work in Europe and North America. Beaver (1975) examined land availability and fertility among 24 Latin American countries for each 5-year period between 1950 and 1969. Although his primary interest was in testing a model of demographic transition, he included as a measure of land availability the natural logarithm of the total land area per 1,000 rural population, weighted by the percent of the population that was rural. The weighting was employed to reflect the assumed decreasing importance of land to fertility with increasing urbanization. He found the effects of land availability on fertility were "strikingly confirmatory" and suggested that this variable be included in transition models (Beaver 1975, p 130).

Sub-national analyses on this topic in Latin America include the work of Hicks (1974) on rural and urban areas in Mexico from 1950 to 1970, and Merrick's (1978) analysis of 155 microregions in six Brazilian states in 1970. Hicks used arable land per worker in agriculture as a proxy for the income-earning potential of children in rural areas of Mexico. Regardless of the interpretation given to the land/worker ratio, greater ratios of land per worker were associated with higher fertility in rural areas, which Hicks (1974, p 414) takes to mean that "fertility is likely to decline in response to a decrease in arable land per agricultural worker." Merrick in his analysis of Brazilian data also found land scarcity to be an important factor influencing fertility.

Size of holdings of an individual family has also been related to fertility in a number of LDCs. These data provide a better indication of the demand for child labor from the perspective of the decision-making unit. Rosenzweig and Evanson (1977, p 1075) found that land size (which they assume to be complementary with child labor) had a positive and significant effect on fertility within a sample of 189 districts in India. This finding was supported by family data collected by Driver (1963) in central India. Driver found greater numbers of children in the landless and small-landholding class. Similarly, Kleinman (1973) used an index of cultivated acreage per farming household as a measure of landholdings for 315 districts of India in 1961. He found the cultivated acreage per household to be significantly and positively related to fertility in a 15-variable regression model.

Studies of limited scope in Bangladesh report conflicting findings on the relationship of size of holdings to fertility. Latif and Chowdhury (1977) report a significant positive relation between size of landholdings and fertility in a northern Bangladesh village, but no relationship in a southern village. Stoeckel and Chowdhury (1969) found landholdings to be negatively related to actual fertility in the Comilla Kotwali Thana of Bangladesh, yet a later report found lower desired family size and greater approval and knowledge of contraception among those of low landholding status (Stoeckel and Chowdhury, 1973). Resolution of these different findings must necessarily await further empirical work.

Three studies which included data on landholdings and fertility in rural Iran show more consistent results (Ajami 1969, 1976; Aghajanian 1978). Aghajanian views the family as the basic unit of production in rural communities, and family labor and land as the major inputs to the productive process. Thus, with size of landholdings as a fixed factor in production, larger holdings were expected to relate to larger family sizes. The empirical results supported this expectation. Size of holdings was strongly and positively related to fertility among a sample of 505 rural households in southern Iran. Ajami (1976) found a similar pattern among rural households in six villages north of Shiraz.

The contribution of child labor to the positive relation between size of holdings and family size received indirect support from the 1975 Survey of Fertility in Thailand (SOFT). As a part of a larger fertility survey, respondents were asked about the need for children's help in a family enterprise. Replies were categorized into perceived advantages of a large family. The percentage of respondents mentioning la-

bor contributed by children as an advantage of a large family increased directly with the size of holdings, ranging from a low of 4 percent among families with no farm business to 50 percent of those with holdings of 21 rai or more (Arnold and Pejaranonda 1977, p 8). Farmers with employees were slightly less likely to mention a large family as an advantage, indicating that where nonfamily labor is being used, one incentive to higher fertility may be reduced. Whether such perceived advantages were related to actual higher fertility among farmers with larger holdings was not examined.

Recent work by Chalamwong (1979) also provides strong direct empirical support for the importance of child labor as a determinant of fertility. The importance of child labor, as measured by the proportion of family labor provided by children, was positively and significantly related to family size among Thai farm families when income, ownership status, cultivated acreage, and a number of demographic variables were included. Chalamwong et al. (1979) reported similar results when they used the proportion of child labor available that was actually used, as a measure of the importance of child labor to the farm enterprise in a later study.

In summary, the available evidence supports the notion that access to land at the national, regional, or individual-family level is likely to result in greater economic returns to child labor, and hence contribute to the maintenance of a higher level of desired family size than would prevail should land be less available. Similarly, the literature regarding individual farm size and land availability supports the more general proposition that the impact of agricultural policy on the demand for labor which children can provide is critical to the fertility impact of the policy. Moreover, the generally negative and perhaps greater impact of land ownership on fertility mitigates against simple interpretations regarding the potential fertility impacts of a land-redistribution policy. If the negative impacts of increasing land ownership are stronger than the positive effects of increasing size of holdings, then careful attention should be given to the conditions under which land is redistributed.

POLICY APPLICATION

The design of fertility-sensitive agricultural and rural-development policy for a nation requires agricultural, institutional, and socio-economic data about the nation and the target population. The generalized model and empirical results presented in the previous sections specify relationships that underlie the interaction between rural policy and human fertility and suggest empirically based causation. When combined with country-specific data and analyses, the framework and empirical results should prove useful in assessing the potential fertility impact of alternative rural policies.

A number of generalizations emerge from the review that indicate the range of possible interactions that may be developed by country analysis as the basis for policy formulation.

(1) Agricultural policy and programs which increase land ownership will likely exert downward pressure on desired family size among rural households through the substitution of land for children as a store of wealth;

(2) Development activities which increase the demand for child labor at the farm level (such as increasing farm size or irrigation) will contribute to the maintenance of a high level of desired family size by raising both the opportunity cost of child education and the family income contribution of children;

(3) Agricultural price and income policy designed to raise income among farm families will facilitate a lower family size desire as families seek to provide greater educational opportunities for a more-limited number of children;

(4) In very-low-income nations or among low-income segments of rural populations, food policy which operates to improve nutrition and give related protection against infectious disease, may, when combined with agricultural policies that increase food output and farm income, have a positive impact on the level of natural fertility.

In general, the idea that fertility behavior of farm families may be influenced by the manner in which agricultural change is brought about has received only limited consideration. The conceptual framework and empirical generalizations described here demonstrate the potential of agricultural policy to influence human fertility in rural areas of developing nations. What remains is the addition of specific country data that can be combined with the more general findings to provide the basis for the design of fertility-sensitive national agricultural and rural-development policy.

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THE PENN STATE
AGRICULTURAL-DEMOGRAPHIC PROJECT

Population growth and food supplies, two major forces shaping national economic and social well-being, increasingly shape patterns of economic and political intercourse between nations. Starting in 1975, researchers at the Agricultural Experiment Station of The Pennsylvania State University sought to understand how family-size decisions and food-production activities are related at the individual farm level. In many developing nations the majority of the population is rural-farm in composition, and farm families make the majority of food-production and family-size decisions.

This bulletin represents a summary of initial research activities of the Agricultural-Demographic Project. As such, the report provides a framework for identifying the links between agricultural policy and fertility, and reviews empirical evidence on the interaction between human fertility and policies designed to influence agricultural production in rural areas of developing nations. A number of generalizations which point to connections between agricultural production and fertility have emerged; these may be developed as a basis for policy formulation by individual country analyses.