SMALL IS BEAUTIFUL: EVIDENCE OF INVERSE SIZE YIELD RELATIONSHIP IN RURAL TURKEY

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University of Massachusetts, Amherst, October 2006

Abstract

This paper examines the relationship between farm size and yield per acre in rural Turkey. The literature on the inverse size-yield relationship (IR) is viewed, and then tested on recent farm-level data for 2002. A strong inverse relationship between farm size and yield is prevalent in all seven regions of Turkey after controlling for household and agro-climatic heterogeneity. The paper also investigates the impact of land ownership inequality and land fragmentation, and finds a negative relationship with the former, but a positive relationship with the latter in regards to land productivity. The findings in this paper provide evidence that rural factor markets are imperfect in Turkey. Further, our results favor labor centered theories explaining inverse size-yield relationship with higher labor input per decare, particularly family labor. Given our findings, we suggest a reconsideration of the most recent reform program in agriculture in Turkey, namely ARIP, which makes markets the sole decision makers of production and resource allocation in agriculture. Based on our findings, land redistribution is necessary based on equity and allocative efficiency.

1- INTRODUCTION:

Two of the most common characteristics of developing countries are the large share of agriculture in their economies and poorly functioning and/or non-existent factor markets. The intersection of these two features produces the widely observed inverse size-yield relationship (IR hereafter) [Sen (1962; 1966); Mazumdar (1965); Berry and Cline (1979); Sen (1981), Cornia (1985); Kotwal and Eswaran (1986); Helbert (1998); Dwayne (1992)].

The inverse relationship between farm size and yield per acre indicates that as farm size gets larger yield per acre gets smaller. IR became a focal point of agrarian debates after the 1960s when Farm Management Surveys in India first established the empirical basis for IR studies. Since then, the evidence has been so widely observed by many others in different countries that IR is considered a "stylized fact" of agriculture in developing countries [Heltberg (1998) for Pakistan; Berry and Cline (1979) for Brazil, Colombia, Philippines, Pakistan, India and Malaysia; Cornia (1985) for 15 different countries; Khusro (1973), Rudra et.al (1974), Bhalla (1979) and Bharadwaj (1974), and Sen (1981) for India, Carter (1984) for Haryana in North India; Kutcher and Scandizzo (1981) for North East Brazil, Benjamin for Java (1995), Masterson (2005) for Paraguay].

Inverse size-yield has many crucial and far-reaching implications for rural development policy, which is in part why it has gotten considerable attention from development researchers. The most prominent implication is the provision of economic justification for redistributive land reforms, as policies to correct for IR imply both efficiency and equity at the same time. Land reforms have played a very important role in economic transformation, creating agricultural surplus, growing consumer demand and creating political stability to maintain rapid industrialization for countries like Japan, South Korea and Taiwan [Heltberg (1998)].If land productivity is higher in small farms and rural factor markets are not correcting for IR, then policies to eliminate it and promote economic growth call for redistributive land reforms.

Another important implication of IR in rural development policy is its outcome for employment. Sen (1999) argues that the choice of technology in agriculture is crucial for resource allocation and employment since in most developing countries the majority of the population is employed in agriculture. According to Sen (1999), certain types of technologies are more appropriate for countries in which labor is abundant relative to other factors of production. If agricultural producers in such countries have failed to adopt such technologies, then the question becomes why they have not.

In addition to those mentioned above, another important consequence of IR is deteriorating environmental conditions and disintegrating communities. Land concentration combined with mechanization in agriculture create a class of landless laborers who, lacking alternative means of procuring a livelihood, find the solution either in cultivating ill-suited and environmentally sensitive tracts of land in forests, uplands, and arid areas, or migrate to other places in search of employment [Heltberg (1998); Kaldjian (2001)].

Due to its policy implications for employment, efficiency, equity, and sustainability, IR has been one of the most important and hotly debated topics in agricultural economics for more than 40 years. Despite the abundance of research and discussion on the topic, as yet there exists no consensus on what causes it [Heltberg (1998); Sen (1999)].

The purpose of this paper is to look at the farm size-yield relationship for Turkey by utilizing a 2002 World Bank survey. In doing so, the structure of this paper is as follows: In section 2 we review the literature and conclude that the majority of explanations for IR are based on intensive labor-input use in smaller farms due to imperfections in factor markets. In section 3 we present econometric analysis and data used for the study. In section 4 we conclude that, despite agro-climatic, land, and farmer heterogeneity, there exists an inverse relationship between farm size and yield per acre in all seven regions of Turkey. Further, we claim that IR is due to existence of an inverse relationship between labor input and farm size, i.e., as farm size decreases, labor input, particularly family labor, per acre increases, resulting in higher yields per acre.

2- SIZE-PRODUCTIVITY DEBATE IN THE LITERATURE:

2.1. Introduction and the classic equation of the IR relationship in agriculture:

In the literature the most common equation that tests the inverse relationship between farm size and yield per acre is based on ordinary least squares (OLS) regressions of simple models such as the following:

$$Log\ (Q) = \alpha + \beta\ log\ (H) + u \qquad (1)$$

Where Q is either the monetary value of total output or output per acre and H is net operated farm size. Operated farm size includes owned and leased in land for each household. An inverse relationship exists when β is less than unity if Q is total output, and when β is negative if Q is output per acre.

Bardhan (2003) argues that one of the problems with such studies is the assumption of the homogeneity of farm output when, in fact, "output" is measured by the total value of a range of specific products produced. This can create biased results, particularly when crop prices vary significantly across types of crops or across regions for the same crop. Market values for cash crops, for example, are typically higher than those for subsistence crops.

Segregating the data based on regions and geographical features might address both of these problems due to the nature of agricultural production. Certain soil types and climate are more suitable to grow certain types of crops, thus homogeneity of farm products is highly likely within regions where land heterogeneity is not enormous. Turkey makes a particularly good case for very distinct regional homogeneity in agriculture as a result of its agro-climate structure which will be detailed in section 3.1.1.

By using either exact, or some modified version of the classical equation (1) many studies have found a significant negative relationship between per acre productivity and farm size for different developing countries. A natural question to ask is then why IR is so common in developing countries, and what accounts for such a relationship?[1]

In the literature, there are three main explanations for IR: the mis-identification hypothesis, [Bhalla and Roy (1988), Benjamin (1995); Benjamin and Brandt (2002); Lamb (2003); Assuncao, and Braido (2004)], the farmer heterogeneity and mode of production hypothesis, [Srinivasan (1972); Chayanov (1966)] and, the factor market imperfection hypothesis [Sen (1962; 1966), Mazumdar (1965); Sen (1981); Cornia (1985); Eswaran and Kotwal (1986); Heltberg (1998), Benjamin (2002)].

2.1. The Mis-identification Hypothesis:

It is argued that the inverse size-yield relationship is a statistical artifact due to omitted variables [Bhalla and Roy (1988); Benjamin (1995); Assuncao, and Braido (2004)]. In the IR literature, debates center around two main reasons that are claimed to constitute *the mis-specification*: omitted land quality, and omitted farmer heterogeneity.

2.1.1. Omitted Land Quality:

Land quality arose as an issue for land productivity differences because the inverse size-yield relationship has been observed as being more robust among villages than within villages [Cornia (1985); Benjamin (1995); Sen (1999)]. The heart of the omitted land quality argument is the observation that fertile lands can support higher population densities, which result in higher land fragmentation; hence smaller farms are more productive due to the inherent fertility of land. In addition, smaller farms are more likely to have higher quality lands since the ones that are the first to

[1] One of the first questions to be answered regarding IR assessment is whether increasing, decreasing or constant returns to scale prevail in agriculture. However, I am not including this discussion in the main body of the paper because it has been established elsewhere that constant returns to scale characterize developing country agriculture. For further discussion on the topic, see Berry and Cline (1979), and Cornia (1985).

be sold during a financial bottleneck are lower quality, resulting in higher overall land quality for the remaining plots on the farm.[2] Given fragmented plots in land and higher population densities in developing country agriculture, it is crucial to account for land quality to eliminate the possibility of systematic correlation between land quality and farm size for a robust analysis of IR.

Unfortunately many datasets, particularly those developing countries, lack information on land quality. Hence, indirect methods of accounting for land quality must be applied. These include relying on geographical dis-aggregation [Rudra (1974); Sen (1981); Carter (1984); Bhalla and Roy (1988)], using price of land or share of irrigation as a proxy for land quality [Khusro (1973); Berry and Cline (1979)], using village or plot fixed effects [Carter (1984); Heltberg (1998); Assuncao and Braido (2004)], and using instrumental variables to proxy for land quality [Benjamin (1995)].

Studies including land quality in IR estimations divide land quality into two categories: exogenous -or nature-made- such as soil type, existence of irrigation canals[3], and endogenous –or man-made- such as introduction of tube-well irrigation, and fertilizer use. Some argue that a clear distinction between exogenous and endogenous land quality is important because man-made land quality incorporates labor input and has to be separated from nature-made land quality [Bhalla and Roy (1988)]. Consequently, when the distinction is not clear, what is observed as land quality might be a result of a blend of labor effort and natural land quality.

Bhalla and Roy's 1988 study is one in which such distinction is made in assessing how much of the IR is due to purely exogenous land quality differences in 176 districts in India. The main observation in their study is that more fertile and rainy areas have higher population densities with smaller farms, and less fertile and arid regions have lower population densities with large farms. They claim that the inverse relationship diminishes in 70 % of all the 176 districts covering 21,000 households in India once controlled for soil quality, thus the IR phenomena cannot be considered as a stylized fact. Since their explanation of small farm productivity per acre is due to natural land heterogeneity, there is no room for policy.

Benjamin (1995) accounts for land heterogeneity using instrumental variables (IV hereafter) and employing a two stage least squares estimation of the regression model. According to Benjamin (1995), land is an endogenous input contrary to considerations in equation (1) type regressions despite

[2] Cornia (1985) observes the opposite in Brazil. He argues that most of the large land holders have the better quality land. This argument seems reasonable when one considers the opportunities of a wealthy farmer compared to a poorer one.

[3] Even though canals are man-made, they are considered exogenous because their location is determined by government mandate, not by farmers themselves.

the fixed nature of farm size and/or land tenure contracts.[4] Land is endogenous because the fortunes of the location and other land augmenting inputs such as irrigation, affect farmers' decision making, in the choice of production technique.

Locating the appropriate instruments is often the most challenging task in formulating IV regression models. A good instrumental variable should be correlated with the endogenous variable, i.e., farm size, but not correlated with the error term, i.e., land quality. Benjamin (1995) draws his instrumental variable from a popular topic in the farm size debate, i.e., population density. Despite his citation of previous debates in anthropology dating back to the 1930s with the conclusion of evolution of cities has nothing to do with land quality, it is not convincing since crux of the debate on land quality is exactly because higher quality land can support more people thus it can be divided into smaller plots [Bhalla and Roy (1998)]. Despite controlling for land quality via IV method, Benjamin (1995) stops short of arguing that land quality is the culprit for inverse size yield relationship in agriculture.

Another study that looks at land quality is one on India by Bhalla (1979), which also controls for crop intensity. One of the arguments in the literature is that smaller farms have higher yield per acre due to crop intensity: a cropping pattern which favors crops with high value-added [Bardhan (1973); Griffin et al. (2002)]. Bhalla (1979) argues that since different crops require different labor and non-labor input requirements, cropping pattern and farm size may dictate a non-random relationship. In a series of regressions despite controlling for land quality via using prices as a proxy for quality, and keeping irrigation and cropping patterns constant, he still finds IR to remain. One problem with his study is that using land prices creates a bias since the per acre price of land tends to fall as farm size increases. Thus, using land prices as a proxy for land quality may tend to undervalue land quality in large farms.[5]

Another approach to account for omitted land quality in IR studies is to look at plot or village fixed effects, if there is availability of panel data. In a study on India, Assuncao and Braido (2004) observe that land characteristics and measurement errors in the plot size are the two explanations for the IR, arguing that the structure of the plots and their specifics affect the optimal choice of non-labor and

[4] Tenure contracts could take the form of either sharecropping contracts or fixed rent contracts. In the former case, land owner and tenant share the output produced. In the latter, the tenant pays a fixed money rent for the leased in land. Consequently, in most rural areas, they are personal land market transactions, and hence are not subject to change every year, and considered very stable, also an argument accepted by Benjamin (1995). His argument regarding endogeneity of land is not about the operation size but the quality of land.

[5] Large farmers face a lower unit price for land due to three factors. First, large farmers generally have easier access to cheap and formal credit, which reduces the land's cost, and hence its price. Second, large plots of land have a lower opportunity cost due to maximum rent chargeable. Last but not least not many buyers can afford large plots of land, thus price per acre might be cheaper due to lack of demand. Conversely, small plots of land are generally more expensive due to higher demand since they are affordable by many versus only a few bidders for large plots of land [Cornia (1985)].

labor inputs. They claim that the inverse relationship between productivity per acre and farm size diminishes when controlled for inputs, and that the “IR puzzle is solved”.

From our point of view their study has a fundamental measurement error. In their study, farm size is measured by cultivated area, rather than the total farm size. IR is not about cultivated land but farm size. One reason small farms produce more value per acre is because land utilization is much higher in smaller farms. This forms the economic justification for redistributive land reforms to increase land utilization. One reason large farms produce less per acre is because land is left fallow. Thus, even if small and large farms produce equal value of output per acre cultivated, this does not disprove the “IR puzzle”. To change the denominator via excluding fallow land from farm size is far from solving the IR puzzle.

2.2. The Farmer Heterogeneity and Mode of Production Hypothesis:

Farmer heterogeneity hypotheses explain IR by farmer characteristics. Farmer heterogeneity literature could be divided into two groups: heterogeneity due to the agrarian structure in which farm size is a proxy for mode of production [Chayanov (1966); Sen (1966)], or heterogeneity due to farmers’ preferences as determined by education, attitudes toward risk and other socio-economic factors [Srinivasan (1971); Banerjee (1990)].

According to Chayanov (1966), a peasant family worker maximizes a different objective than any other worker, thus s/he operates under a peasant mode of production. A peasant’s objective is subsistence, thus her objective function is to minimize the effort given subsistence needs as determined by the dependency ratio within the household, i.e., the ratio of mouths to hands. Given farm size, a crowded family with a higher dependency ratio generates higher yields per acre, and as the dependency ratio changes based on the life cycle of the household, so does the effort, and yield per acre.

In addition to the micro-household based preferences for peasant behavior, the macro reason for the peasant mode of production which Chayanov observes is missing rural factor markets. In the absence of markets, peasants do not have monetary motivation to work harder, since they cannot accumulate wealth via exchange. Hence, given the objective of subsistence combined with missing rural markets, neoclassical tools would be meaningless in analyzing peasant behavior.

Despite its strength in delineating a separate mode of production for peasants based on strong empirical evidence and paving the road for labor based theories of IR, Chayanov’s (1966) pioneering work in explaining productivity per acre founded on household demographics and life cycle is inadequate. Even though Chayanov’s (1966) argument regarding subsistence needs being the motive for labor effort could be extended to form the basis for a "starving farmer effect", this is only true for small subsistence level farmers with little or no access to alternative forms of employment and income. It does not provide much insight regarding why middle size farms still do have higher productivity per acre compared to large ones. Furthermore, it does not explain why given size and dependency ratio, some farms stay large. In addition, to hire labor in peak seasons such as harvest when intensive work is required to avoid crop losses is a common practice, even among the very small farms, thus it is not completely accurate to assert that there are no factor markets in rural developing agricultural settings [Sen (1981)]. A Chayanovian explanation for IR also ignores macroeconomic, social, and cultural determinants of labor supply such as unemployment, social norms against female laborers, and or socio-political structure of the province within which the household operates [Agarwal (1994); Sen (1981); Mazumdar (1965); Cornia (1985)].

The second strand of literature on farmer heterogeneity focuses more on educational differences among farmers, as well as small farmers' behavioral differences compared to large ones. Schultz (1964) claims that the productivity of farmers could be increased by educating them. Education increases productivity because farmers can read the instructions on machines, and thus are more able to apply productivity-enhancing techniques [Sen (1999)]. Even though this explanation offers some insights, education does not adequately explain IR since small farms are likely to lack access to such machines entirely, yet are still more productive than larger farms.

Risk is another feature that creates differential behavior among different farmers based on size. One explanation is put forth by Srinivasan (1971) regarding farmers' behavior in the face of uncertainty in agriculture. Given two choices of income source; self cultivation -which is more uncertain- versus wage labor, -which is certain- Srinivasan (1971) claims that since smaller farms are self-cultivated they are more productive because smaller farmers are more risk averse.[6] Bardhan (1973) offers a good critique, arguing that in agriculture uncertainty is not only confined to small owner-cultivated farms but also affects large farms which use wage laborers. Thus, in the case of agriculture, wages are not independent of uncertainty. Hence differentials in risk based on size in agriculture, is not a convincing explanation for IR.

Banerjee (1999) indicates that farmer characteristics matter in the sense that they are related to farm size: tenants with larger land plots are more efficient because they are more independent to own and use tools that help raise productivity.

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[6] The argument has the assumption that farmer is an Arrow type risk averse person, i.e., as her wealth gets smaller she will become more risk averse, hence she will devote most of her time on her land to maximize farm income.

Agarwal (1994), Alderman et al. (1995), Deere and Leon (2003), and Masterson (2005) introduce gender differences in farm productivity. Being a female farmer may result in different access to economic opportunities which, in turn, results in different crop choice, and subsequently different output outcomes per acre.

2.3. The Factor Market Imperfections Hypothesis:

The most common explanation in the IR literature is the hypothesis of imperfect factor markets. Mainstream theory suggests that through perfectly competitive markets all factors of production are fully utilized and receive their marginal contribution, and resources are allocated efficiently across alternative uses [Schultz (1964); Conning (2000)]. At this point, assuming all farms operate under the same production function with constant returns to scale, a really interesting question is then how come markets do not *distribute land* towards small farms where *land is relatively more productive than labor* and distribute labor towards large farms *where labor is relatively more productive than land.* So a Pareto improvement -also an increase in technical efficiency of the system as a whole- could occur when small farmers trade in labor for land with large ones up to a point where marginal *rates of technical substitution are equal* in each and every farm, and eliminate IR. The obvious answer is because markets are imperfect and therefore not allocating the resources efficiently, hence IR prevails. What is less obvious is which factor market is the culprit, and which factor causes IR.

The main theme in the imperfect markets- inverse-size-yield literature is that small and large farms use different proportions of inputs due to different factor prices -resulting from imperfections of markets- which then give different incentives to farmers operating on different scales [Mazumdar (1965); Sen (1966); Berry and Cline (1979); Sen (1981); Cornia (1985); Eswaran and Kotwal (1986) Griffin et al. (2002); Benjamin (2002)]. As argued by Cornia (1985), the prices of land and capital are generally higher for small farmers whereas the price of labor is higher for large farmers, resulting in usage of different proportions of inputs by farms according to their resource position (access to and the cost of production factors).[7]

According to Cornia (1985), small farmers apply more labor per unit of land than large ones in several ways: first, small farmers engage in more intensive use of labor in each crop activity, second, they cultivate a larger portion of their land, and third, they have a more intensive use of the land, such as multi-crops, or multi harvests. In addition, small farmers are better in land terracing, canalization, and land infrastructure, which requires more input of labor per acre.

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[7] Labor is more expensive for large farms due to supervision and or worker search cost [Eswaran and Kotwal (1986)], and credit is cheaper and more accessible for large farmers due to the need for collateral, which small farmers lack. For land, see footnote 5.

Cornia's (1985) answer to the IR puzzle is that the relationships is due to better utilization of both primary inputs such as land and labor and intermediate inputs such as fertilizers and pesticides on small farms. In an extensive study including 15 developing countries, Cornia (1985) looks at the usage of labor and non-labor inputs including labor in man days, irrigation, fertilizers, pesticides, and fuel, in addition to land use intensity, and share of cultivated land. For all countries except Bangladesh and Peru- which are densely populated countries with little differentiation in farm size-, he observes the inverse relationship between farm size and yield per acre. This relationship is particularly pronounced when farm size changes from medium to large.

As pointed out by Bardhan (1973) what may be the more interesting question behind IR is not what is used more or less but why is it done so? In other words, the most interesting portion of the analysis of IR is the inquiry of *why smaller farms use more input per acre* (and hence produce higher yields per acre) which entails assessment of the institutional framework of traditional agriculture in developing countries and a closer look at market imperfections.

A detailed analysis of the reasons for factor market imperfections in developing countries is beyond the scope of this paper, however it is useful to mention a few. To start with, no market is scale neutral. Input and output prices differ based on scale. The sources of differences in land prices for large farms, for example, are discussed above. In addition, land markets may exhibit imperfections because land is more than just a productive factor. It is an asset of insurance, bondage, prestige, power and wealth. Land is a portfolio asset, particularly in countries with undeveloped capital markets to hedge against inflation [Cornia (1985); Kaldjian (2001)]. It is a source of political power which in turn produces economic benefits [Binswanger et al. (1995); Karaomerlioglu (2000)]. Last but not least, it is the place of ancestral home and thus has non-monetary value to people who live on or off of it. In short, the price of land is almost always above its expected economic returns.

Capital markets are imperfect since formal credit requires collateral. Thus capital markets favor *haves* over *have nots*. In addition, large farmers have greater access to machinery due to scale effects and/or government contacts which may provide access to cheaper capital [Cornia (1985)].

Labor markets are imperfect due to many reasons. The first of these is transactions costs. Despite willingness to hire in or out labor, farmers may not partake in the labor market simply because they cannot afford job/worker search costs. Second, large farmers incur higher costs than the market wage rate because of the supervision required in agriculture, thus do not hire labor as much even in the absence of search costs. These examples could be elaborated further, but in short, labor is generally cheaper for small farmers, and land and capital is cheaper for large farmers. Another reason land and capital tend to be priced higher for smaller producers in developing countries is because it is much easier to form a monopoly in land and capital markets than it is in labor markets not only because labor is the relatively abundant factor, but also because unemployed land and capital can survive without losing their value if left idle, but unemployed labor cannot [Berry and Cline (1979)] survive without food. This leaves laborers with a weaker bargaining position.

Most of the researchers who identify rural market imperfections as the culprit for the inverse size-yield relationship recognize that it is the combination imperfections in all markets that plays a crucial role in IR. However, Sen (1981) claims that only one factor –labor- takes the brunt of the burden of all factor market imperfections. Peasants compensate for the lack of land and credit markets by putting more labor into production, thereby resulting in higher yields per acre, i.e., IR. Thus, most of the studies that will be reviewed here can be generalized under the category of labor-based theories of IR.

2.3.1. Labor Based Hypothesis:

The first labor-based explanation in the IR debate emerges from Arthur Lewis' (1954) seminal article on *Economic Development with Unlimited Supplies of Labor*, in which he assumes zero marginal productivity or in other words, zero marginal cost of labor in agriculture, and introduces disguised unemployment in agriculture.[8] Picking up the concept of zero marginal productivity from Lewis (1954), and applying the inter-sectoral duality between industry and agriculture to intra-sectoral duality between large and small farms, many agricultural economists tried to explain the existence of IR as a result of the intense use of labor in agriculture: i.e., the cheapness of labor in smaller farms leads to the intense use of it, thereby resulting in higher yields per acre [Sen (1966); Bhalla (1979); Bardhan (1973); Sen (1981); Carter (1984); Cornia (1985); Heltberg (1998); Benjamin (2002)].

This intra-sectoral duality of wages between large and small farmers is explained via different mechanisms by different economists. Sen (1966) explains it in terms of subjective real costs of labor. Marginal disutility of labor for peasants in family farms is smaller than the marginal disutility of workers in commercialized, larger farms because there is surplus labor in small farms which results in fewer hours or less effort for the family worker, resulting in lower real cost of labor.

Mazumdar (1965) explains the duality among wages by pointing to the lower opportunity cost of labor in small farms due to unemployment. The opportunity cost of family labor may be less than the

[8] However, the zero marginal productivity assumption- along with the existence of surplus labor in agriculture- was later discredited by Viner (1967) by referring to the impossibility of such an assumption given the nature of agricultural work: an additional worker always adds something positive which wouldn't be there in the absence of the worker, such as better weeding, better soil preparation, etc. The solution to the bottleneck of positive marginal productivity of labor is offered by Sen (1962; 1966) who proposes labor effort not labor as an individual worker should be taken in calculations of MPL. None of the studies in this paper refer to zero marginal productivity of labor.

wage rate because an outside job is not guaranteed, i.e., the wage rate in a small farm is discounted by the unemployment rate, and thus cheaper.

Other explanations of duality among wages are related to supervision. Labor supervision has been among the most common explanations of IR [Rudra et al. (1973); Sen (1981); Feder (1985); Eswaran and Kotwal (1986); Banerjee (1990)]. Labor supervision in agriculture is costly since workers keep moving in a large open field unlike industry where both the worker and the machine are fixed in a relatively small place. It is because of labor supervision costs that large farms do not use more labor input per acre. The main argument is that labor supervision, provided mostly by the family members enters the equation because it is a "transactions cost" and hence part of the imperfect labor markets story [Feder (1985)]. Consequently, labor is hired in large farms to the extent that it can be supervised by family members. This puts family labor in the center of labor-based hypotheses.

Rudra et al. (1973) tests the centrality of family labor to labor input per acre and its outcomes in productivity per acre by analyzing farms in India.[9] They claim that higher ratios of family labor to total labor input is an indicator for higher labor input in farms, and since higher labor input is an indicator of higher yield per acre, then provided that the smaller the farm, the higher the labor input, then it must hold true that the smaller the size the higher the yield per acre. In their econometric study, the findings are in support of their hypothesis, however not valid for all the regions included by the study. This raises questions about the ability of labor-based theories in explaining the IR phenomenon.

These questions are answered by Sen (1981) via controlling for tenure type and technology, which are assumed to be identical in Rudra et al.'s (1973) study. According to Sen (1981), pooling the data and treating sharecroppers, fixed rent tenants, and owner cultivators as identical modes of agricultural production creates biased results because sharecropping is less efficient than owner cultivated or fixed rent tenancy farms. Different tenure types have different labor dynamics. In the literature, the reasons for the inefficiency in sharecropping range from Marshallian disincentive[10] to lower crop intensity[11] per acre. Thus, the existence of sharecropping in same size holdings might result in biased results and might not show the IR which actually exists and can be explained by labor-based theories.

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[9] Discussion and reference in Sen (1981).

[10] The Marshallian Disincentive argument is the following: there is less incentive on the side of the tenant due to the nature of sharecropping contracts: landlords and tenants share the output, and since the tenant's marginal returns to effort and input supply are much less than the relevant marginal products, the tenant has less incentive to supply inputs, including labor and intermediate inputs, than if he were the owner.

[11] Another argument for inefficient sharecropping contracts is the lesser variety of crops cultivated that increase the yield per acre. It is argued that lower intensity of crop cultivation is chosen by the landlord. For a more detailed discussion, see Sen (1981).

Rudra’s results conform to labor-based theories when also controlled for technology. Acording to Sen (1981) relaxing the assumption of identical technology will correct for both capital bias and labor supervision bias. There are two different types of technology having two different impacts on the inverse relationship between labor input and farm size. One is land augmenting and the other is labor augmenting. Land augmenting technology, such as irrigation and use of fertilizer increases labor input per acre, given family worker per acre, and will result in a lower ratio of family labor to total labor (assuming labor is hired to compensate for the need to increase labor input). Labor- augmenting technology, such as tractorization, would reduce labor input per acre and increase the ratio of family to total labor. Even though family labor input is the major factor behind IR, when not controlled for technical change, that relationship cannot be captured in regressions based on pooled observations without differentiating for technology. After controlling for tenure type and tractor usage, Sen (1981) finds the relationship between family labor use (and hence more intense labor use) and yield per acre to hold as predicted by labor based theories, and concludes that; “the inconsistencies in Rudra’s study are exactly because labor-based theories hold.”

Another way to test if IR is due to higher labor input per acre for small farms is to analyze whether labor demand is dependent on farm size [Berry, and Cline (1979); Benjamin (1995); Barret (1996); Lamb (2003)]. Once IR is established by equation (1) type of regressions, these studies go a step further and look at the use of labor per acre based on farm size with the following equation:

$$Log\ (labor\ per\ decare) = \alpha + \beta\ Log\ (size) + u \qquad (2)$$

Equation (2) can also be used to test the relation between other intermediary inputs such as fertilizers, and capital as dependent variables and to see if there is a systematic variation with farm size.

Another category within labor-based theories of IR includes work that doesn’t elaborate why labor is used more intensively in smaller farms despite claiming labor input as the reason for the inverse relationship between size and yield. Carter’s 1984 study on India finds IR due to higher labor input per acre as size gets smaller after controlling for land quality and village heterogeneity using a village fixed effects regression model for Haryana for the years 1969/72. These years correspond to the Green Revolution, i.e., the introduction of High Yield Varieties (HYV). HYVs are claimed to diminish if not eliminate IR [Deolikar (1981)]. If IR is a result of labor input per acre, it is plausible to argue that IR might break down with technical progress, such as the Green Revolution or tractorization since it weakens the human component of agricultural production.

Visaria (1970) explains IR from a purely subjective point of view, and claims that IR is the result of higher motivation to work on one's own land. The love and care which is involved in working one's own farm leads one to put more effort into one's own land yielding higher productivity per acre.

After reviewing the literature on IR briefly our conclusion is that in the context of developing country agriculture, given empirical analysis, labor-based theories are better able to explain IR. According to Sen (1981), the crux of the debates on IR, as well as the possible solution, is not about scale advantages or unemployment. IR reflects intensive labor use on small farms, and the inability to solve this through land and credit markets. Hence IR evidence is an indicator of two things: first allocative inefficiency, second connectedness between the ownership of assets and the distribution of resources through markets. The reason for market imperfection, i.e., the failure of markets to allocate resources efficiently cannot be solved through rural markets because markets themselves function connected to the existing inequalities. That is, the ownership of productive assets is connected to the distribution of productive assets.. "*The most important effect of credit and land market imperfections seems to be that, although the IR relations exist and would seem to reflect a very low opportunity cost of labor on small farms, the degree to which land and credit is leased and let out to small farmers seems very limited*." It is because of this connectedness that those who are poor in land but rich in labor and thus can reap higher yields from their land fail to lease-in more land to utilize their labor. In other words, it is due to connectedness that markets fail allocative efficiency which demonstrates itself by the existence of IR. Labor-based theories point to this failure more than any other existing explanation for IR.

The following empirical investigation of IR for the case of Turkey will employ a labor-based hypothesis. The set up used to test for the existence of IR in rural Turkey will be a modification of classical equation (1) OLS regressions after controlling for family labor, tenure type, farmer heterogeneity, and land heterogeneity via geographical differentiation. We will also employ type (2) regressions to analyze the relationship between labor and other intermediate input use intensity and farm size.

3- EMPIRICAL INVESTIGATION:

3.1. Agro-Climate features of Turkey and descriptive statistics of the dataset:

3.1.1. Turkey's agro-climate features:

Turkey is a major agricultural producer by international standards with 35% of all lands in use for agricultural production, excluding pastures. With nearly 25 % of the Middle East's and North Africa's arable land and abundant water resources, Turkey ranks in the top five producers for chickpeas, chillies and peppers, cotton, cucumber, eggplants, green beans, lentils, nuts (pistachios, chestnuts, and walnuts), onions, sugarbeets, tomatoes, watermelons and melons, stone fruit, olives, and sheep's milk.

Turkey is the world's largest producer of apricots, hazelnuts and figs [Kaldjian (2001); Longworth (2005)].

Regions in Turkey are divided geographically and climatically, and hence there is substantial homogeneity within a region in terms of agro-climatic features [Aresvik (1975); Longworth (2005)]: South East Anatolia and Central Anatolia are the most arid regions with the minimum rainfall of between 40 mm-600mm per year. The Black Sea and Mediterranean get the highest precipitation with 2500mm to 3000mm. Most of the soils have a high ph structure of 7.5 to 8.5 and high lime content which is considered good for agriculture. The salt content is relatively high and irrigated land is frequently saline. The soils are almost universally deficient in phosphate and nitrogen in the country.[12] Based on agro-climate homogeneity within regions, regional analysis provides a good control mechanism for agro-climate heterogeneity.

3.1.2: Descriptive Statistics of the dataset:

The data we are using is the Quantitative Household Survey for the year 2002 (QHS).[13] In the dataset 70% of all the households have primary school education, whereas 9% are illiterate on the average in Turkey (Table 3). The average age of the head of household is 50 for men, and 55 for women, and average size of the household is 5.7. The most crowded households are located in South East Anatolia with 8.2 members on the average, and the least crowded in Marmara with 4.5 (Table 4).

Landlessness is common and land distribution is quite skewed in Turkey. On the average 14% of the households are landless, the highest percentage of landless households resides in Central Anatolia with 19%, and the lowest is in Marmara with 6% (Table 5). Turkey's land ownership Gini coefficient[14] is .67: The Aegean region has the most unequal land ownership distribution with .74, and Marmara has the lowest with .55. Land markets distribute land in the form of leasing land via fixed rent tenancy or sharecropping with an average size ranging from 30 decares to 121 decares. Land leasing seems to benefit both small and large farmers, and land markets seem to distribute land towards the landless peasants since the ratio of landlessness reduces significantly in all regions, from 14% before to 2% after land market participation for all Turkey (Tables 5 and 6 compared).

[12] For more detailed discussion on agricultural land features, see Aresvik (1975); Gozenc (2006).

[13] QHS is a very detailed untapped dataset with 1292 variables covering many aspects of rural life; production, consumption, earnings, savings, wealth, cultural life, and even perceptions of farmers' own welfare. The dataset includes 5302 rural households from 7 regions, 73 provinces, 389 towns, and 517 villages in rural Turkey. The survey was conducted by the World Bank (WB) to study the impact of Agricultural Reform Implementation Program (ARIP) which aims to reduce government spending in agriculture. It was implemented in 2001 and will phase out in 2007.

[14] "Gini coefficient is a measure of inequality, defined as the mean of absolute differences between all pairs of individuals for some measure. The minimum value is 0 when all measurements are equal and the theoretical maximum is 1 for an infinitely large set of observations where all measurements but one has a value of 0, which is the ultimate inequality (Stuart and Ord, 1994)." In Iain Buchan (2002).

Turkish peasants work on a farm that is on the average 92 decares.[15] The three Anatolian regions, Central, East and, South East, have much larger farms with 161, 132, and 122 decares per household. However, land per person is not the highest in any of these regions. Marmara, the region that holds the least crowded households, also has the most farm land per person, 20 decares. The Black Sea region has the lowest land per person at 11 decares. Farm sizes in the Black Sea region are almost half of the country's average with 50 decares. Farms are fragmented: on the average each farm has 7.5 separate plots of land. The highest fragmentation is in Central Anatolia with 11.1, followed by South East Anatolia with 9. The lowest fragmentation occurs in Marmara with 3.9, followed by Mediterranean with 5.2 separate plots per farm (Table 10).

Farms in all regions are operated mostly with family labor. On the average 77% of all labor input is from family members. The remainder is obtained through labor markets, communal labor, institutional labor such as government help or a mixture of family and hired labor (Table 7).

The general picture depicted by the dataset is a typical one for developing countries: middle aged, male, uneducated household heads managing small family farms.

3.1.3. Descriptive Statistics of the independent variables and the discussion of the model:

The descriptive statistics of the variables for each region I will be using in my regressions are summarized in Tables 3 through 17 in Appendix A.

As can be seen from Table 11, productivity per acre for small farms is substantially higher compared to large farms in all regions of Turkey. On the average, farms smaller than 10 decares are 4 times more productive per decare than those which are double their size, and 20 times more productive than those which are ten times their size. The same inverse trend is also observed in labor input per decare in man days; farms smaller than five acres are using more than twice as much labor input per decare as farms smaller than 10 but larger than 5 decares -47 man days per decare versus 21 man days per decare- for Turkey (Table 12).

The same trend seems to be valid for fertilizer and pesticide spending and for total non-labor input expenditures per decare(exclusive of fertilizers and pesticides); farms smaller than 5 decares are spending significantly more -377 YTL per decare- than those that are larger than 500 decare – 30 YTL per decare- (Tables 13 and 14).

[15] One decare= 0.2474 acres.

The dependency ratio, or mouths to hands ratio, is 1.45 mouths per a pair of hands on the average for Turkey. It is highest in South East Anatolia with 1.80 mouths for a pair of hands, and lowest in Marmara with 1.31 (Table 4).

The ratio of irrigated land to total land in operation doesn't have a pronounced variation. It ranges from 21% in the smallest farms to 28% in the largest ones that are more than 500 but less than 1000 acres (Table 15). The sharecropping ratio is low in Turkey in general (4%). It is highest in South East Anatolia with 9%, and lowest in the Mediterranean region with only 1% (Table 16).

3.2. Regression Model

Based on the observed patterns in the dataset, to test if IR exists in Turkey we undertake an estimation of the form similar to the classical form (1) which will be tested for pooled data (Turkey) and for each region: Mediterranean, Aegean, Marmara, Central Anatolia, East Anatolia, South East Anatolia, and Black Sea.

$$Log\ q = \alpha + \log(H) + \beta \log(X) + u \quad (3)$$

Where q is output per decare, α is the intercept, H is farm size, X is a matrix consisting of household head's age, household head's educational attainment, household size, provincial land ownership inequality, dependency ratio, dependency ratio squared, share of irrigated land to cultivated land, share of sharecropped land to cultivated land, total labor input per decare, share of family labor in total labor input, share of family labor in total labor squared, total fertilizer/pesticide expenditure per decare, total other non labor expenditure per decare, credit per decare , and land fragmentation, and where u is the error term.

Auxiliary to the main regression (3), to further analyze the role of labor input we will test to see if there exists an inverse relationship between labor input per decare and farm size utilizing the following log-log equation, which is a modification of type (2) equations:

$$Log\ l = \alpha + \log(H) + \beta \log(Y) + u \quad (4)$$

Where α is the intercept, l is total labor input per decare, H is farm size and matrix Y consists of household head's age, household head's educational attainment, household size, provincial land ownership inequality, dependency ratio, dependency ratio squared, share of irrigated land to cultivated land, share of sharecropped land to cultivated land, total labor input per decare, regional average for agricultural wage rate, credit per decare, and land fragmentation, and where u is the error term.

To test whether other non-labor inputs also exhibit an inverse size relationship we will test the following:

$$Log\ k = \alpha + log\ (H) + \beta\ log\ (W) + u \qquad (5)$$

Where *α* is the intercept, k *is the non-labor input per decare,* H is farm size and matrix W consists of household head's age, household head's educational attainment, household size, provincial land ownership inequality, share of irrigated land to cultivated land, share of sharecropped land to cultivated land, credit per decare , and land fragmentation, and where *u* is the error term.

Regressions (3), (4), and (5) will be tested for each region and for Turkey as a whole.

It is necessary to elaborate each component in (3) in more detail, since (4) and (5) use the same variables. The variable q is the total monetary value of farm production per decare in this study. It includes value of total crops, animal sales, and secondary products produced on the farm, such as diary products, or processed grains.[16] Farm size is the size of operational holdings: i.e., the total area of land that is owned and leased-in (out) by the household.

Household head's age and educational attainment are introduced to control for farmer heterogeneity. We expect the education level of the household head to be positively related to productivity per decare since better educated farmers have improved access to knowledge and tools which might enhance productivity. We expect age to have a positive relationship since age is used as a proxy for experience. However after some point, age might pose disadvantages in agriculture because most of the work is physically demanding, and because older household heads might be too conservative to try new and more efficient techniques.

The dependency ratio is the ratio of total number of household members to workers in the household.[17] To test Chayanovian arguments regarding the peasant mode of production, we introduce the dependency ratio and its square to test if the dependency ratio within a household makes a difference in the productivity per decare by adding extra stress, and hence motivation to work. The square term is introduced because we suspect a non-linear, diminishing relationship between the dependency ratio and yield per decare, since too many mouths to too few hands might create a

[16] Output can be measured in two units: physical weight or volume, or in money units, i.e., in terms of "value." Measuring output in terms of weight or volume could only be plausible for highly specialized mono-crop or mono-product farms. Most farms produce multi-crops and dairy products, therefore this is not a convenient method to be used for the developing country agrarian context.

[17] We calculated the number of workers in the household via assuming members younger than 15 but older than 11 as half workers. The same method was applied to people who are older than 65 and younger than 75. People who are on the two extremes of these ranges are considered full dependents.

negative effect on yield per decare if household labor is devoted mostly to reproduction of labor power and not for agricultural production.

Provincial land ownership inequality is captured with the Gini coefficient for land ownership distribution per province in each region. This variable is introduced to control for the macro environment in which each household is operating. Land ownership inequality could have different impacts on land productivity. If the only option for laborers is working on their own farm due to limited availability of land as a result of land concentration in fewer hands, assuming labor input increases productivity, then land ownership inequality should have a positive and significant impact on productivity per acre. On the other hand, land ownership inequality might affect productivity negatively via affecting the production process, particularly if rural markets are connected. If land concentration translates into monopoly power in the markets where the chieftain is also the seller of inputs and the buyer of output, there would be less ability to use non-labor inputs such as fertilizers due to limited availability or high input prices, and less motivation to work on one's own farm due to low output prices, both of which cause lower yields on land.

We control for land heterogeneity via disaggregating data among regions [Rudra (1973); Berry and Cline (1979); Sen (1981)]. However it is not adequate to account for within-region heterogeneity. We introduce the share of irrigated land to cultivated land[18], and fertilizer and pesticide expenditure per decare[19] to control for land augmenting technical progress. In addition, we introduce a variable that sums the costs of fodder, veterinary costs, electricity bills for the barns, as well as costs of oil and gas for machinery. We expect these variables to have positive and significant relationships with yield per decare since such spending on the farm enhances productivity.

Ratio of labor input per decare is the total number of man days divided by the farm size for each household. Family labor ratio is the share of family labor in total labor input.[20] We expect a positive relationship between labor input per decare and yield per acre, as well as share of family labor and yield per acre. In other words, we expect a negative relationship between labor input per decare and farm size.

[18] Unfortunately, the dataset doesn't allow us to make a distinction between exogenous irrigation such as canal systems versus endogenous irrigation such as tube-well systems. This will bias our results against the labor-based hypothesis, i.e., what may in effect be labor input, could be considered as land quality. However, despite controlling for endogenous land quality, if we were to find IS, it means that our results could have been stronger when accounting for exogenous land heterogeneity.

[19] Using monetary value per decare, rather than physical units is not ideal, since price differences might create regional biases. This problem is solved to an extent via disaggregating the data. Also there is little price variation in input prices due to oligopoly. All fertilizers and pesticides are produced by six large companies with considerable market control.

[20] See Table 8 in Appendix A for details on components of total labor.

The ratio of sharecropped land to total cultivated land is included to introduce land tenure type. It is important to include this variable since type of tenure is claimed to matter for productivity by impacting incentives. We expect a negative relationship between the ratio of sharecropped land and productivity per decare.

Credit per decare is the total amount of credit divided by the farm size. Credit access allows for better and more non-labor inputs such as fertilizers, pesticides, and land. If the impact of non-land input dominates then credit should have a positive impact on productivity per acre, however if it is the land access that is dominant, then the relationship between credit per acre and productivity per acre might be negative since farm size would grow larger by better credit access which distorts the labor input per decare component, and might lead to lower yield per decare.

Fragmentation is claimed to reduce yield per acre not only because labor, fuel and time is spent moving in between plots rather than on them, but also larger farm size is more convenient for application of farm machinery [FAO (1999), OECD (2006)]. However, it is also argued that land fragmentation benefits farmers because it reduces the risks of drought, frost, floods, pests and other uncertainties as a result of separated plots [Kaldjian (2001)]. Helburn[21] claims that for Central Anatolia, fragmentation benefits small farmers in terms of decreasing risk, since "having all one's land in a single soil type, in a single location and single exposure is considered risky". We introduce land fragmentation in our regression analysis to test which of these claims holds for Turkey.

4. Regression Results and Discussion:

Our results suggest a very strong inverse size-yield relationship (IR) in rural Turkey. The summary results of the regressions for Turkey and for each region are illustrated in Table 18. The relationship weakens but prevails significantly even after disaggregation of the data and controlling for land and farmer heterogeneity. For Turkey in general, one percent of increase in farm size results in 1.28 percent of decrease in productivity per decare. The IR is most pronounced in the Black Sea Region with -1.37 elasticity, and least pronounced in the Mediterranean with -1.09.

The two richest and most developed regions in Turkey – the Mediterranean and the Aegean - have the lowest elasticities in terms of IR, which confirms the literature that IR is a backward agriculture phenomena. In these regions where the coefficient is lower – but the relationship is still very highly elastic-, off-farm and non-agricultural employment opportunities are more available compared to other regions, which might suggest that because labor has other employment alternatives it is not employed as much, weakening the inverse relationship. It could also be due to the availability of

[21] Discussion in Kaldjian (2001).

credit with which large farmers can substitute labor with machines to a certain extent, which results in a weakening of IR.

Labor input per decare is significant at a 1% level for all regions except South East (SE) Anatolia. However in SE Anatolia, the ratio of family labor is significant at a 1% level. On the average, a one percent increase in the share of family labor in total labor results in a 1.86 percent increase in yield per decare in Turkey. This elasticity is much higher than the elasticity of labor, which supports the labor-based hypothesis, and emphasizes the importance of family labor. Family labor is significant in four regions out of seven, except the Black Sea, the Aegean, and East Anatolia. For the majority of the regions, (five out of seven) the household demographics such as education level and age are not significant. However household size is. Again, this points to the importance of family labor in yield per acre.

Contrary to the claims of the Organization for Economic Cooperation and Development (OECD) (2006) and the Food and Agriculture Organization of the United Nations (FAO) (1999) reports on Turkey, land fragmentation is positively and significantly correlated to yield per decare. One percent of increase in land fragmentation results in 0.1 percent increase in yield per decare at the 1% level of significance. However, when data is disaggregated based on geographical regions, significance is lost. This is because the data loses a lot of variation in the fragmentation variable when we disaggregate the data by regions, and hence lose statistical significance. Different fragmentation patterns with respect to regions in Turkey support our earlier claim regarding agro-climatic homogeneity within regions. Despite illustrating variation across Turkey, there is little variation within regions. Nevertheless the sign of the coefficient is positive for all regions except Marmara, supporting Kaldjian's (2001) arguments that fragmentation impacts productivity positively as a result of risk diversification.

In addition to the findings discussed above, other interesting findings emerge from the analysis. The Chayanovian argument of a life cycle hypothesis which is captured by the dependency ratio in our regressions is significant at 1% for Turkey. A one percent increase in the dependency ratio results in an almost 10 percent increase in yield per decare. It is significant at 5% in SE Anatolia, Marmara and East Anatolia. However it is not significant in other regions. The diminishing relation between the dependency ratio and IR suggests that, after a certain point, the presence of too few hands to work for too many mouths, limits the hours for farm production, impacting productivity negatively.

To our surprise, there is also a non-linear relationship between the family labor ratio and productivity per decare. Up to a threshold point (>.95), family labor has a positive impact which then becomes negative when family labor ratio gets closer to 1. Non-linearity of the relationship may point to the fact that when farmers cannot employ hired labor during extremely busy times such as harvest, they might be losing a large portion of their output since harvesting most crops is a time sensitive process.

As expected, land ownership inequality has a differential impact on productivity per decare. For the country in general, a one percent increase in land ownership inequality in the province in which the farm operates is associated with a 0.46% decrease in productivity per decare. In Central Anatolia this relationship is strongest with a coefficient of 1.80 followed by the Blacksea with 0.94. In East Anatolia, and the Mediterranean, even though not significant, the sign of the coefficient is negative. In the Aegean and Marmara, the coefficient is positive but not significant.

Credit per acre is significant and positive for only the regions where such markets are more developed and credit usage is common, i.e., for Marmara, and Aegean. In other regions credit per decare is not common enough to create a difference that would allow for statistical testing.

The ratio of sharecropped land confirmed our expectations of having a negative relationship to productivity per decare. For four out of seven regions and for Turkey on the average, it is robust and statistically significant at the 1% level. It is hard to make claims on the reasons for such inefficiency without further investigation, which is conducted based on type (4) regressions.

Examining the determinants of labor input per decare using regression (4) suggests that labor input per decare doesn't present a significant and consistent relationship based on the tenure type (Table 18). All else equal, the ratio of sharecropping is significant at the 5% level and positive in the Black Sea region, and not significant elsewhere. Our results make a case against the Marshallian disincentive explanation of inefficiency in sharecropping. According to this view, sharecropping is a relatively inefficient tenancy arrangement due to lower incentives to provide labor since peasants do not have the full claim to the residual. On the contrary, when one studies the regression results for (5) in Table 19, the ratio of sharecropping is significantly negative for determining variations in non-labor input expenditures per decare in SE Anatolia, where land inequality is among the highest, and feudal relations are prevalent [Yakin (1981)]. These findings are in support of arguments made by Sen (1981), Cornia (1985), and Rao (2005) that the landlords' choice of input and crop type, not the tenant's choice of labor input is the explanation for lower productivity on sharecropped land.

Another important finding pertains to land fragmentation. All else equal, for Turkey, a one percent increase in land fragmentation results in a 0.33% increase in labor per decare. This relationship is significant at the 1% level. The relation stays significant and positive across all the regions of Turkey with the exception of the Black Sea.

It is clear that the culprit of IR is the intensive labor use per decare as farm size gets smaller, as indicated by regression results for equation (4) (Table 19). On the average a one percent rise in farm size results in a 0.96 percent decline in labor input per decare. The inverse relation and its magnitude seems to be similar across all regions, ranging between 0.94 and 0.72.

Another important variable is the ratio of irrigated land to cultivated land. A one percent increase in irrigation results in 0.78 percent increase in labor input per decare on the average in Turkey. The relationship is significant at the 1% level for six of the seven regions and ranges from 0.37 to 1.33.

Land ownership inequality is significant for labor input per decare in rural Turkey with the exception of SE Anatolia and the Mediterranean. A one percent increase in the Gini coefficient is associated with a 1.56 percent increase in labor per decare for Turkey. This relationship is strongest in Marmara with a 3.9 percent change in labor per decare. The relationship is reversed in Central Anatolia. In this region, as provincial land ownership inequality increases by one percent, labor input per decare decreases by 1.09 percent.

One further interesting finding of regression (4) is the empirical observation regarding the impact of average agricultural wage rates. For the pooled sample, i.e., Turkey, the wage rate in agriculture has a negative impact on on-farm labor input per decare, i.e., as the wage rate gets higher peasants supply less labor to their farm. As the wage rate increases by one percent, labor input per decare decreases by 0.6 percent. This finding is in agreement with Mazumdar (1964); Sen (1966); Sen (1981); Eswaran and Kotwal (1986); de Janvry et al. (2004); and, Benjamin (2002), and insinuates that farmers take outside opportunities into consideration when deciding to work on their own farm.

There is not a consistent and widely observed significant relationship between farm size and non-labor inputs as illustrated by the results of regression (5) (Table 20). For Turkey, the coefficient is positive but not significant. However, when data is disaggregated based on regions, the insignificance retains but the sign changes. The sign of the coefficient reverses for all the regions except two: Marmara and Central Anatolia. This finding is in contrast to Berry and Cline (1979) and Cornea (1985) where both studies find a significant inverse relationship between per acre non-labor input and farm size for different developing countries.

The share of irrigated land to total cultivated land is positively related to non-labor input per decare. For five regions out of seven, the relationship is significant and positive, and ranges from 1.45 in South East Anatolia to 3.67 in Black Sea. This supports Cornia's (1985) observation that irrigation requires more labor input.

A very interesting finding from regression (5) is the association between land ownership inequality and non-labor input usage per decare. For Turkey, a one percent increase in the provincial land ownership Gini results in a 3.17 percent decrease in the non-labor input per decare. It is significant and negative in two regions, Mediterranean and Blacksea, and significant and positive in East Anatolia. Our guess is that the negative relationship between inequality and non-labor input usage might be indicative of the chieftain effect that we elaborated earlier i.e., either higher prices or decreased availability of non-labor inputs are related to lower usage of such inputs. The positive association of provincial inequality and non-labor input might be due to survival distress, i.e., when inequality is high, land is utilized fully via the application of fertilizers, and other productivity enhancing inputs to increase yields.

Conclusion and Policy Implications:

Several interesting conclusions come out of this study. First, this paper's main contribution to the continuing debate over inverse-size yield relationship is an affirmation of a very strong inverse relationship in the case of Turkey. As pointed out by Kaldjian (2001), productivity problems in Turkish agriculture are ascribed to a number of intertwined causes, ranging from "an ill-defined 'backwardness' among farmers and peasants, the variability and vagaries of nature, declining soil fertility, and the legacy of Ottoman-era practices to a variety of much more contemporary administrative, technical, social, and operational inadequacies"[Keyder (1984); Aydin (1988)]. Notably, FAO (1999) and Cakmak (2004) claim that due to small size "…Farm output …remains low in comparison to the country's enormous potential".[22] Further, in the most recent OECD (2006) country report on Turkey, it is stated that "stopping land fragmentation and consolidating the highly fragmented land is indispensable for raising agricultural productivity."[23] Our study is the first quantitative work on Turkish agriculture which discredits such "beliefs", and demonstrates their lack of firm empirical grounds.

Second, this study suggests that labor-based hypotheses conform well with the Turkish data. Labor input per decare seems to be driving the inverse size-yield relationship in Turkey. Additionally, the significance of family labor is consistent with hypotheses regarding supervision constraints with respect to labor, according to which hired workers are not perfect substitutes for family labor. Third, the Chayanovian argument of peasant mode of production is part of the IR puzzle for Turkey. However, the farmer heterogeneity hypotheses is not. Fourth, even though land heterogeneity explains part of the inverse size-yield relationship, IR is still very robust and significant despite controlled land heterogeneity. Fifth, land fragmentation seems to be impacting land productivity positively for the country in general. At the very least, our regional analysis does not support OECD (2006) and FAO

[22] FAO, Turkey, (1999): online: country profile Turkey: http://www.new-agri.co.uk/00-3/countryp.html
[23] OECD Economic Surveys, Turkey, 2006, p.186.

(1999) claims regarding this relationship. Last but not least, the degree of land ownership inequality and access to credit matters. The findings in this paper point not only to economic but also to social dimensions that might be crucial determinants of farm productivity. Land ownership inequality has a positive impact on labor input and a negative impact on non-labor (non-land) input. Such a pattern might be suggesting non-economic reasons for why such variation in input usage exists. However, for a better assessment of the inequality-productivity nexus, one needs to look at social relations of production based on thorough regional analysis inclusive of economic social, historical, and cultural dimensions as suggested by Rao (2005).

The findings in this study suggest the need for implementing more equitable land holding/ownership distribution to increase total output, and to attain allocative efficiency. Turky faces the potential for major socio-economic change with possible accession to the European Union (EU). With a large proportion (40%) of the population living in rural areas, agriculture has become the most "hotly" debated issue surrounding this development due to the sector's low productivity. Currently, agricultural production accounts for only 15% of Gross Domestic Product (GDP), while employing 30% of the labor force.[24] Suggesting land consolidation as a solution to low productivity in agriculture seems to be an ill-advised policy for Turkish agriculture. On the contrary, redistributing land from large farms to smaller ones would solve the low productivity problem of the sector since smaller farms have higher land productivity.

As demonstrated by the findings in this study, rural factor markets are highly imperfect. This is reflected by the robust inverse relationship between farm size and yield per decare. Thus, Turkey should proceed with caution in implementing so-called market friendly reforms as part of an effort to spur development in the agricultural sector and join the EU. Of Turkey's 70 million people, forty percent live in rural areas, and of those, 41% are living under poverty[25] –. It is very likely that inequality of agricultural land holdings, and low labor productivity in the sector could be a major player in rising poverty.

However, the Agricultural Reform Implementation Program (ARIP) has been in effect since 2001 with the purpose of transforming agriculture via "market friendly[26]"policies. "By the end of 2003, the reform program reduced the fiscal outlays on agricultural subsidies by about US $5.4 billion to US $0.7 billion annually. Roughly 70% of the subsidy cuts were associated with measures aimed at reducing agricultural commodity price subsidies. The changes to agricultural output subsidization took the form of greater market deregulation through the phasing out of state-set prices and reduced intervention purchases financed by the budget. Reforms also imposed hard

[24] State Statistics Institute, 2004.
[25] State Statistics Institute, 2005.
[26] Aysu (2002), Cakmak (2004).

budget constraints on state marketing and processing enterprises and the quasi-state Agriculture Sales Cooperative Unions. The remaining 30% of the cuts were aimed at reducing agricultural input subsidies, notably for credit and fertilizer." [27]

Given the inverse productivity-size relationship in agriculture, what is needed for increased productivity in agriculture and overall growth doesn't seem to be so-called market friendly reforms but land redistribution supported by technical and financial assistance for farmers.. Turkey can expect rising inequality and poverty in the years to come, as indicated by the most recent poverty study conducted by the State Institute of Statistics in 2005. Surely, agrarian transformation initiated by implementation of ARIP is taking place at the expense of a great majority of the people. Transformation ought not happen by crippling the agricultural sector, particularly when a large proportion of the population depends on that sector, and when there is little economic justification to do so. This is exactly what market friendly reforms seem to be doing despite evidence of market failures in the form of an inverse relationship between farm size and yield per acre.

[27] Agricultural Reform Implementation Project (Loan 4631 -TU) Proposed Amendment of the Loan Agreement., p.1.

Table 18: Summary Results for Regression (3) Dependent variable: Yield per decare

Region	Constant	ln farmsize	ln hh size	ln hhhh educ.	ln hhh age	Independency ratio	ln provincial inequality	ln credit per acre	ln labor per decare	ln family labor ratio	ln irrigation ratio	ln ratio shrcrp	ln per fert/pest exp.per dec.	ln non-labor input exp. per dec.	ln fragmentation	R^2	N
Turkey	14.29**	-1.28**	0.13**	0.16**	-0.11	9.89**	-0.46**	0.01**	0.30**	1.86**	0.51**	-0.55**	0.02**	0.04**	0.09**	0.77	5,084
Marmara	10.4**	-1.21**	0.20**	0.23	-0.19	20.35*	0.93	0.01*	0.20**	1.47*	0.45**	-0.74*	0.004	0.04**	2.21*	0.78	759
Aegean	16.53**	-1.18**	0.01	-0.04**	-0.07	4.5	0.23	0.01*	0.35**	1	0.93**	-0.29	-0.03	0.03*	0.05	0.7	861
Mediterranean	20.60**	-1.09**	0.29**	0.29*	-0.2	-9.6	-1.56	-0.17	0.31**	2.4**	0.60**	-2.21**	0.05	0.12**	0.001	0.71	667
SE Anatolia	11.66**	-1.29**	-0.01	-0.01	-0.31	16.66*	1.06	0.01	0.07	2.68**	1.15**	-0.34*	0.003**	0.05**	0.1	0.71	469
Central Anatolia	19.66**	-1.33**	0.29**	0.21	-0.34	-1.6	-1.80**	-0.004	0.19**	1.50*	0.92**	-0.73**	0.04**	0.06**	0.01	0.69	847
East Anatolia	8.13**	-1.29**	0.34*	0.18	0.13	21.99*	-0.73	0.03	0.39**	1.69	-0.16	-0.16	0.001	0.04	0.11	0.81	317
Black Sea	14.99**	-1.37**	0.33**	-0.01	-0.06	10.9	-0.99**	0.01	0.29**	0.16	0.93**	-0.31	0.02	0.02**	0.04	0.79	1,164

**Significant at 1% level

* Significant at 5% level

Robust standar errors

Table 19: Summary Results for Regression (4) Dependent variable: Labor input per decare													
Region	Constant	lnfarmsize	ln hh size	ln provincial inequality	ln hhhh educ.	Independency ratio	lnwage_rate agr	lnratio of irrigation	ln ratio shrcrp	ln credit per acre	ln fragmentation	R^2	N
Turkey	14.88**	-0.96**	0.12**	1.56**	0.19**	-1.14	-0.60**	0.78**	0.12	0.03**	0.33**	0.53	5,084
Marmara	4.28**	-0.94**	0.37**	3.91**	0.39**	-8.8	N/A	0.87**	0.09	0.01**	0.23**	0.54	759
Aegean	5.02**	-0.85**	0.07	1.56**	0.23	-2.01	N/A	0.38**	-0.36	0.02**	0.18**	0.37	861
Mediterranean	3.84**	-0.72**	0.11	0.54	0.04	1.39	N/A	0.47**	0.45	0.02**	0.43**	0.38	667
SE Anatolia	3.41**	-0.76**	0.25**	0.81	-0.004	-1.74	N/A	1.20**	0.06	0.03	0.2*	0.5	469
Central Anatolia	5.65**	-0.85**	0.26**	-1.09*	0.22	-7.17	N/A	2.5**	0.34	0	0.32**	0.46	847
East Anatolia	8.99**	-0.80**	0.60**	2.45**	-0.02	-15.53*	N/A	1.33**	-0.69	0.01	0.21*	0.62	317
Black Sea	8.5**	-0.8**	0.25**	0.88**	0.12	-13.2*	N/A	0.37*	0.41*	0.01	0.01	0.51	1,164

**Significant at 1% level

* Significant at 5% level

Robust standar errors

Table 20: Summary Results for Regression (5) Dependent variable: non-labor input per decare												
Region	Constant	lnfarmsize	ln hh size	ln provincial inequality	ln hhhh educ.	credit per acre	lnratio of irrigation	ln ratio shrcrp	lnwage_rate agr	ln fragmentation	R^2	N
Turkey	2.03	0.02	0.84**	-3.17**	0.19	0.03**	2.54**	-0.92	0.81**	0.17**	0.06	5,084
Marmara	21.80*	0.24	0.71**	-3.11	-0.07	0.02	1.11	0.7	N/A	0.04	0.05	759
Aegean	12.75**	-0.05	1.21**	0.01	0.78	0.02	2.5**	-0.72	N/A	0.18**	0.07	861
Mediterranean	18.50**	-0.24	0.49*	-5.5*	0.34	0.04**	1.18**	0.75	N/A	0.43**	0.04	667
SE Anatolia	12.41**	-0.11	0.57*	2.2	0.94**	0.05*	1.45**	-3.56*	N/A	0.2*	0.11	469
Central Anatolia	17.19**	0.04	0.38*	2.29	0.14	0.02*	1.75**	0.45*	N/A	-0.07	0.05	847
East Anatolia	15.07**	-0.17	0.46	4.6**	0.67	0.03	0.26	-6.48	N/A	0.07	0.08	317
Black Sea	21.74**	-0.32	2.09**	-12.6**	-0.32	-0.05	3.67**	1.32	N/A	0.78**	0.14	1,164

**Significant at 1% level

* Significant at 5% level

Robust standar errors

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APPENDIX A

Table 1: Share of Agriculture in Employment and Gross Domestic Product, 2004

Years	***Value Added by Agriculture as a share of GDP %***	***Share of Agriculture in Total Employment (12+)***
1980	26.1	55
1985	19.7	51
1990	17.5	46.5
1991	15.2	47.4
1992	15	43.5
1993	15.4	44.6
1994	15.5	44.8
1995	15.7	46.8
1996	16.9	44.9
1997	14.5	42.4
1998	17.3	43
1999	15	41
2000	14.5	35.9
2001	12.9	37.6
2002	11.9	34.9
2003	11.7	32.7
2004	9.08	32.9
2005	11.5	29.9
2006	N/A	29.9

Source: State Statistics Institute.

Table 2: Gender Composition of rural Households in Turkey, 2002:

GENDER AGE COMPOSITION OF HHHS				
REGION		**MALE**	**FEMALE**	**TOTAL**
Meditterranean	**AVG. AGE**	50.2	59.1	50.4
	STD	13.7	9.8	13.7
	FREQ	699	16	715
Aegean	**AVG. AGE**	48.3	53.3	48.4
	STD	12.6	13.2	12.6
	FREQ	883	7	890
SE Anatolia	**AVG. AGE**	47	50.6	47.1
	STD	13.6	12.3	13.5
	FREQ	476	15	491
Marmara	**AVG. AGE**	52.2	54.7	52.2
	STD	12.5	11.2	12.5
	FREQ	787	9	796
Central An.	**AVG. AGE**	49.2	47.9	49.2
	STD	13.3	15.3	13.3
	FREQ	894	9	903
E. Anatolia	**AVG. AGE**	47.4	58.4	47.5
	STD	13.3	13.6	13.4
	FREQ	326	5	331
Blacksea	**AVG. AGE**	52.1	59.1	52.2
	STD	13.5	13.3	13.5
	FREQ	1157	22	1179
Total	**AVG. AGE**	50	55.3	50
	STD	13.3	12.8	13.3
	FREQ	5222	83	5305

Source: QHS, 2002

Table 3: Educational attainment of rural Household Heads in Turkey, 2002

REGION	ILLITERATE	LITERATE	PRIMARY	SECONDARY	HIGH SCHOOL	UNIVERSITY	GRADUATE	TOTAL
Mediterranean	9%	7%	**67%**	8%	8%	1%	0%	714
Aegean	6%	9%	**76%**	5%	4%	0%	0%	887
SE Anatolia	19%	7%	**61%**	9%	4%	0%	0%	490
Marmara	5%	10%	**73%**	5%	5%	1%	0%	795
Central An.	7%	8%	**73%**	6%	5%	1%	0%	901
E. Anatolia	11%	12%	**66%**	5%	5%	1%	0%	331
Blacksea	9%	12%	**66%**	6%	5%	2%	0%	1,179
TURKEY	**9%**	**9%**	**70%**	**6%**	**5%**	**1%**	**0%**	**5,297**

Table 4: Household Size in regions, 2002

Region	Household Size	Dependency Ratio
Mediterranean	5.6	1.41
Aegean	4.7	1.36
SE Anatolia	8.2	1.80
Marmara	4.5	1.31
Central An.	5.8	1.45
E. Anatolia	7.9	1.74
Blacksea	5.5	1.40
TURKEY	5.7	1.45

Source for Tables 3 & 4 : QHS, 2002.

Table 5: Land Ownership Structure, in decare, 2002

REGION		No Land	<5	5-9.99	10-19.99	20-49.99	50-99.99	100-199.99	200-499.99	500-999.99	1000+	Total
Meditterranean	Mean	0	3.0	6.4	13.8	31.9	65.0	126.4	255.2	604.3	2050.0	54.7
	ST.d	0	1.1	1.3	3.1	8.5	13.5	24.8	65.6	93.8	777.8	135.6
	Freq	122	35	47	100	182	127	67	25	7	2	714
Aegean	Mean	0	2.9	6.7	13.7	31.3	67.0	130.8	268.5	.	3325.0	50.5
	ST.d	0	1.1	1.3	2.7	8.1	14.4	26.0	80.5	.	567.9	227.5
	Freq	138	39	69	145	276	153	50	13	0	4	887
SE Anatolia	Mean	0	2.8	6.5	13.7	31.5	64.6	130.0	287.3	595.0	1543.8	94.5
	ST.d	0	2.5	1.5	2.9	8.1	13.9	24.2	72.8	99.6	544.6	176.5
	Freq	90	2	16	33	106	101	77	54	7	4	490
Marmara	Mean	0	2.5	7.0	13.5	32.2	69.6	134.7	276.8	566.7	1272.5	64.6
	ST.d	0	1.0	1.5	2.7	8.7	14.1	27.6	86.7	115.5	385.4	94.8
	Freq	55	25	46	90	226	201	116	31	3	2	795
Central An.	Mean	0	2.1	6.4	14.2	32.7	66.6	134.8	274.0	597.0	1000.0	105.4
	ST.d	0	1.2	1.4	2.5	9.1	13.4	27.5	72.3	104.0	0.0	121.2
	Freq	171	6	7	23	136	192	207	142	16	1	901
E. Anatolia	Mean	0	2	6.3	14.3	31.0	67.4	129.2	265.4	611.4	1081.7	113.5
	ST.d	0	0	1.2	2.4	9.3	14.8	28.6	72.2	111.7	141.5	158.0
	Freq	33	1	16	37	59	50	71	52	9	3	331
Blacksea	Mean	0	2.8	6.7	13.7	30.1	66.0	119.2	265.9	600.0	2275.0	41.2
	ST.d	0	1.2	1.4	2.7	7.9	12.9	23.2	64.7	0.0	1059.0	147.3
	Freq	125	76	116	212	377	190	66	12	1	4	1179
TURKEY	Mean	0	2.8	6.7	13.7	31.4	66.8	130.9	273.2	598.8	1973.3	68.4
	ST.d	0	1.1	1.4	2.7	8.4	13.8	26.8	73.3	98.3	993.5	157.8
	Freq	734	184	317	640	1362	1014	654	329	43	20	5297

Table 6: Farm size (Operational Units), in decare, 2002

REGION		No Land	<5	5-9.99	10-19.99	20-49.99	50-99.99	100-199.99	200-499.99	500-999.99	1000+	Total
Meditterranean	**Mean**	**0**	**2.9**	**6.5**	**13.4**	**32.1**	**65.4**	**132.7**	**267.8**	**640.9**	**1502.8**	**75.9**
	ST.d	**0**	**1.0**	**1.5**	**3.0**	**8.6**	**13.6**	**26.8**	**77.8**	**117.4**	**638.7**	**158.9**
	Freq	**24**	**33**	**44**	**105**	**211**	**154**	**88**	**42**	**8**	**5**	**714**
Aegean	**Mean**	**0**	**2.8**	**7.0**	**13.9**	**32.0**	**67.3**	**133.8**	**273.6**	**540.5**	**3358.5**	**63.7**
	ST.d	**0**	**1.0**	**1.4**	**2.8**	**8.3**	**13.9**	**24.8**	**74.9**	**41.7**	**596.8**	**231.1**
	Freq	**8**	**25**	**61**	**150**	**334**	**215**	**70**	**18**	**2**	**4**	**887**
SE Anatolia	**Mean**	**0**	**3.4**	**6.2**	**13.8**	**31.5**	**66.3**	**130.9**	**298.9**	**589.2**	**1634.5**	**122.3**
	ST.d	**0**	**1.1**	**1.5**	**2.9**	**8.1**	**14.7**	**25.2**	**86.3**	**97.1**	**463.4**	**214.0**
	Freq	**13**	**4**	**22**	**35**	**124**	**123**	**88**	**63**	**12**	**6**	**490**
Marmara	**Mean**	**0**	**2.5**	**6.7**	**13.7**	**31.7**	**68.9**	**136.7**	**278.2**	**630.7**	**1220.0**	**84.3**
	ST.d	**0**	**1.1**	**1.4**	**2.7**	**8.5**	**14.5**	**27.7**	**81.0**	**106.9**	**287.3**	**116.9**
	Freq	**13**	**24**	**43**	**79**	**208**	**213**	**147**	**58**	**7**	**3**	**795**
Central An.	**Mean**	**0**	**1.9**	**6.8**	**14.1**	**32.3**	**68.3**	**137.6**	**291.8**	**611.7**	**1324.3**	**160.8**
	ST.d	**0**	**1.0**	**1.4**	**2.9**	**9.0**	**13.7**	**27.8**	**82.1**	**118.2**	**360.1**	**180.7**
	Freq	**10**	**9**	**11**	**28**	**137**	**210**	**254**	**195**	**40**	**7**	**901**
E. Anatolia	**Mean**	**0**	**3**	**6.1**	**14.2**	**30.9**	**67.1**	**130.4**	**268.3**	**631.7**	**1122.5**	**132.4**
	ST.d	**0**	**1.4**	**1.1**	**2.5**	**8.9**	**15.1**	**28.2**	**78.2**	**140.9**	**173.2**	**167.4**
	Freq	**3**	**2**	**18**	**33**	**63**	**61**	**76**	**58**	**15**	**2**	**331**
Blacksea	**Mean**	**0**	**2.8**	**6.8**	**13.9**	**30.5**	**66.1**	**123.9**	**283.2**	**600.0**	**2076.2**	**50.2**
	ST.d	**0**	**1.1**	**1.4**	**2.7**	**8.0**	**13.4**	**27.6**	**59.6**	**0.0**	**1019.3**	**153.5**
	Freq	**8**	**70**	**112**	**228**	**425**	**220**	**93**	**16**	**2**	**5**	**1179**
TURKEY	**Mean**	**0**	**2.8**	**6.7**	**13.8**	**31.5**	**67.2**	**133.6**	**284.8**	**614.4**	**1759.7**	**91.7**
	ST.d	**0**	**1.1**	**1.4**	**2.8**	**8.4**	**14.0**	**27.4**	**80.9**	**115.0**	**862.6**	**180.8**
	Freq	**79**	**167**	**311**	**658**	**1502**	**1196**	**816**	**450**	**86**	**32**	**5297**

Table 7: Per capita land owned and land Gini for regions, 2002, in dectares.

REGION	Per capita owned land	Per capita land holding	Land ownership Gini	Land holding Gini
Mediterranean	11.4	15.8	0.68	0.64
Aegean	14.5	17.6	0.74	0.66
SE Anatolia	13.3	16.0	0.66	0.59
Marmara	15.7	20.5	0.55	0.54
Central An.	23.1	33.6	0.61	0.54
E. Anatolia	16.4	19.22	0.60	0.56
Blacksea	8.9	11.38	0.65	0.63
Total	14.5	19.10	0.67	0.62

Source: Quantitative Household Survey, 2002

Table 8: Labor Input and components for Regions, 2002.

REGION	DAYS WORKED	FAMILY LABOR	WAGE LABOR	COMMUNITY LABOR
Mediterranean	163	70%	16%	2%
Aegean	252	78%	9%	1%
SE Anatolia	119	73%	13%	1%
Marmara	151	83%	9%	1%
Central An.	124	76%	11%	2%
E. Anatolia	98	72%	7%	2%
Blacksea	140	80%	9%	1%
TURKEY	**156**	**77%**	**10%**	**1%**

Source for Tables 5 through 8: QHS, 2002.

Table 9: Leased-in Total land by Regions: 2002 QHS (decares)

REGION	Mean	Std. Dev.	Min	Median	Max	Freq
Mediterranean	62	116	3	30	1200	191
Aegean	30	49	2	20	570	343
SE Anatolia	107	196	2	50	1300	124
Marmara	57	90	2	30	700	260
Central An.	121	161	2	70	1160	311
E. Anatolia	85	128	3	50	750	68
Blacksea	31	90	2	15	1100	162
TURKEY	**68**	**124**	**2**	**30**	**1,300**	**1,459**

Source: QHS, 2002

Table 10: Farm Fragmentation

Mediterranean	5.2
Aegean	6.7
SE Anatolia	3.9
Marmara	9.0
Central An.	11.1
E. Anatolia	6.3
Blacksea	7.6
TURKEY	7.5

Table 11: Productivity per acre, (in million TLs), 2002

	TURKEY			Marmara			Aegean			Mediterranean		
Farm Size	Mean	Variance	Frequency	Mean	Variance	Frequency	Mean	Variance	Frequency	Mean	Variance	Frequency
<5	561.80	1,878.0	156	253.60	292.00	20	535.10	1,238.00	23	408.90	945.80	30
5-9.99	75.77	195.0	300	63.03	60.15	40	79.38	188.00	59	100.80	245.10	41
10-19.99	20.56	51.7	647	18.19	22.03	78	19.31	20.66	147	30.69	81.79	102
20-49.99	6.38	16.0	1472	6.96	10.15	201	8.36	16.29	329	6.55	28.98	205
50-99.99	2.08	9.5	1165	2.08	6.86	210	2.25	2.36	211	1.93	2.07	151
100-199.99	0.58	0.8	791	0.64	0.75	145	0.99	0.94	69	0.64	0.43	84
200-499.99	0.24	0.4	439	0.35	0.33	55	0.38	0.59	17	0.55	0.92	41
500-999.99	0.07	0.1	82	0.07	0.05	7	0.18	0.11	2	0.12	0.13	8
1000+	0.03	0.1	32	0.03	0.03	3	0.00	0.00	4	0.11	0.17	5
Total	26.76	345.80	5084	14.44	64.48	759	26.86	221.90	861	31.85	226.10	667

	SE Anatolia			Central Anatolia			East Anatolia			Black Sea		
Farm Size	Mean	Variance	Frequency	Mean	Variance	Frequency	Mean	Variance	Frequency	Mean	Variance	Frequency
<5	194.00	167.30	4	114.30	60.76	7	275.70	201.90	2	982.30	3,575.00	70
5-9.99	43.72	101.40	20	413.70	1,025.00	10	55.97	107.00	18	567.10	1,864.00	112
10-19.99	28.21	104.90	35	166.50	210.00	26	8.77	12.33	33	237.60	559.50	226
20-49.99	3.09	3.20	123	114.90	220.40	131	2.78	3.15	61	168.60	343.70	422
50-99.99	4.23	27.54	121	97.26	157.60	195	0.89	1.02	57	95.08	96.55	220
100-199.99	0.54	0.59	87	59.59	86.56	241	0.26	0.30	74	77.57	107.50	91
200-499.99	0.23	0.26	62	44.79	52.58	192	0.08	0.07	56	99.37	119.50	16
500-999.99	0.10	0.10	11	37.78	58.58	38	0.05	0.04	14	4.47	2.20	2
1000+	0.02	0.03	6	25.97	13.00	7	0.01	0.01	2	0.87	1.26	5
Total	7.66	44.77	469	22.10	560.80	847	6.60	37.26	317	48.38	472.70	1164

Table 12: Total Labor Input per Acre (in mandays), 2002

	TURKEY			Marmara			Aegean			Mediterranean		
Farm Size	Mean	Variance	Frequency	Mean	Variance	Frequency	Mean	Variance	Frequency	Mean	Variance	Frequency
<5	47.3	90.0	156	31.5	32.4	20	76.2	113.9	23	52.7	116.7	30
5-9.99	20.6	25.6	300	14.7	16.9	40	27.5	22.8	59	30.9	48.1	41
10-19.99	9.1	10.8	647	9.8	9.4	78	13.1	11.6	147	9.6	17.1	102
20-49.99	5.2	8.5	1472	5.1	6.4	201	8.1	14.1	329	4.3	6.6	205
50-99.99	2.7	4.3	1165	2.5	6.1	210	4.7	5.1	211	2.5	3.5	151
100-199.99	1.3	1.8	791	1.0	1.0	145	2.8	3.6	69	1.4	1.8	84
200-499.99	0.7	0.8	439	0.8	0.7	55	1.3	1.5	17	1.2	1.4	41
500-999.99	0.5	0.7	82	1.2	1.8	7	0.8	0.1	2	0.8	0.9	8
1000+	0.2	0.4	32	0.2	0.1	3	0.0	0.1	4	0.7	0.7	5
Total	6.2	20.0	5084	4.9	10.2	759	10.7	25.0	861	7.9	30.6	667

	SE Anatolia			Central Anatolia			East Anatolia			Black Sea		
Farm Size	Mean	Variance	Frequency	Mean	Variance	Frequency	Mean	Variance	Frequency	Mean	Variance	Frequency
<5	21.9	16.2	4	38.4	54.5	7.0	27.0	29.0	2	42.9	85.5	70
5-9.99	10.6	13.0	20	10.7	9.9	10	12.8	14.1	18	19.3	19.3	112
10-19.99	5.2	5.8	35	4.1	4.0	26	4.7	6.3	33	7.9	7.3	226
20-49.99	3.5	5.6	123	2.6	4.4	131	4.0	4.4	61	4.9	5.2	422
50-99.99	1.7	2.0	121	2.0	3.9	195	1.5	1.7	57	2.6	2.4	220
100-199.99	1.1	1.2	87	1.0	1.5	241	0.8	0.5	74	1.7	2.0	91
200-499.99	0.6	0.6	62	0.5	0.7	192	0.4	0.3	56	0.6	0.3	16
500-999.99	0.6	0.7	11	0.3	0.4	38	0.3	0.2	14	0.1	0.2	2
1000+	0.2	0.2	6	0.1	0.2	7	0.1	0.1	2	0.1	0.1	5
Total	2.7	5.3	469	1.8	6.5	847	2.7	5.9	317	8.4	24.3	1164

Table 13: Total Fertilizer and Pesticide Spending Expenditure per Acre (in million TL), 2002

	TURKEY			Marmara			Aegean			Mediterranean		
Farm Size	Mean	Variance	Frequency	Mean	Variance	Frequency	Mean	Variance	Frequency	Mean	Variance	Frequency
<5	92.38	308.50	156	42.31	49.90	20	92.14	184.80	23	170.40	387.20	30
5-9.99	38.67	78.65	300	37.01	50.08	40	48.58	141.30	59	80.63	97.79	41
10-19.99	38.35	229.60	647	72.72	451.10	78	50.70	345.80	147	56.08	68.31	102
20-49.99	20.00	68.19	1472	20.12	26.75	201	20.82	46.01	329	28.75	37.65	205
50-99.99	13.32	28.61	1165	12.80	12.75	210	13.71	18.78	211	24.25	37.41	151
100-199.99	10.91	19.48	791	11.39	10.96	145	13.78	16.07	69	27.09	47.01	84
200-499.99	9.04	14.43	439	11.23	8.55	55	15.17	21.43	17	23.01	21.43	41
500-999.99	7.98	10.48	82	15.87	12.14	7	3.09	3.93	2	20.86	17.71	8
1000+	7.08	10.84	32	11.79	4.20	3	0.24	0.31	4	18.61	21.03	5
Total	21.49	108.80	5084	22.59	146.50	759	27.17	154.10	861	40.74	99.58	667

	SE Anatolia			Central Anatolia			East Anatolia			Black Sea		
Farm Size	Mean	Variance	Frequency	Mean	Variance	Frequency	Mean	Variance	Frequency	Mean	Variance	Frequency
<5	22.36	20.25	4	448.00	1,152.00	7	17.50	24.75	2	43.93	68.78	70
5-9.99	16.36	15.19	20	19.30	20.66	10	18.31	46.06	18	27.67	22.14	112
10-19.99	11.86	15.59	35	31.00	30.53	26	10.53	34.63	33	19.47	21.78	226
20-49.99	13.02	15.26	123	31.95	198.10	131	8.50	19.99	61	15.04	34.39	422
50-99.99	11.39	22.74	121	10.25	10.94	195	17.94	95.24	57	8.55	8.27	220
100-199.99	8.72	10.78	87	8.94	11.90	241	2.61	3.36	74	7.11	8.45	91
200-499.99	7.46	8.25	62	6.34	7.04	192	5.92	25.03	56	8.76	12.78	16
500-999.99	9.95	7.90	11	5.98	8.12	38	2.30	3.66	14	0.63	0.65	2
1000+	8.23	10.13	6	6.75	3.01	7	0.15	0.22	2	0.03	0.02	5
Total	11.07	16.18	469	16.49	131.10	847	8.87	45.46	317	16.83	30.80	1164

Table 14: Total non-labor input Expenditure per decare (in million TL), 2002

	TURKEY			Marmara			Aegean			Mediterranean		
Farm Size	Mean	Variance	Frequency	Mean	Variance	Frequency	Mean	Variance	Frequency	Mean	Variance	Frequency
<5	247.50	722.00	156	138.10	207.80	20	365.10	1,008.00	23	342.40	871.20	30
5-9.99	78.76	124.40	300	90.99	160.80	40	74.22	90.80	59	159.00	177.20	41
10-19.99	73.82	195.50	647	105.80	335.30	78	101.10	280.00	147	95.45	122.90	102
20-49.99	42.18	62.92	1472	59.96	69.00	201	51.49	87.33	329	55.39	72.64	205
50-99.99	33.14	51.40	1165	42.91	48.65	210	39.57	47.05	211	37.41	42.27	151
100-199.99	25.12	34.48	791	33.37	23.69	145	32.90	32.76	69	36.30	71.69	84
200-499.99	18.29	19.70	439	28.70	22.96	55	35.62	46.17	17	26.95	27.12	41
500-999.99	15.33	18.35	82	22.56	11.62	7	9.19	12.75	2	24.99	24.59	8
1000+	12.30	19.16	32	16.48	8.68	3	0.55	0.46	4	22.26	27.72	5
Total	47.26	158.90	5084	55.79	128.90	759	64.84	215.50	861	71.96	210.90	667

	SE Anatolia			Central Anatolia			East Anatolia			Black Sea		
Farm Size	Mean	Variance	Frequency	Mean	Variance	Frequency	Mean	Variance	Frequency	Mean	Variance	Frequency
<5	57.99	30.92	4	908.90	1,882.00	7	225.00	166.20	2	144.80	372.20	70
5-9.99	53.31	57.19	20	45.48	70.39	10	98.99	126.90	18	51.69	100.30	112
10-19.99	39.68	55.08	35	107.20	183.70	26	36.90	52.69	33	42.08	79.80	226
20-49.99	31.50	37.94	123	41.28	53.46	131	28.20	28.59	61	25.45	31.76	422
50-99.99	21.01	18.55	121	37.84	48.79	195	34.46	142.90	57	16.87	20.16	220
100-199.99	17.96	18.74	87	22.72	28.96	241	12.31	17.26	74	19.42	25.85	91
200-499.99	11.43	7.66	62	17.17	14.68	192	8.08	4.91	56	17.55	24.25	16
500-999.99	17.15	22.78	11	15.43	19.32	38	7.32	6.56	14	1.69	2.33	2
1000+	26.53	30.78	6	7.92	4.20	7	7.64	8.68	2	0.13	0.21	5
Total	25.00	32.04	469	37.55	184.60	847	27.18	76.03	317	36.03	108.60	1164

Table 15: Ratio of Irrigated Land in Total Farm Size (in percentage), 2002

	TURKEY			**Marmara**			**Aegean**			**Mediterranean**		
Farm Size	Mean	Variance	Frequency	Mean	Variance	Frequency	Mean	Variance	Frequency	Mean	Variance	Frequency
<5	23%	51%	156	20%	41%	20	36%	47%	23	53%	86%	30
5-9.99	27%	42%	300	15%	33%	40	44%	46%	59	47%	47%	41
10-19.99	25%	40%	647	15%	30%	78	36%	43%	147	42%	45%	102
20-49.99	24%	38%	1472	15%	30%	201	35%	41%	329	34%	44%	205
50-99.99	23%	37%	1165	12%	25%	210	31%	41%	211	43%	44%	151
100-199.99	22%	34%	791	10%	21%	145	39%	42%	69	41%	45%	84
200-499.99	21%	32%	439	10%	25%	55	41%	45%	17	39%	44%	41
500-999.99	21%	33%	82	0%	0%	7	15%	21%	2	50%	53%	8
1000+	28%	41%	32	0%	0%	3	25%	50%	4	80%	45%	5
Total	24%	37%	5084	13%	27%	759	35%	42%	861	41%	47%	667

	SE Anatolia			**Central Anatolia**			**East Anatolia**			**Black Sea**		
Farm Size	Mean	Variance	Frequency	Mean	Variance	Frequency	Mean	Variance	Frequency	Mean	Variance	Frequency
<5	92%	17%	4	14%	38%	7	0%	0%	2	5%	21%	70
5-9.99	49%	46%	20	40%	45%	10	50%	45%	18	7%	25%	112
10-19.99	28%	40%	35	39%	42%	26	52%	48%	33	8%	25%	226
20-49.99	28%	41%	123	22%	36%	131	38%	44%	61	10%	27%	422
50-99.99	27%	40%	121	21%	33%	195	32%	40%	57	11%	26%	220
100-199.99	25%	38%	87	16%	26%	241	29%	38%	74	18%	34%	91
200-499.99	30%	39%	62	16%	25%	192	20%	30%	56	22%	32%	16
500-999.99	22%	40%	11	16%	27%	38	33%	30%	14	0%	0%	2
1000+	37%	46%	6	18%	31%	7	5%	7%	2	8%	17%	5
Total	29%	41%	469	19%	31%	847	33%	40%	317	10%	27%	1164

Table 16: Ratio of Sharecropped Land in Total Land (in percentage), 2002

	TURKEY			Marmara			Aegean			Mediterranean		
Farm Size	Mean	Variance	Frequency	Mean	Variance	Frequency	Mean	Variance	Frequency	Mean	Variance	Frequency
<5	0%	1%	156	0%	0%	20	0%	0%	23	0%	0%	30
5-9.99	3%	25%	300	0%	0%	40	0%	3%	60	0%	0%	41
10-19.99	3%	18%	647	3%	16%	78	2%	15%	147	2%	18%	103
20-49.99	3%	18%	1472	2%	11%	201	4%	19%	330	2%	12%	205
50-99.99	4%	20%	1165	2%	12%	210	4%	16%	212	1%	4%	152
100-199.99	4%	40%	791	2%	8%	145	3%	14%	69	0%	0%	84
200-499.99	6%	23%	439	3%	18%	55	4%	15%	17	2%	7%	42
500-999.99	7%	23%	82	14%	38%	7	0%	0%	2	0%	0%	8
1000+	4%	9%	32	0%	0%	3	0%	0%	4	3%	6%	5
Total	4%	24%	5084	2%	12%	759	3%	16%	868	1%	10%	676

	SE Anatolia			Central Anatolia			East Anatolia			Black Sea		
Farm Size	Mean	Variance	Frequency	Mean	Variance	Frequency	Mean	Variance	Frequency	Mean	Variance	Frequency
<5	0%	0%	4	0%	0%	7	0%	0%	2	0%	2%	70
5-9.99	6%	22%	20	40%	126%	10	0%	0%	18	2%	12%	112
10-19.99	3%	17%	35	1%	6%	26	0%	0%	33	5%	22%	226
20-49.99	7%	28%	123	0%	1%	131	7%	24%	61	3%	20%	423
50-99.99	16%	45%	121	2%	9%	196	4%	16%	57	4%	21%	220
100-199.99	9%	33%	87	8%	68%	243	1%	5%	74	3%	14%	92
200-499.99	6%	23%	62	9%	30%	192	2%	14%	56	0%	0%	16
500-999.99	5%	15%	11	10%	29%	38	2%	8%	14	0%	0%	2
1000+	2%	5%	6	14%	16%	7	0%	0%	2	0%	0%	5
Total	9%	32%	469	6%	42%	853	3%	14%	317	3%	19%	1173

Table 17: Ratio of Family Labor in Total Labor Input (in percentage), 2002

	TURKEY			Marmara			Aegean			Mediterranean		
Farm Size	Mean	Variance	Frequency	Mean	Variance	Frequency	Mean	Variance	Frequency	Mean	Variance	Frequency
<5	89%	25%	156	93%	13%	20	85%	27%	23	83%	31%	30
5-9.99	83%	32%	300	87%	28%	40	84%	29%	59	68%	42%	41
10-19.99	78%	34%	647	80%	34%	78	78%	31%	147	77%	36%	102
20-49.99	77%	34%	1472	84%	29%	201	77%	30%	329	72%	38%	205
50-99.99	78%	33%	1165	82%	31%	210	79%	28%	211	67%	39%	151
100-199.99	74%	35%	791	86%	24%	145	68%	35%	69	67%	38%	84
200-499.99	68%	35%	439	75%	32%	55	68%	30%	17	54%	39%	41
500-999.99	69%	37%	82	80%	22%	7	99%	2%	2	47%	44%	8
1000+	66%	40%	32	59%	52%	3	87%	20%	4	41%	54%	5
Total	77%	34%	5084	83%	29%	759	78%	30%	861	70%	39%	667

	SE Anatolia			Central Anatolia			East Anatolia			Black Sea		
Farm Size	Mean	Variance	Frequency	Mean	Variance	Frequency	Mean	Variance	Frequency	Mean	Variance	Frequency
<5	100%	0%	4	91%	24%	7	58%	60%	2	91%	23%	70
5-9.99	89%	27%	20	85%	23%	10	78%	43%	18	87%	28%	112
10-19.99	92%	21%	35	78%	38%	26	79%	39%	33	75%	36%	226
20-49.99	82%	31%	123	79%	29%	131	74%	41%	61	76%	36%	422
50-99.99	70%	38%	121	79%	30%	195	67%	43%	57	85%	26%	220
100-199.99	70%	38%	87	73%	34%	241	69%	44%	74	79%	32%	91
200-499.99	53%	41%	62	72%	29%	192	74%	42%	56	55%	38%	16
500-999.99	51%	44%	11	77%	29%	38	66%	44%	14	64%	51%	2
1000+	44%	44%	6	81%	11%	7	31%	44%	2	100%	0%	5
Total	73%	37%	469	76%	31%	847	72%	42%	317	79%	33%	1164