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Impact of Land Use Rights on the Investment and Efficiency of Organic Farming

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Received: 20 October 2019; Accepted: 12 December 2019; Published: 13 December 2019

Abstract: This study investigated the impact of three land tenure arrangements on organic farming (OF) in terms of increment of efficiency, yield, and investment in soil-improving activities by using farm-level data gathered from three districts located at Punjab, Pakistan. A multivariate tobit model that captured the probable substitute and investment choices, as well as the endogenous nature of land tenure arrangements, has been employed in this analysis. The empirical outcomes displayed that rights of land use affected the decisions made by farmers to invest in land and to improve efficiency. In detail, owner-farmers with secure rental arrangements invested more in improving their land and productivity compared to those with unsecured lease agreements. The yield per hectare was the highest for owner cultivation farm, while sharecropper output seemed the lowest, which are in agreement with the hypothesis of Marshallian inefficiency.

Keywords: land use policy; land tenure system; organic farming; investment; productivity; sustainability

1. Introduction

Improving land rights across developing countries has emphasised that agricultural land is more productive under secure land use rights, when compared to those that are insecure [1]. Secure leasing arrangements embolden farmers to invest in soil and productivity improvement due to the assurance that they can hold the land for a longer time to gain investment returns. Gao, Sun [2] asserted that investment and its sources to finance investment can be affected by secure ownership. The drawback of leasing contracts stems from the owner's inability to fully engage in the renewal of the contract that hinders the tenant's investment in long-term soil improvement techniques as the tenant's uncertainty towards the land decreases the chances to reap benefits in future [3]. In detail, a drop in investment slows down productivity.

Due to the limiting effect of sharecrop on the tenant's efforts, the "Marshall's conventional theory" considers sharecrop as incompetent, unless production risks and farmer pose more risk aversion [4,5]. Reforms of agriculture land, which offer assurance (secure rights) of farmland, may enhance productivity [6]. Both contention for adequacy and the general conviction that neediness is linked to uncertainty have led many stakeholders to help agrarian land reform activities in many countries [7].

Despite the immense literature of land rights impact on investment and productivity, confirmation has remained complex [4,8]. Shaban [5] claimed that shared leases are likely to reduce inputs and

productivity by 32% and 16%, respectively. Nguyen, Bauer [9] discovered that enhancing land investment affected tenure security significantly upon assessing the impact of secure land rights and investment on agriculture within the context of Thailand. Lovo [10], in the context of Malawi, reported that soil conservation was positively affected by secure ownership rights. Gao, Sun [2] asserted that right of land use for long-term basis promoted investment for soil conservation in China. Banerjee and Ghatak [11] revealed that leasing laws contributed to a handsome share of crop, whereas greater secure rights had a positive impact on both productivity and investment. Meanwhile, Arcand, Ai [12] considered Tunisia did not recognise a factually noteworthy contrast in productivity caused by its sharecropper. Gavian [3], as well as Pender and Fafchamps [13], did not provide concrete evidence for Marshall's efficiency assumptions, but the farmers seemed to apply a similar amount of inputs to lower security contracts, such as sharecrop and lease agreements. In the context of Ethiopia, Kassie and Holden [14] showed that sharecropper could have been more productive than agricultural arable land due to the possible threat of expulsion from landowners. As for the case in Pakistan, Jacoby and Mansuri [15] reported that supervised occupants were more beneficial than non-managed occupants, signifying the role of managing in productivity gaps between owners and tenants. As such, there is a pressing need to assess the impact of land tenure on organic farming (OF) productivity and soil fertility investment.

Soil quality has a vital role in OF. Stockdale, Shepherd [16] described that the management of minerals in organically based soil differs from the conventional agricultural farming. In OF, mineral source is added as organic compost, while non-synthetic fertilisers are largely and slowly released into nature [17]. Amidst the change from conventional to organic approaches, that is the reason for the decrease in yields in the first to fourth year, trailed by a rise once the soil has developed adequate biological activity [18]. Organic farming (OF) is, thus, more sensitive in terms of land tenure system, as insecure land use rights can replace tenants frequently and inconsistent farming approaches adversely affect biological activities. This phenomenon resulted in reduced soil quality and farm yield.

This study focused on organic wheat production in the Punjab region of Pakistan, whereby wheat is an essential crop and the Punjab province produces 80% of the country's wheat production [19]. Wheat is a prime food item for over 500 million people in Pakistan and northern India [20]. Since organic production efficiency is not as impressive as that of conventional farming, it is integral to determine the productivity enhancing factors for sustainable agriculture. Akram, Akram [21] affirmed from a strategy perspective that superior comprehension of the relative adequacy of farmland under various arrangements can be a decent delineation of the degree to which land tenancy arrangements can affect the resources utilised and the comprehensive yield of farm activities.

This study looked into leases and inefficiencies by exploring how land ownership systems had affected soil improvement and investment to boost organic farm yield. The inhibition of fixed-term shareholder contracts and uncertainty in leasing contracts have often led to a slump in production, which has always been a major concern for policy makers in Punjab, Pakistan. A multivariate approach had been employed in this study to investigate other features of farms and households in the relationships of lease agreements with soil improvement investments and productivity measures. In order to assess the broader economic significance of land rights, instrumental variables were adopted to evaluate the impact of leasing contracts on agricultural productivity. As such, features of landlords, such as living location and distance of the land or location in the same village, were used as a tool to examine the endogenous rental contracts.

1.1. Land Reforms and Arrangements in Pakistan

Similar to other developing countries, the security of land use rights and land lease contracts dictates, to a great extent, the societal position and financial solace in the outskirts of Pakistan [22]. Since 1947, the initiation of Pakistan land possession rights has been seriously diverted, and less than 1% of farmers have held more than 25% of farmland. In fact, nearly 65% of farmers have retained about 15% of arable land retention of nearly 2 hectares or less. Uneven land allocation has led to

leasing arrangements as fixed lease agreements and sharecrop. Sharecropper and fixed lease tenants had cultivated more than 5.45 million hectares of arable land [23].

Uneven allocation of land in the state has led to two endeavours of land reforms. The first effort, in 1959, witnessed a land reform that stipulated the maximum private land was 500 acres of irrigated land and 1000 acres of non-irrigated land. One problem with this reform is the setting of a maximum cap based on an individual instead of family, thus allowing a family to own a huge piece of land. As a consequence, the second and latest effort was made in 1973 in which the upper limit of ownership was reduced to 150 acres of irrigated and 300 acres of non-irrigated land. Despite looking nice on paper, the applications of the reforms were poor. The acquired land for redistribution was only 0.9 million acres and one-third of the land was recovered in 1959. The upper cap was still based on individuals and not families. As a result, many landowners continued to hold huge land areas in a protracted joint family frame, leaving only insignificant and less prolific land [23].

On the other side, 38.5% of the labour force is directly link with the agriculture sector and they cultivate land by a different tenure arrangement system [24]. The main forms of tenure arrangements in Pakistan, especially in the survey zone, refer to self-farming, fix-renter, and sharing agreements. The self-farming form is farmers who cultivate produce on their own land. Farmers who cultivate such lands have the right to transfer, including the right to sell the land. Next, the fixed rental agreement refers to landowner who rent out the land to tenants who are responsible for cultivating the land and paying an annual fix rent to the landowner, whereas a sharecropper reflects the agreement between a farmer/operator and the landlord/owner with the goal of sharing the crop with the landowner as payment for land use. Although the sharecropper agreement increases the landlord's risk, when compared to the fixed lease agreement, it allows the landlord to reap along the farmers' yields, thus decreasing conceivable moral threat [25]. In certain circumstances, the sharecropper receives 1/4, 1/6, or even 1/8 of the yield, contingent upon the terms and conditions of the contract, as well as the investment contribution. Generally, land is given by landowner, while family and pecuniary labour, seeds expenditure, and land-preparing costs are consumed by tenants. Fertilisers, pesticides, irrigation, and harvesting costs are distributed between landowner and sharecropper. The fixed lease agreements are usually informal and are likely to change from one to three years, wherein extension of the lease year depends on the mutual consultation between landlord and tenant. If a fixed lease agreement is informal, the tenants may consider that the arrangement is unsafe because they may end up facing issues related to guaranteed advantages of their investment for long haul land improvement steps which possess a threat to organic farming, as organic approaches required at least three years to create adequate biological activities to boost farm productivity [18].

1.2. Organic Agriculture in Pakistan

The modern history of OF in Pakistan dates back to 1996, when a non-profitable and non-governmental organisation (NGO) called Lok Sanjh initiated a collaboration with grassroots farmers to convince them into adopting ecological production approaches (http://loksanjh.org/project-3/about-us.html). The Farmers Field Schools (FFS) were established to strengthen the capacity amongst farmers and to undertake training, so as to enable them to learn alternative farming techniques. Approximately 10,000 farmers have received training through the FFS approach. Lok Sanjh had initiated an organic farmer committee to develop the Organic Farmer's Association (OFA). The OFA has been duly supported by Lok Sanjh to establish a guaranteed system for farmers in maintaining the quality of the organic agricultural products within the region. A number of identical bodies have been established in light of equivalent initiatives to promote OF.

The Pakistani government has strongly supported OF primarily for two reasons. First, it has sought to diminish the additional pressure on foreign currency exchange due to costly fertiliser and synthetic pesticide imports. Second, the government has aimed to tackle economic and ecological challenges to confront the agricultural sector. In 2008, an Independent Executive Committee of OF was established by the National Agriculture Research Centre (NARC) (http://www.parc.gov.pk/

index.php/en/faqy/102-narc/national-institute-of-organic-agriculture). Alongside other features, this executive committee ensures technology dissemination across the Pakistani agricultural community. Approximately 5000 students and farmers have received training in OF practices. Besides, Pakistan has introduced an OF system to register organic farmers and traders (http://www.parc.gov.pk/index.php/en/nioa-achievements). Pakistan's OF production methods have been certified by Zwolle, Netherlands, in adherence to (EEC NO. 2092/91) and USDANOP standards (https://pakof.com/). Registered organic farmers participate in identifying new production technologies and disseminating new information to small farmers across Pakistan. Both NARC and Pakistan Agricultural Research Council (PARC) have been the major proponents of organic food and its production. With technical assistance provided by NARC, many private farms across the Islamabad region have begun producing organic foodstuff, particularly fresh fruits and vegetables for nearby markets.

Organic farmers sell their produce either at designated stores or directly to large certified companies, such as Panda, Prince Departmental Store, or Sultan Son's [26]. In Pakistan, hotels, foreigners, and affluent families are the primary consumers of organic foodstuff. Despite that a dedicated marketplace for organic products is largely non-existent, world-renowned hotels in Islamabad, such as Serena and Marriott, are prominent organic customers. Given the dearth of systematic support in the field, most farmers are dependent on their personal farming methods, some assisted via NARC training to enhance agricultural land fertility as well as to control weed and pests.

2. Materials and Methods

2.1. Data and Variables

This study gathered data from three major districts located in the Punjab Province viz. Toba Tek Singh, Jhang, and Khanewal (Figure 1). These districts were selected for consultations with the main stakeholders of this study, such as growers, villagers, NGOs, and organic farmers. The choice of these areas had also been based on the OF project initiated by the Lok Sanj organisation [27]. Purposive sampling was performed and 400 farmers (landowners, sharecroppers, and fixed renters) were selected from the three regions. A stratified random sampling technique was employed to choose the sample households, so as to ensure that each household shared similar probability of being involved in the study, irrespective of farm size. In identifying land rights, proximity was defined as the basic criterion. The final dataset comprised information obtained from 301 farms, 120 owner cultivation, 123 fixed renters, and 58 sharecroppers Table A3 (see Appendix A). Farmers with multiple land right arrangements were excluded to avoid conflict. In this study, growing leguminous crops (green compost) and organic compost were viewed as the catalysts to upgrade yield and profitability, as well as to enhance soil.

The survey gathered information regarding the characteristics of both family and farm level. The variables used in analysis are listed in Table A1 (see Appendix A). Family factors included age, education level, family unit size, tractor and different basic machineries claimed by the agriculturists, as well as livestock. Organic farming (OF) is somewhat complex as it demands enhanced characteristic asset administration practices, for example, mulching and excrement planning and application as well as efficient administration input [28]. In particular, formal education can improve potential management skills. Other family attributes incorporate participation of farmers in non-cultivating work, regardless of their position in agriculture associations, as well as farmers' access to both credit and development services.

The farm level variable is inclusive of distance between farmland and farmer's residence, dummy variable that identifies if the farmland is located at the owner's village or other place, farm size, and soil fertility. A farmland that is fertile is denoted by 1, while 0 for otherwise by using the dummy variable to measure soil fertility.

Comprehensive data were gathered based on the quantity and price of raw materials, such as seeds, manure, agricultural labour (family and hired), and agricultural production. Since some

observations were denoted as zero, the investment specification for dependent variables was subject to censor.

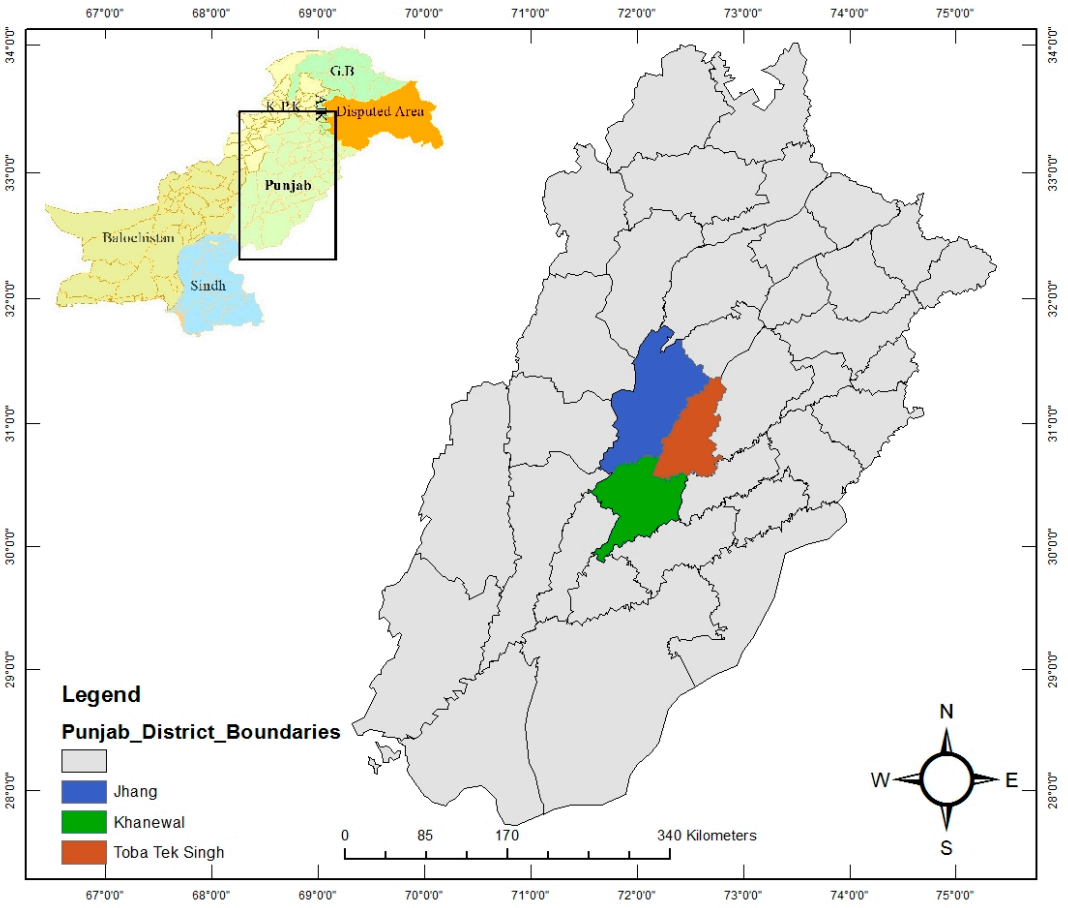

Figure 1. Sample Area.

2.2. Conceptual Framework

The link between land tenure and investment measures to improve and protect soil conservation and agricultural productivity is a vital area of study in the existing literature. As indicated by Gao, Sun [2] without market truancy, transaction expenses and asymmetry information, the allocation of land rights is irrelevant to the efficiency of the farm, although the prosperity can be affected. On the other hand, agricultural production is highly risky, the outcome depends on the adoption of technology and efforts by the farmer, tied with labour and imperfections in the credit market plus transaction costs associated with land transfers. Moreover, in the rental market, it is extremely difficult for farmers to reap positive social benefits [29].

Otsuka and Hayami [30] claim that if production is assured and the tenant's efforts can be applied, the land rights agreement is irrelevant to the outcome. In other cases where tenants efforts cannot be applicable and the agent is considered as risk-neutral (the agent is the individual who offers different kinds of goods and services (training, seed, manure, guide to quality assurance, and provides assistance for tenure arrangements, etc.) to the farmer). In such a case, a fixed lease agreement ensures the renter arrangement level of benefits will be the best deal for the landlord. Fixed lease and sharecrop contracts have been practiced in the selected region for study, which advocate that agents are not essentially in a risk-neutral situation, and therefore engage in sharecrop agreements to mitigate the risk.

Feder and Onchan [31] explain that if credit is a mandatory restraint on investment demands, property guarantees are likely to lead to a higher investment due to an increased credit availability. As a result, owned property secures more chances of investment incentives and the ability to invest

in soil conservation. Gavian and Fafchamps [32] claim that the importance of soil improvement investment in land relates to agricultural specific holdings, whether the holding rights are permanent (for example ownership) or short term (fixed rental or sharecrop contract). On the same route, Jacoby and Mansuri [33] indicate that generally less investment in land improvement and conservation measures, such as organic and green manure, are made by the fixed rental and sharecropper to their counterpart, except where the landlord has the commitment to reward the fixed and sharecropper for their investment in soil conservation. If the lessor is fully committed to rewarding the lessee, the fixed lease agreement essentially grants the users rights during the contract, and allows the tenant to be entitled to financial compensation when it pollutes or improves the quality of the land. As an enduring pretender, the tenant is motivated so that the "hold up problem" will disappear. This vigorous incompetence is conjoined to fixed renter and the sharecropper problem.

Bernstein and Brass [34] argued that when a landowner gives land and utilisation credits to the sharecropper, it is potentially considered to be advantageous for the landowner to limit the tenant's investment in land improvement measures. If investment in technology to improve farmland is reduced, production will decline, and obligated tenants will be unable to repay their loans and will therefore still be liable to pay. Therefore, in areas like West Bengal, the landowner offers consumer loans to the sharecropper. However, land improving investment, such as investment in manure, may not be beneficial due to the moral hazard and "Marshall inefficiency". This can be driven by a landlord who seeks to reduce productivity and cement the long-term obligations of the tenant (landlord usually offers only land to sharecropper and all other operating expenses, such as irrigation, fertilisers, pesticides, and harvesting costs, are distributed evenly between landlords and tenants in Punjab, Pakistan). These hypothetical contentions have prompted two fundamental hypotheses regarding the connection between tenancy contracts and investment, and in addition to land use rights in relation to productivity. These theories attest that an increase in security towards land rights has a positive impact and enhances investment on soil conservation, although land right security lessens the cultivation of efficiency in the Marshallian sense. It should be noted that the most common method used in the study of Marshall's performance assumptions is to compare crop production under sharecropping arrangements with a fixed lease agreement against those with owner cultivated arrangements [4].

This study focused not only upon the effect of land rights arrangement on cultivation inputs, but also on soil enhancing and yield improving investment and production efficiency. To look at these hypotheses, this study begins with a production function of agriculture at a farm level as

$$y = f(x, t, n, ; z) \quad (1)$$

where yield is y, labour is x, land is t, and inputs (due to market requirement, land and labour are often fixed elements for the time being, thus known as quasi-fixed factors) are denoted by n. Inputs include investment for land improving activities, such as organic manure and green manure (animal and chicken droppings and weed compost are generally used as organic fertilisers or manure, while leguminous crops and weed are used as green manure). Agricultural farm and household characteristics are denoted by z. Generally, increase in organic mineral nourishment may boost production, but decreases with passage of time if crop rotation is neglected. The decrease in yields is due to soil debasement, which erodes the initial goal of the investment. In view of the continuous cultivation of the same crop at the same plot, mineral debasement of land may occur. Companies are being conducive in maximising farmers to typically invest in organic fertilisers that build soil structures and naturally complement nutrients in the soil at relatively low costs. Farmers apply different techniques to maximise profit and invest in organic compost in one of them. Despite the low cost, organic manure is slower than the other methods to enhance soil fertility [33] (effects of organic manure on yield that are prolonged to at least three years have been verified via field trials, while artificial fertiliser has immediate effect for only a crop and is thus unsuitable for organic farming to some extent [33]).

This study proposes that agents are the main cause that maximise profit π, which is given as

$$\pi = \max_{x,t,n} [py(x, t, n; z) - wx - r(\theta, \delta) - cn]. \quad (2)$$

Output price is p, unit labour cost is denoted by w, and land cost is represented by $r(\cdot)$. This mirrors the three different regimes of land rights stipulated in farm contracts, namely, sharing, fixed leasing, and owned. The cost of land is calculated as follows:

$$r(\theta, \delta) = (1 - \theta)\bar{r} + \theta\delta py \quad (3)$$

The ratio of sharing output is denoted by δ, for sharecropper $\theta = 1$, while $\theta = 0$ for fixed contractor. The land cost for share contract is δpy and for fixed contractor is $\bar{r}$. C refers to the cost vector related to unconventional inputs, while variable Z has been described earlier.

Profit maximisation π can be described as price function, characteristics, endowment of household, and the types of land rights represented by θ and δ, as given in the following:

$$\pi = \pi(p, w, c, z, \theta, \delta) \quad (4)$$

Hotelling lemma can be directly applied to any specific function of profit, as shown in Equation (2). The reduced form of yield specification for conventional (labour) and unconventional (organic and green manures) requirements for input and output are given in the following:

$$x = x(p, w, c, z, \theta, \delta) \quad (5)$$

$$t = t(p, w, c, z, \theta, \delta) \quad (6)$$

$$n = n(p, w, c, z, \theta, \delta) \quad (7)$$

$$y = y(p, w, c, z, \theta, \delta) \quad (8)$$

Equations (4)–(8) portray that leasing arrangements, farm and household characteristics, as well as input and output prices, affect both profit and demand for inputs and output. With nil moral hazard, the optimal use of input and outcome became independent of the contractual terms (θ and δ).

2.3. Empirical Specification

The empirical analysis employed a simplified formal specification in Equations (5)–(8) for verification of output supply, input demand, and agricultural productivity. Initially, this study analysed the comparisons of land rights under sharecrop contract, land cultivated by owners, and fixed lease contract in terms of per hectare profit, productivity, and inputs. Land cultivated by owner was also compared with fixed lease contracts. Second, given that this study investigated the impact of leasing contracts on soil improvement investment (leguminous crop as green manure, G, and organic manure, M), the multivariate method was employed to study the holding systems, as well as how farm and investment decisions were effected by household characteristics Equation (7). This method took into account the possibility of substitutability and investment complementarity. Upon using this instrumental way to determine the effect of distinctive holding system on yield per hectare, the characteristics of farms and households were included.

Given the nature of the variables of investment decision, tobit specifications were applied to cover the investment range of soil improvement measures, which were expressed as follows:

$$\begin{aligned} J^*_{im} &= \beta_{im} Q_{im} + \gamma_{im} Z_{im} + \mu_{im} \\ J_{im} &= \begin{cases} J^*_{im} \; if \; J^*_{im} > 0 \\ 0 \; otherwise \end{cases}, \; m = M, G \end{aligned} \quad (9)$$

Here, J^*_{im} describes the anticipated profit for household i that derives from investing two productivity-enhancing and land-improving measures presented by m. J_{im} refers to the indicator variable observed when investing in measures to improve and stimulate soil, otherwise 0, while J^*_{im} signifies an unnoticed concealed variable. The following had been assumed: μ_{im} is error that is independent and has identical distribution; whereas β_{im} and y_{im} are the parameters evaluated. Land rights arrangement vector is denoted by Q_{im}, while considering variables θ and δ that represent land cultivated by landowner and under sharecropper contract or fixed lease contract. Family characteristics, such as farmers' age, education level, and farm features (e.g., farm size and regional fix-effects) are denoted by Z_{im}. The multivariate tobit model can be used by assuming that the error of an individual Tobit estimation may have no correlation. While some studies reflect land rights to be exogenous, latest studies have reported that investment choices and leasing measures can be set together, causing the endogenousness of land use rights variables, as given in Equation (9) [35]. Concurrently, Jacoby and Mansuri [33] stated that most agricultural contracts form a ratio between contract choices and unobserved characteristics of farmers, resulting in the endogenous nature of land use rights arrangements. In order to explain this potential endogenousness of the leased variable, this study defines 'lease' as a function of its factors in the regression, as given below:

$$Q_{im} = J_{im}\varphi_{im} + Z_{im}\gamma_{im} + \epsilon_{im} \tag{10}$$

where the parameters evaluated are φ_{im} and γ_{im}, while ε_{im} is the error. The dependent variable in Equation (9) is not continuous, hence, the method prescribed by [36] was applied to address endogeneity issue. The authors developed several endogenous tests and methods for effective assessment in light of censoring and simultaneity. The endogeneity test was developed by including μ_{im} from Equation (9) to the condition of ε_{im} of (10) as $\mu_{im} = \varepsilon_{im}\varphi_{im} + v_{im}$. μ_{im} was substituted in Equation (9) and a conditional model was generated.

$$J^*_{im} = Q_{im}\tau_{im} + Z_{im}a_{im} + \varepsilon_{im}\varnothing_{im} + v_{im} \tag{11}$$

The null hypothesis test $\varnothing_{im} = 0$ represents the Q_{im} exogenous test. If $\varnothing_{im} = 0$ is not rejected, the assumption that the variable lease arrangement is an exogenous determinant of soil improvement investment and measures to improve productivity is not rejected. The test was performed by first assessing Equation (10) and then using the residual from the model as the estimate of ε_{im} in Equation (11). Standard censored regression was used to evaluate Equation (11). Exogenous is rejected if the coefficients of the other elements are significant. Since the dependent variable in Equation (10) is distinct, a linear probability approach was employed at the second stage evaluation for valuation and calculation of standard error. Adopting the aforementioned approach involved identification of the exception vector mechanisms. The excluded variables from the regression of investment choice at the second stage for landowner cultivated land by himself serve as dummy variables to display if the farmer's home and the farmland are situated at the same vicinity (village), as well as the distance from the farmland to the farmer's living arrangement. The factors that served as measuring tools of fixed lease occupants' dummy variable are the landowner's home and his rented land located in the same village or otherwise, as well as the distance of the landowner's living arrangement from farmland. (It is significant that apart from increasing the cost of cultivation, more prominent is the long distance between landlord and farmland that can possibly increase the supervising expenses of the farm. Leasing brings about possibly one-sided gauges [15]. In any case, this study, which specifically made this inquiry, found that the sharecrop contract was not directed in the study zone). As suggested by [12], land lease decisions may be directed by heterogeneity of marginal differences of the landowner, which depends on the qualities of the landowner. Investment decisions of a tenant, nevertheless, do not depend on the individualities of the landowner.

3. Results

3.1. Farm-Level Evidence

The difference between yield and input of these rental agreements were examined in this study. Table 1 tabulates the differences in production characteristics, inputs and other levels of the farm, as well as the household attributes of land cultivated by the owner and share-lease agreement. The table lists the t value and degree of freedom (df) of the mean difference between owner and share-lease agreement in the context of household and farm attributes to indicate the significance level. Mostly variables assumed the equal variances except seed per hectare, government special credit facility, extension contract, irrigation facility, and soil fertility. In detail, yield per hectare was 10.84% higher in owner cultivated land than that of sharecrop lease agreement with 1% significance level.

Table 1. Comparison of characteristics between owner and sharecroppers.

Variables	Owner		Sharecroppers		Mean Differences	T-Value	Df
	N	Mean	N	Mean			
Yield per hectare (kilograms)	120	3713.9880	58	3311.21	402.78 ***	3.87	176.00
Average income per hectare (Pak rupees)	120	113,004.08	58	100,200.48	12,803.59 ***	3.88	176.00
Profit per hectare (Pak rupees)	120	70,062.60	58	62,124.29	7938.31 ***	3.87	176.00
Size of the farm (hectares)	120	5.08	58	3.83	1.26 **	2.53	175.30
Organic experience in years	120	5.28	58	4.67	0.61 ***	3.66	176.00
Organic manure used in wheat (kilograms/hectares)	120	5241.49	58	4673.02	568.47 ***	3.87	176.00
Green manure used in wheat (Leguminous crops)	120	2.07	58	1.84	0.22 ***	3.54	176.00
Seed per hectare (kilograms)	120	125.66	58	121.81	3.85 **	2.00	95.65
Hired labour at the farm (days)	120	19.01	58	16.98	2.03 ***	3.87	176.00
Family labour at farm (days)	120	10.56	58	9.38	1.18 ***	3.87	176.00
Respondent have livestock	120	0.84	58	0.81	0.03	0.52	176.00
Age of the respondent	120	42.78	58	46.40	3.62 *	−1.75	176.00
Education of the respondent (years)	120	7.37	58	7.72	−0.36	−0.50	176.00
Govt. provide the special credit facility	120	0.34	58	0.19	0.15 **	2.25	133.50
Extension contract	120	0.83	58	0.43	0.40 ***	5.44	88.98
Farm has the water pump/tube well irrigation facility	120	0.91	58	0.78	0.13 **	2.16	84.03
Rate the soil fertility of your farm	120	0.88	58	0.72	0.15 **	2.27	87.92
Farmer practice crop rotation	120	0.88	58	0.81	0.07	−0.26	176.00

*, **, *** show the level of significance at 10%, 5%, and 1%, respectively.

Almost all kinds of raw materials application displayed significant difference between owners and sharing agreement cultivation. Variance in the use of organic manure in two types of farming systems was more distinct, as the owner used 5241.49 kg per hectare when compared with 4673.02 kg per hectare for sharecropper. Use of green manure was 11.11% higher for cultivation by owner than sharecropper, along with use of more seeds. Hence, soil improvement and increase in yield products were noted more for land cultivated by owner than that cultivated by sharecrop agreement.

Other household and farm attributes were included in the multivariate analysis, such as marginally low soil quality in share-lease contract, as signified in Marshall's inefficiency assumption. A significant variance was also observed in farmland size, use of labour, and education between the two systems. In particular, farm size under owner's cultivation was, on average, higher than that under share contract, while sharecropper was more educated than owner because OF is unacceptable amidst layman. Owned farms used higher family and hired labour (10.56 and 19.01 days/ha) than did those on a share contract (9.38 and 16.98 days per ha). The findings evidently suggested that 34% of owner-farmers had credit access, and only 19% of sharecroppers had that facility.

Table 2 shows the comparison of fixed rent and sharecrop contracts, crop yield was significantly lower in share contracts than fixed rent contracts; the lower level of yield in sharecroppers is also steady in the Marshall's theory of inefficiency. Under the fixed rent agreement, hefty amounts of organic and green manures were applied on the ground despite the shorter fixed renter agreement period than

that of sharecropper. However, sharecroppers intend to have lives stocks, but this difference is not significant. Only three variables (organic farming experience, and use of green manure and extension services) did not assume the equal variance hypothesis under Levene's test.

Table 2. Comparison of characteristics between fixed renter and sharecropper.

Variables	Fixed Renter		Sharecroppers		Mean Differences	T-Value	Df
	N	Mean	N	Mean			
Yield per hectare (kilograms)	123	3485.18	58	3311.21	173.98 *	1.80	179.00
Average income per hectare (Pak rupees)	123	105,074.64	58	100,200.48	4874.16	1.57	179.00
Profit per hectare (Pak rupees)	123	65,146.31	58	62,124.29	3022.02	1.56	179.00
Size of the farm (hectares)	123	4.28	58	3.83	0.46	1.58	179.00
Organic Experience in years	123	4.93	58	4.67	0.25	1.07	163.88
Organic manure used in wheat (kilograms/hectares)	123	4918.63	58	4673.02	245.61 *	1.80	179.00
Green manure used in wheat (leguminous crops)	123	1.96	58	1.84	0.11 **	2.04	100.64
Seed per hectare (kilograms)	123	124.89	58	121.81	3.08	1.64	179.00
Hired labour at the farm (days)	123	17.80	58	16.98	0.81 *	1.66	179.00
Family labour at farm (days)	123	9.85	58	9.38	0.47 *	1.68	179.00
Respondent have livestock	123	0.80	58	0.81	−0.01	−0.21	179.00
Age of the respondent	123	44.52	58	46.40	−1.88	−0.91	179.00
Education of the respondent (years)	123	7.13	58	7.72	−0.59	−0.82	179.00
Govt. provide the special credit facility	123	0.16	58	0.19	−0.03	−0.45	179.00
Extension contract	123	0.69	58	0.43	0.26 ***	3.40	104.70
Farm has the water pump/tube well irrigation facility	123	0.81	58	0.78	0.04	0.58	179.00
Rate the soil fertility of your farm	123	0.77	58	0.72	0.05	0.70	179.00
Farmer practice crop rotation	123	0.84	58	0.81	0.03	0.45	179.00

*, **, *** show the level of significance at 10%, 5%, and 1%, respectively.

Table 3 shows the comparison of contracts between owner and fixed rent. For owners who cultivated land (3713.99 kg), the yield per hectare was 6.16% higher than fixed renters (3485.19 kg) at the 5% significance level. Owners had more raw materials per hectare than fixed tenants did. Organic and green manures, as well as labour, were widely applied on land cultivated by owners. Land cultivated by owners was more fertile than land under fixed lease agreement, thus owners reaped higher yield per hectare.

Table 3. Comparison of characteristics between owner and fixed renter.

Variables	Owner		Fixed Renter		Mean Differences	T-Value	Df
	N	Mean	N	Mean			
Yield per hectare (kilograms)	120	3713.99	123	3485.18	228.80 **	2.86	241.00
Average income per hectare (Pak rupees)	120	113,004.08	123	105,074.64	7929.43 ***	3.22	241.00
Profit per hectare (Pak rupees)	120	70,062.60	123	65,146.31	4916.29 ***	3.21	241.00
Size of the farm (hectares)	120	5.08	123	4.28	0.80	1.57	241.00
Organic experience in years	120	5.28	123	4.93	0.36 ***	2.79	241.00
Organic manure used in wheat (kilograms/hectares)	120	5241.49	123	4918.63	322.87 **	2.86	241.00
Green manure used in wheat (leguminous crops)	120	2.07	123	1.96	0.11 **	2.29	241.00
Seed per hectare (kilograms)	120	125.66	123	124.89	0.76	0.55	241.00
Hired labour at the farm (days)	120	19.01	123	17.80	1.21 ***	3.01	241.00
Family labour at farm (days)	120	10.56	123	9.85	0.70 ***	2.98	241.00
Respondent have livestock	120	0.84	123	0.80	0.04	0.91	241.00
Age of the respondent	120	42.78	123	44.52	−1.75	−1.10	241.00
Education of the respondent (tears)	120	7.37	123	7.13	0.24	0.41	241.00
Govt. provide the special credit facility	120	0.34	123	0.16	0.18 ***	3.27	224.63
Extension contract	120	0.83	123	0.69	0.14 **	2.63	232.83
Farm has the water pump/tube well irrigation facility	120	0.91	123	0.81	0.10 **	2.16	224.81
Rate the soil fertility of your farm	120	0.88	123	0.77	0.10 **	2.11	230.94
Farmer practice crop rotation	120	0.88	123	0.84	0.05	1.03	237.92

, * show the level of significance at 10%, 5%, and 1%, respectively.

3.2. Econometrics Estimation

This segment elaborates the outcomes of the multivariate analysis regarding the impact of land tenure arrangements on demand for input materials and productions by weighing in the characteristics of farms and households. In meeting the research objective, the effects of land holding systems on soil improvement and productivity investment measures (organic and green manures) and yield were determined via demand of input analysis by employing multivariate tobit model. The output delivery function used to capture the effect of lease on performance was measured using the instrument's volatile method to account for the eventual endogenous nature of the lease.

3.2.1. Land Tenure Arrangement and Investment

The regression (first phase) for land tenancy contracts on farm and household attributes was based on Equation (10), while Table 4 lists the instruments used in the regression (second phase) of investment. Sharecropper category was omitted, and the specifications were evaluated as a linear probability model. The characteristics of farm and household were estimated to be related to the variables of land lease arrangement. It is noteworthy to emphasise here that significance variables, including farmland distance from owner's home, as well as landlord's home and farmland, are situated at the same village and were indicated by a dummy variable. These are factors that served as identification tools in the estimation. The table incorporated the F-test of these instruments (location and distance) on joint significance in the leasing regime regression. The hypotheses in both regressions indicate that they are rejected if they are equal to zero at 1% significant level. The findings signified that plots far from the landlord's home were unlikely to be cultivated by the owners, but more likely to be fixed rentals. Likewise, agriculture land in the same village as the residence of the landlord was more probably cultivated by himself. These lands most probably adopted sharecropping than fixed rentals. Landowners prefer sharecropper schemes to fixed rentals if their agriculture land is closer to their residency, which enables them to monitor the activities performed by the agents.

Table 4. Determinants of land use rights estimated by linear probability model.

Variables	Fixed Renter		Owner	
	Coefficient	T-Value	Coefficient	T-Value
Farm size	−0.096 *	−1.18	0.019 ***	2.50
Soil fertility	0.094 *	1.28	0.134 **	1.89
Tube well	0.090	1.07	−0.181 **	−2.25
Extension services	0.048 *	0.75	0.209 ***	3.42
Household size	−0.003	−0.02	−0.005	−0.37
Age	−0.002 *	−0.95	-0.004 *	−1.58
Education level	0.011	0.16	0.003	0.50
Livestock	−0.058 **	−1.77	0.060 **	1.84
Organisation member	−0.097	−1.58	0.100 *	1.71
Tractor	0.076 *	0.80	−0.026	−0.29
Tillage	0.060	0.64	0.096	1.07
Harvester	−0.165 **	−2.16	0.049	0.67
Organic experience	0.021	0.72	0.076 ***	2.77
Distance	0.069 **	2.09	0.081 **	2.28
Farm location	0.153 **	1.92	0.016 **	2.20
Region	0.089 ***	2.40	0.033	0.92
p-value	0.000		0.000	

*, **, *** show the level of significance at 10%, 5%, and 1%, respectively. *p* value in square brackets.

Table 5 presents the outcomes obtained from the second phase of the investment using Equation (11). Sharecropper was omitted to further explore the Marshall's theory of inefficiency. The model also evaluated the effect of land tenure arrangements on the pattern of investment, family control, and farm characteristics. The table shows the results of correlation coefficient (p) of jointly significance with likelihood ratio test and rejected null hypothesis that was uncorrelated with investment norms, which

highlights the effectiveness of multivariate tobit model over a p-rate tobit model. The residual variables (RESO and RESF) were retrieved from the first stage regression of owned cultivated farm and fixed rent lease, which were statistically insignificant at the investment level. No deviation was noted from concurrency and its coefficient was always consistently estimated [37]. The $\chi 2$ statistics for Wald test for these residual vectors are presented in the table.

Table 5. Investments in land-improving measures estimation by multivariate tobit model.

Variables	Organic Manure	T-Value	Green Manure	T-Value
Owner	0.417 **	2.41	0.359 **	2.31
Fixed rent	−0.278 **	−2.43	−0.213	−1.24
Farm size	−0.043 *	−1.44	−0.121 *	−1.83
Soil fertility	0.188 *	1.5	0.151 **	1.81
Tube well	0.205 *	1.78	0.261	0.53
Extension services	0.316 *	1.95	0.194	0.75
Organisation member	0.159 ***	2.51	0.095 *	1.97
Household	−0.288	−1.06	−0.027	−1.01
Age	0.039 **	2.33	0.042 *	1.87
Education level	0.398 *	1.52	0.029 *	1.58
Livestock	0.976 ***	3.26	0.263 **	2.39
Tractor	0.630 *	1.29	0.443 **	2.75
Tillage	0.611 *	1.29	0.14	1.27
Harvester	0.59	1.53	0.069	1.53
Organic experience	0.843 ***	3.09	0.744 ***	2.57
RESF	0.241	0.9	0.127	1.06
RESO	0.041	1	0.191	0.54
Number of observations	301		301	
Cross equation correlation				
pMG	0.575 **	2.68		
X2 significance for joint statistics	121.15 [0.00]			

Location and distance employed as identifying instruments. *p* value in square brackets. *, **, *** show the level of significance at 10%, 5%, and 1%, respectively.

The values show that the null hypothesis, which refers to the residuals of each investment equation equal to zero, cannot be denied; re-confirming the results for individual t statistics. These results affirm the exogenous idea of the renting factors, which is not unusual as land rights are normally procured through inheritance, gift or land purchasing across the sample area. Unlike other regions and countries, individuals are less likely to participate in property activities, such as gaining ownership of land.

Table 5 shows the key coefficients for fixed rental and owner-cultivated variables. The specifications for organic manure and legumes indicated that even after controlling the farm attributes, the coefficients of owner cultivation were positive and varied considerably from the 0% to 5% level, signifying that owners were encouraged to invest more in soil improvement than sharecroppers did. (We did not calculate marginal effects in this study. The authors of [7] noted that tobit estimates depended on the coefficient of marginal effects largely based on the assumption of distribution.) Fixed lease coefficient gave different correlation (signs) and significance. Significantly positive effects on the application of manure, even after controlling for their own livestock and other farm level features, owners applied more manure than other kind of tenure systems. Livestock, access to extension services, and aging factors have positively significant impact on organic and green manure. However, farm size has a negative impact on two kind of manures. Investment in organic and green manures is higher in fertile lands, hence more profitable.

The outcomes displayed that wealth had multiple effects; machinery variables (tractor, tillage, and harvester) were positive and differed from zero for two investment scenarios. Higher education appeared to enhance both the motivation and chances to invest in land improvement and yield-increasing

activities. In assessing the null hypothesis with equal regional effects, the sample likelihood ratio was 121.15 at 1% significant level.

3.2.2. Land Tenure Arrangements and Farm Yield

The result of impact assessment of leasing arrangements on agricultural productivity is presented in Table 6. The evaluation of probit regression in the first stage covered rental agreement in light of farm and household attributes, as well as identification instruments. (A dummy variable—representing if the farmer is living in the same village where the farm was located and the farmer's home distance from the farmland—was used as an identifying instrument under owner-cultivated farm. The instrument for fixed renter was captured using dummy variable, which showed if the landowner was living in the same village where the agriculture land was located and the distance of the landowner's home from the farmland.) The projected values of the regression (first phase) for lease arrangement variables were applied in productivity features to control the endogenous rental variables. Evaluation outputs of the yield determinants in Table 6 display that owner-cultivated and fixed lease contracts had positive and statistically significant per hectare yield. This showed that after adjusting the other factors, the outcomes continued to be lower for sharecropper when compared to fixed renter and owned cultivation. This offers auxiliary backing to the Marshallian inefficiency hypothesis, as share contracts seemed to be less effective than the other two types of arrangement, mainly because the incentive scheme anticipates only a fraction of the minimal yield at certain level of investment. Thus, education and access to extension services exhibited positive and statistically significant impacts.

Table 6. Determinants of farm yield estimation.

Variables	Coefficient	T-Value
Owner	0.459 **	1.97
Fix renter	0.591 *	1.48
Organic manure	0.706 ***	3.10
Green manure	0.270 *	1.43
Family labour	0.575	0.98
Hired labour	0.706	1.18
Farm Size	0.726 **	1.83
Soil fertility	0.137 **	2.40
Household	0.138	0.18
Education level	0.539 **	2.69
Age	−0.123 *	−1.98
Organic experience	0.572 **	2.06
Tube well	0.135	1.33
Tractor	0.546 ***	2.11
Tillage	0.194	0.42
Harvester	0.307	0.82
Livestock	0.549 ***	2.52
Credit facility	0.260 *	1.77
Extension services	0.289 **	1.88
Organisation member	0.152 *	1.51
Region	0.188	1.10
Cons	0.367 ***	2.50
R2	0.883	
Adjusted R2	0.806	
p Value	0.00	

*, **, *** show the level of significance at 10%, 5%, and 1%, respectively.

4. Discussion

Land tenure system (owner, fix renter, and sharecropper) affects investment and farm productivity. Crop yield was significantly lower in share contracts than owner-cultivated and fixed rent contracts;

the lower level of yield in sharecroppers is also steady in Marshall's theory of inefficiency. This perception shares the view that since tenants in fixed lease agreements have to bear a higher cost of land, they attempt to reap higher yield. This similar scenario was observed in conventional farming, as they relied on fertilisers heavily; thus, the same pattern was found in OF. Compared to fixed tenants, sharecroppers gained lower yield per hectare, which proves Marshall's assumption of inefficiency that tenants are less involved in the production process because they only receive maximum share of output at a given level of investment. It was discovered that fixed renters and sharecroppers faced problems to get credit which lead to reduced investment. Nguyen, Bauer [9] asserted that the accessibility of credits explicitly depends on the security prerequisites from institutional sources or indirectly rely on the priority of the protected borrower-owner. Almost all landlords who received institutional loans in the survey area used land as security, which highlights the importance of land as guarantee for institutional credit.

Another positive effect of land ownership on soil-improving measures and investment is in agreement with moral hazard and land use rights. As noted earlier, tenants uncertain of their future benefit from investment in the medium and long term, due to informal arrangements, will tend to reduce their investment in such activities. Similarly, moral issues may arise due to incentive pattern that forces farmers to share crops with landowners, thus reducing both productivity and investment. The positive impact of land ownership on investment in soil improvement measures is in line with the following results reported by Nguyen, Bauer [9] within the context of Thailand. Particularly in OF, the use of manure is a basic need and owner invested more in manure because they are convinced that investments have a long-term effect on land productivity. Although fixed renters had lower number of livestock than owners and sharecroppers did, they could still get manure from the market for cultivation purposes. Jacoby and Mansuri [33] claimed that inadequate assurance from landowners that led to uncertainty of land tenure resulted in reduction of soil-improving activities in rural Pakistan. This projects a necessary condition to own livestock, but inadequate conditions for investment, but more use of organic and green manures under owner's cultivation gave consistent results, similar to those reported by Deininger and Ali [7] for Uganda, and Jacoby and Mansuri [33] for Pakistan. With an increment in farm size, the farmers were less likely to meet the manure needs of farming, which is in agreement with that reported by Deininger, Ali [29] for Ethiopia. On the contrary, Lovo [10] found that the use of landfills in large plots was less than small farm.

Extension services also encourage to invest in organic and green fertilisers and supported the concept of social networks to promote information flow among farmers, thus the increasing investment in agricultural technology [38]. Experienced farmers claimed that they invested more in land improvement to enhance productivity, moreover, adaptation of OF demands higher cost for soil improvement to enhance soil fertility. Farmland that receives higher levels of improvement investment through the use of manure in the long term, particularly green manure, seemed to contradict the findings reported by Lovo [10], who asserted that older possession of land is equated to low investment in land improvement for conventional farming, but this differs for the OF scenario. The regional effect t reflects climate change and availability of infrastructure, in addition to uncovering the variances in the regulation of regional land use rights agreements [39].

The land tenure system also showed impact on overall productivity of farm. The statistically significant difference of productivity per hectare portrayed by share contract arrangement is in line with the findings reported by [5], who stated that share contract land arrangements were less productive than owners. Similarly, Goldstein and Udry [40], in the context of Ghana, claimed that due to insecure land use rights, many potential outcomes in the sample area were lost. However, Place and Otsuka [35] and Arcand, Ai [12] reported results that negate the above findings due to absence of statistically significant impact of land arrangements on yield. Jacoby and Mansuri [15] described that the protection of output via sharecropper required considerable landowner control to avoid ugly behaviours of sharecroppers from emerging. This finding is attributable to the absence of monitoring sharecroppers by the owners across the sample.

The bottom line of the results encouraged to protect the tenants through legal ways instead of informal contracts and introduce some special incentives for tenants to increase investment in inputs. Decisively secure land use rights can play an important role in the sustainable growth of organic farming.

5. Conclusions

The importance of secure land tenure arrangements in social and economic growth of developing countries has garnered the interest of both legislators and researchers. Reforms of agriculture land are often considered as an efficiency enhancement by taking measures to secure land tenure arrangements. This productivity contention has driven many proposals to aid agriculture land reforms, particularly amidst emerging nations. This study had investigated the effects of land use rights on farmers, on land improvement and productivity, as well as on investment decisions for organic agricultural productivity by looking into 301 organic wheat producers in Punjab, Pakistan. In detail, this study evaluated the changes in the farmers' right to organise their land use rights and their investments in light of land improvement and production growth. The gathered information on inputs and outputs suggested that yield per hectare and requirement for inputs, such as organic and green manure and labour, were more significant in owner and fixed renter plots, than the land under sharecrop agreement, which is in agreement with the hypothesis of Marshallian inefficiency. This study has demonstrated that land right security is integral when farmers make decisions concerning investments about land (soil) improvement measures, such as extensive use of organic fertilisers and leguminous crop cultivation. The owner-farmer with secure rental arrangement invested more to improve both land and productivity when compared to those with insecure lease agreements. Jacoby and Mansuri [33] asserted that fixed renters, who had previously rented, continued to invest less in land improvement activities due to the insecure period for insufficient obligations.

This study provides empirical support for the assumption that farmers with land or with secure land rights are more fruitful than those with insecure lease agreements. The reason for higher productivity amidst owned plot than the parallel sharecropper is that the sharecropper only receives a portion of the marginal yield at a particular use of input level. Such lower reap of profit leads to lower investment for land improvement technology. Since high supervision costs in Pakistan have been viewed as a hurdle to landowners in controlling their sharecropper, less initiative is taken by these sharecroppers that eventually causes lower yield. Haider and Kuhnen [22] proposed a method of avoiding the Marshall's ineffectiveness with farmers in Pakistan's agricultural arrangements by turning share contract into fixed lease agreement. This offers better incentive structure for share contractors to invest more in technology, so as to boost productivity.

Inclusively, the outcomes are effective collectively, as they suggest that improving the responsibilities of landowners can reduce the risk of failure in dealing with renegotiation and rental agreements. Hence, more formal contractual arrangements which protect the right of tenants are needed to improve efficiency, apart from urging farmers to increase their investment and productive activities in enhancing organic agricultural productivity through secure land arrangements.

Author Contributions: M.W.A. and W.H. conceptualized the idea of the study design, performed statistical analysis, and wrote the manuscript. N.A., S.A., U.K., K.u.R. and A.M. helped in the data collection and provide their intellectual insights.

Funding: Chinese scholarship council and Northeast Forestry University.

Acknowledgments: We would like to acknowledge the Lok Sanjh Foundation Pakistan, for providing technical data related to this study.

Conflicts of Interest: The authors of this research declare no conflict of interest.

Appendix A

Table A1. Descriptive statistics.

Variables	Description	Mean	Std. Deviation
Education (Years)	Number of years schooling	7.34	4.52
Age	Age of respondent number of years	44.19	12.75
Household size	Number of family members	6.88	1.84
Tillage	Respondent owns tillage; Yes = 1, No = 0	0.60	0.49
Tractor	Respondent owns tractor (2W); Yes = 1, No = 0	0.76	0.43
Harvester/thrasher	Respondent owns harvester/thresher; Yes = 1, No = 0	0.48	0.50
Livestock	Respondent owns livestock; Yes = 1, No = 0	0.82	0.39
Organisation member	Respondent is a member of any agriculture organisation; Yes = 1, No = 0	0.38	0.49
Credit access	Respondent has the credit facility from Govt.; Yes = 1, No = 0	0.24	0.43
Distance from residence (km)	Distance of farmland from the respondent's house	2.78	1.88
Farm location	Farm located in same village; Yes = 1, No = 0	0.69	0.46
Farm size (hectares)	Size of farmland in hectors	4.51	3.72
Soil fertility	Farmland is considered as fertile; Yes = 1, No = 0	0.80	0.40
Tube well/water pump	Respondent owns tube well/water pump; Yes = 1, No = 0	0.84	0.36
Organic experience in years	Respondent's experience in organic farming	5.02	1.04
Organic manure used in wheat (kg)	Organic manure use in kg	5000.02	908.30
Green manure used in wheat (leguminous crops)	Number of leguminous crops cultivated in a year	1.98	0.37
Yield per hectare kg	Yield per hectares in kilograms (kg)	3542.88	643.55
Hired labour at the farm (days)	Number of hired labour days other than family	18.12	3.24
Family labour at farm (days)	Number of family labour days other than hired labour	10.04	1.89
Average sale for per hectare (PKR)	Sale price multiple with hectare yield (PKR)	107,296.67	20,297.81
Average total expenses for per hectare wheat (PKR)	Total expenses for one hectare of wheat	40,772.73	7713.15
Profit per hectare (PKR)	Total sale of per hectare minus cost of per hectares (PKR)	66,523.98	12,584.65
Seed per hectare (kg)	Seed used in one hectare (kg)	124.60	11.35
Extension Services	Respondent have the access to extension services; Yes = 1, No = 0	0.70	0.46
Crop rotation	Respondent practice crop rotation strategy; Yes = 1, No = 0	0.85	0.36

Table A2. Selected region for research.

Region	Frequency	Percent	Valid Percent	Cumulative Percent
Toba Tek Singh	102	33.9	33.9	33.9
Jhang	98	32.6	32.6	66.4
Khanewal	101	33.6	33.6	100.0
Total	301	100.0	100.0	

Table A3. Types of land tenure rights.

Land Rights	Frequency	Percent	Valid Percent	Cumulative Percent
Owner	120	39.9	39.9	39.9
Fixed rent	123	40.9	40.9	80.7
Sharecropper	58	19.3	19.3	100.0
Total	301	100.0	100.0	

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