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Analysis of the Effect of Land Fragmentation on Crop Productivity in Jiroft, Iran

Mahdi Sabati GAVGANI[*1], Davood MOHAMMADZAMANI[2]

[1]Department of Agricultural Mechanization,Jiroft Branch,Islamic Azad UniversityJiroft, Iran
[2]Department of Agricultural Mechanisation, Takestan Branch, Islamic Azad University, Takestan, Iran

[*]Corresponding author: sabati1073@gmail.com

ORCID: 0000-0002-4585-9199[*]

Abstract

Agriculture plays a key role in the economy of Iran. However, its growth is decreasing in the recent past due to land fragmentation. It is a constraint for agricultural productivity. The study aims at analyzing the impact of land fragmentation on productivity and profitability of crops. The primary data were collected from 120 farmers of rural area of Jiroft. This study calculated the extent of land fragmentation by using Simpson index. Production function was employed to estimate the impact of land fragmentation on the crop productivity. The results suggested that higher the land fragmentation of the farms, negative is the impact on the productivity. The findings of the study have important implication for formulating of efficient land use policy.

Keywords: Agriculture, Constraint, Impact, Simpson Index

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INTRODUCTION

In Iran, agriculture sector's share is almost 8.3 percent in Gross Domestic Product (IRNA) and employs almost 24.7 percent of total labour force. However, with the passage of time, share of agriculture is decreasing and most of the people are suffering with low level of employment in this sector (IRNA, 2021).

Agriculture productivity is a significant determinant of Iran's economy. The foremost element for agricultural production is land which has a substantial value in rural areas due to its leading role as a sign of economic, social and political status. Land is a fixed and immovable natural resource that employed as a source of earning. Land also works as a safety against risks and shocks. Even though, land is the main strength in rural areas Iran, but its distribution is highly asymmetric (Ansari;TahmasebiNejad and Salami, 2018) and ownership is shrinking quickly due to fragmentation.

Land fragmentation refers to the existence of separate number of plots of same landowner at different places and they can be framed as single units. Agricultural fragmented land is a complicated phenomenon comprises on five aspects such as total fragmented plots, size of plot, topography and distance from the farm buildings of plots and plot scattering (Ashtiani, 2014).

Agricultural land fragmentation is widespread throughout the world resulted from social, political, institutional and historical factors such as land reforms, inheritance laws, consolidation, housing schemes, transaction costs and personal valuation of land ownership (Latruffe and Piet, 2014).

It has both positive and negative effects on agricultural productivity and efficiency. If the production strategies, price level of different inputs and production level are in favour of land fragmentation, then it does not affect agricultural efficiency but if this condition does not prevail then this leads to low efficiency of agriculture (You, 2010). Land fragmentation has great influence on the economic growth development of an economy and leads to subsistence agriculture. Economic growth and development are linked with mechanization, but land fragmentation is a big constraint for it (Mcpherson, 1982).

Land fragmentation is also common in Iran which is a main reason for low agricultural productivity, such as due to continued process of land fragmentation almost, 68 percent of total farms or about 80 percent of the cultivated area has become small, subsistent and below subsistent level farms where modern advanced technology for increased crop production cannot be effectively applied. In Iran, per capita arable landholding is only 0.2 ha (IRNA, 2021).

Studies on land fragmentation has analysed the determinants of land fragmentation (NajibiKhairabadiet al., 2010), impact of land fragmentation on land productivity (Kadigi et al., 2017), production diversification (Ciaian et al., 2018), technical efficiency (Jha et al., 2005), cost of production (Villanueva and Colombo, 2017), inefficient use of inputs and labor force availability (Nguyen et al., 1996; Shuhao et al., 2008). However, the findings of these studies are mixed as its effects are specific to each case. Keeping in view the importance of this subject area of research, the aim of this study to investigate the impact of land fragmentation on crop productivity and provide guidance for policy makers on land consolidation measures to promote agricultural sustainability.

MATERIAL and METHOD

Study area

The geographical location along with topographic condition has made Jiroft a diverse climate. Climatic conditions, fertile soils, and surface and groundwater resources have provided the basis for the production of millions of tons of tropical and cold products; So that, since a long time ago Jiroft has always been a very important center of agriculture in the country.

In this study, primary data were collected from wheat and Potato growers of Jiroft district in 2019. Potatoes are planted in early fall and wheat in early winter. In Southern Iran, there are two cropping seasons, Autumn and winter. Autumn starts from November and winter from January. Data were collected through multistage random sampling technique. Four administrative divisions of the district were selected. From each administrative division, two villages were selected randomly. A total of 120 farmers (small, medium and large) were selected following a multistage stratified random sampling procedure.

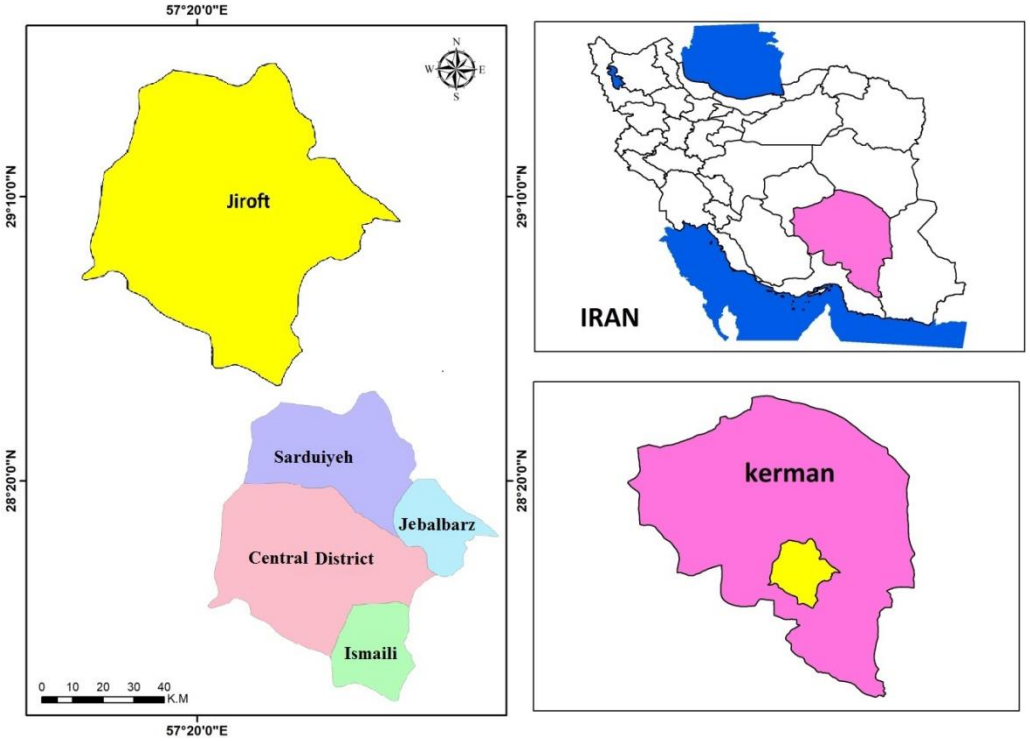

Figure 1. Geographical location of Jiroft

The results of the present article can be used by regional and national managers and policymakers on crop productivity in Jiroft .

The following formula was used to determine the sample size for the present study.

$$n = \frac{(P(1-P)Z^2}{e^2}$$

n: represents the total sample size selected for the study.

P: represents the estimated proportion of population being farmers. It was hypothesized that 60 percent of the rural population are engaged in agricultural sector.

Z: is the level of confidence according to the standard normal distribution. The present study considered 5 percent probability level (Z = 1.96)

e: is the tolerated margin of error set at 9 percent for this study. Putting these values in the formula yields a sample size of 114 respondents for the present study which, for ease of calculations, is increased to 120 respondents.

Descriptive statistics

The socioeconomic characteristics of farmers such as age, education family size, farm size, and input costs etc. are provided in Table 1.

Table 1. Summary statistics of the important variables

Variables	**Definition of Variables**	**Mean**	**S. D**
Output	Output value per hectares in rials	1405896.4	1215867
Age	Age of the household head in years	48	12.45
Education	Number of schooling years of household head	8.35	6.46
Family Size	Total household members	8.01	3.45
Farm Land	Total farm land in acres	15.41	13.35
Fertilizer cost	Expenditures on fertilizers in rials	16921.25	18222.25
Seed cost	Expenditures on seed in rials	230006.35	24731.05
Labor cost	Expenditures on hiring labor in rials	9770.85	11314.4

Net return, gross return and total cost of all three categories of farmers

Gross return, total cost and net return for wheat and potato producers were calculated. The average net return, gross return and total cost per hectares of Wheat farm consumed by all three categories of farmers are indicated in Table 2.

Table 2. Net return, Gross Return and Total Cost per Acre of Wheat Growers

Wheat Farmer Category	**Average Gross Return/Hectares (Rials)**	**Average Total Cost / Hectares (Rials)**	**Average Net Return / Hectares (Rials)**
Small	228500.25	22280.13	570.12
Medium	23773.09	23069.37	703.5
Large	23042.25	22896.36	145.38
Overall	23222.03	22748.47	473.04

The total gross yield per hectare for small, medium and large farmers was 22850.25, 23773.09 and 23042.25rials, respectively. Similarly, for the average total cost per hectare, they consumed 22280.13, 23069.37rials and 22896.36rials, respectively. The average net yield per hectare for small, medium and large farmers was 570.12, 703.5 Rials and 144.38 rials, respectively.

The average net return, gross return and total cost per acre of Potato farm consumed by all three categories of farmers are indicated in Table 3.

Table 3. Net return, Gross Return and Total Cost per Acre of Potato Growers

Potato Farmer Category	**Average Gross Return/Hectares (Rials)**	**Average Total Cost / Hectares (Rials)**	**Average Net Return / Hectares (Rials)**
Small	40166.66	23904.48	16262.18
Medium	46887.82	33292.31	13595.51
Large	46450	40888.13	5561.87
Overall	44501.49	32694.97	11806.52

The total amount of gross return per hectares was rials40166.66for small farmer, rials46887.82for medium farmers and rials46450 for large farmers. While, these three group of respective farmers were consumed rials23904.48, rials33292.31and rials40888.13of average total cost respectively. The price for average net return per hectares was rials16262.18, rials13595.51and rials5561.87respectively by small, medium and large farmer. The overall result showed that the large farmer had more average gross return per acre that gained least profit as compared to the others.

Model specification

Analysis in which semi-logarithmic equation can be used to check the multiple linear regression model variables estimation results.

Ln Y=β0i + β1iSI +β2iEH + β3iAH + β4iFS + β5iFS +β6iSC+ β7Ifs+ β8Ilc+ vi ……..…(1)

Y= βo + β1 (Simspon Index) + β2 to βnare socio-economic variables + vi (Disturbance term) With; βoi,…,β8i are unknown coefficients,vi is adisturbance term with standard properties, and i=1,…,120.

A spatial problem is fragmentation of land which depending on many facts, factors and parameters. Six relevant factors were cited by King and Burton (1982): number of parcels that belongs to holding, holding size, shape of every parcel, size distribution of parcel and the spatial distribution of parcels. In Iran, there are large complexions are present in land fragmentation. In this way, few roads are present to access parcel and ownership rights have many problems. For example, undivided shares that are owned to parcel, i.e. it may belong to more than one landowner; or a parcel may have dual or multiple ownership, i.e. the land is owned by one person whilst the trees growing on the land are owned by someone else and a third party has ownership rights to the water. In addition, a land parcel may not have a title deed. The existence of all these different factors highlights the complexity of representing and measuring land fragmentation. For measuring and representing the land fragmentation are used Simpson index, Average plot distance and Farm Size. Simpson's land fragmentation index formula are as follows:

$$SI = 1 - \frac{\sum_i^n ai^2}{(\sum_i^n ai^2)^2} \quad \text{…….. (2)}$$

Where;

n: is denoted by number of plots

ai: is denoted by area of each plot.

Simpson index (SI) Value lies between the zero and one, 1 degree value of SI indicating the lower degree of land fragmentation and near to zero-degree value of SI indicating that higher degree of land fragmentation.

Simpson Index value can be determined by the average plot size, the number of plots and the plots size distribution. Distance to the plots and farm size cannot be captured by the SI. Distance between each parcel and the effect of economies of scale are captured by using the average distance of plots to the homestead and farm size within a farm.

Production function approach

In order to estimate the impact of land fragmentation on crop productivity, production function approach was used here. The typical examples of production function in literature are Cobb-Douglas and Translog production functions. Despite the well-known limitation, the Cobb-Douglas production form is used in this study because it has the advantage of being easily interpreted in economic term and has achieved widespread support from data of various industries, including agriculture and for various countries.

Thus, a typical Cobb-Douglas production function is specified as:

$$lnY_i = \sum_j \alpha_j \, lnX_{ij} + \sum_k \beta k + \varepsilon_i \text{……(3)}$$

Where; Yi: represents the total value of agricultural output of farm household i.

Xij: is the quantity of input j used by farmer i.

α and β are input intensity parameters that represent the elasticities of output with respect to the individual inputs.

εi: is the error term summarizing the effects of omitted variables.

The variables included in the vector Xij are age, education of the household head, family size, farm land, fertilizer cost, seed cost, and labor cost.

RESULTS and DISCUSSION

Results of Simpson's land fragmentation index is givenin Table 4. The value of meanfragmentation indexis 0.62. Results indicated that land fragmentation is more at the small size of farm and very low land fragmentation at the large farm. Thus, it canberevealed that high extent of land fragmentation is linked with the farming of small plots. These results are in line with the study of Sundqvist and Andersson (Sundqvist and Andersson, 2007); Okezie et al., Latruffe and Piet (Okezie et al., 2012; Latruffe and Piet, 2014) who also quantified the degree of land fragmentation by using household level data.

Table 4. Extent of Land Fragmentation in study area

SI Index	No. of Respondents	Farm Size(Hectares)
0.01-0.20	40	1.25
0.21-0.40	45	5
0.41-0.60	32	8.75
0.61-0.80	17	15
0.81-1.00	11	25

The Cobb-Douglas production function approach was used to estimate the impact of land fragmentation and other different socio-economic variables onproductivity of wheat and potato growers. Theindependent variables included in model were farmsize, education, age, family size, total seed cost,fertilizer cost, labor cost and Simpson index. Thedependent variable in the model was productivityvalue of crop output per acre which is employed by previous studies.The value of each cropoutput is estimated by using village level medianprices of the prices that farmers indicate their cropswould currently fetch on the market. This avoids theproblem of using the same set of prices for all farm. The results of production function in Table 5 showsthat the coefficient of Simpson index is negative andstatistically significant, indicating that land fragmentationtends to decline crop productivity. High degree of landfragmentation results in uneconomic sub-division ofland that leads to high cost of production and hindering of mechanization. The results suggested that with the higher land fragmentation of the farms indicating the negative impact of impson index on the adoption of new technology and management practices by improving the requirement of labor for the betterment of the production throughout the year.

Table 5. Econometric Results of the Impact of Land on productivity of Farmers

Variables	Coefficients	T Statistics
Constant	3.24**	3.12
SI	-0.010**	2.60
Edu	0.073*	1.739
Age	0.095	0.930
Family Size	-0.168	1.614
Farm size	0.068*	2.22
Fertilizer Cost	-0.048	2.47
Seed Cost	-0.253	2.68
Labor Cost	-0.131	1.76
R^2	0.39	
Adjusted R^2	0.27	

Regarding socio-economic variables, education appeared to have positive and significant impact of crop productivity.Thus, these results highlighted the human capital theory as indicated by other studies (Kousar and Abdulai, 2015). Coefficient of family size is negative but statisticallyinsignificant.Physical assets of farmers like land appearedto have positive impact on land productivity. It indicates that physical assets of farmers like land appear to be important inputs in the productionprocess. The linkage of farm size and productivity isexpected to be positive because of the existence ofeconomies of scale.

These results offer evidence fromthe previous literature (Kousar et al., 2019). However, the link may not be positive in some cases as some previous isnot consistent on the presence of sucheconomies of scale in agricultural production likereported .The coefficient of expenditures on inputs like fertilizer,seed and labor have expected negative sign, indicating that higher input prices have negative effect on cropproductivity. This is probably due to the fact thatland fragmentation tends to enhance time and costof inputs such as seed, labour, and fertilizers whichin turn decline the crop productivity.

CONCLUSION

Land is important source of minerals, agriculturalconsumables and other primary products and hence,its role is very crucial for agricultural production.Land fragmentation is an arising issue since last twodecades. It refers to the existence of separate numberof plots of same land owner at different places andthey can be framed as single units. Agriculturalland fragmentation is a complicated phenomenoncomprised on five aspects such as number of fragmented plots, plot size, topography and distancefrom the farm buildings of plots and plot scattering. It is a constraint for agricultural mechanization hencetechnological advancement and the resulting economicgrowth. In developing countries like Iran, besidesland fragmentation, uneven distribution of cultivableland is also problematic. Agricultural productivity and profitability may suffer due to uneven distributionand fragmentation of land. The study in hand aims at analysing the impact ofland fragmentation on productivity and profitabilityof crops. The primary data has been collected from 120 farmers of rural area of Jiroft. Respondent were selected using multistage randomsampling technique. Multiple regression was used inorder to meet the set objective by using the collecteddata on the software of Social Package for SocialScientists (SPSS). For measuring and representingthe land fragmentation Simpson index, Average plotdistance and Farm Size were used. Simpson index (SI)value lies between zero and the one, 1-degree value of SI indicates the lower degree of land fragmentationand near to zero-degree value of SI indicates thehigher degree of land fragmentation. Simpson Indexvalue can be determined by the average plot size, the number of plots and the plots size distribution. Theresults suggested that higher the land fragmentationof the farms, negative is the impact of Simpson indexon the adoption of new technology and managementpractices by improving the requirement of labor for the betterment of the production throughout the year.The higher value of the Simpson index regarding labor cost, increases but fertilizer costs reduced,seed costs. While the impact of land fragmentation on the modern technologies and management have a negative effect on the productivity. The findings have important implication for the design of land consolidation programs that will help to employ modern technology. The problems associated with land fragmentation can be overcome by applying the specific land management programs like; voluntary parcel exchange, land consolidation, land funds, landbanking and cooperate farming. This study provides analysis to analyzing the impactof land fragmentation on productivity and profitabilityof crops. Calculated the extent of land fragmentationby using Simpson index. Production functionwas employed to estimate the impact of land fragmentation on the crop productivity. It is critical forimproving Iran’s com-petitiveness in the world market through quality improvement and value addition.

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