# Investigation of Date Palm Production, land ownership and contracting and Farm to Market Distance: A case of small dates growers in district Khairpur

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**Abstract:**

*P*resent *study is an attempt to investigate the empirical relationship of production of dates, type of the farmer, tree holding and the distance of farm to the market in district Khairpur. Cross sectional data has been collected through self-administered questionnaire. Randomly selected 202 small farmers (holding 5 or less than 5 acres of land) were interviewed. The empirical relationship has been established using Ordinary Least Squares (OLS) method of multiple regressions. The results indicate that the farm to market distance has a negatively significant impact on the production of dates. The production of dates has a statistically weak relationship with farms where the farmers grow trees on contract than that of the trees which are owned by the farmers. As per the standardized coefficients, the ownership of the trees by the farmers is the dominant factor affecting the date production rather than the trees taken on contract.*

*Keywords: Dates production, OLS, regression, farm to market distance, tree ownership*

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## 1.    Introduction

In world the date palm is an ancient and famous cultivated tree; it is considered more per hectare food producing tree then other trees. The archeological evidences for cultivation of date palm have been traced back as far as around 7000 B.C., in Mehargarh, Pakistan. Later during the excavation of historical sites in the Indus Valley and evidence of date palm cultivation also found from Harappan period 2600 to 1900 BCE (Susan 2007).

The dates are still produced in all the four provinces of Pakistan. According to the estimates of FAO (2015), the total area under cultivation for date palm has been hovering around 90,000 hectares during 2010 to 2014. Following three tables present 5 years' actual figures on area under harvest (in hectares); yield tons per hectare and production in tons for top seven date producing countries between 2010 and 2014.

**Table No.1.  Yearly and Average Area under harvest for dates in top seven countries (2010 and 2014)**

|  | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
|  | **Algeria** | **Iran** | **Saudi Arabia** | **Iraq** | **Pakistan** | **Egypt** | **Oman** |
| Year | Area Harvested (in Hectares) | | | | | | |
| 2010 | 161091 | 156618 | 155118 | 123000 | 90124 | 41945 | 31353 |
| 2011 | 162134 | 156023 | 156023 | 123230 | 93100 | 41652 | 31348 |
| 2012 | 163985 | 156848 | 156848 | 139944 | 89600 | 38503 | 32374 |
| 2013 | 203496 | 203496 | 156901 | 203496 | 89654 | 37923 | 34195 |
| 2014 | 242632 | 242632 | 107281 | 242632 | 91145 | 44037 | 36255 |
| Average | 186667.6 | 183123.4 | 146434.2 | 166460.4 | 90724.6 | 40812 | 33105 |

**Source:** Online database of Food and Agriculture Organization (www.fao.org)

Above table no. 1 presents the rank of top 7 countries according to area harvested in hectares. Algeria is the country that has allocated highest number of hectares for date production. As an average of 5 years (from 2010 to 2014), a total of 186667.6 hectares have been utilized for harvest of dates. Iran ranks second as far as the harvest of area in hectares is concerned. The average area under harvest for the same period has been 183123.4 hectares followed by Iraq with 166460.4 hectares and Saudi Arabia with 146434.4 hectares. Pakistan ranks number 5th with an average area under harvest around 90724.6 hectares. Egypt and Oman on 6 and 7 number with 40812 hectares and 33105 hectares of land for date's cultivation respectively.

**Table No. 2.  Yearly and Average Yield per hectare in tons of dates in top seven countries (2010-2014)**

|  | Egypt | Oman | Iran | Saudi Arabia | Pakistan | Iraq | Algeria |
|---|---|---|---|---|---|---|---|
|  | Yield hectogram or tons/Hectare | | | | | | |
|  | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 2010 | 322554 | 88159 | 65326 | 63922 | 58147 | 46152 | 40023 |
| 2011 | 329773 | 85495 | 68746 | 64613 | 59858 | 50246 | 44710 |
| 2012 | 363627 | 86799 | 70880 | 65738 | 58550 | 46837 | 48136 |
| 2013 | 350307 | 90190 | 74578 | 69799 | 58754 | 33225 | 51501 |
| 2014 | 332682 | 90578 | 77027 | 71476 | 58939 | 27302 | 56499 |
| Average | 339788.6 | 88244.2 | 71311.4 | 67109.6 | 58849.6 | 40752.4 | 48173.8 |

**Source:** Online database of Food and Agriculture Organization (www.fao.org)

Table no. 2 presents the rank of top 7 countries with regard to the yield hectogram or tons per hectare. The highest yield hectogram has been given in Egypt with an average of 5 years equal to 339788 tons per hectare followed by Oman with 88244.2 tons per hectare. Iran stands third with 71311.4 tons per hectare and KSA stands at fourth position with 67109.6 tons per hectare. Pakistan stands at 5th position with 58849.6 tons per hectare. Given the fertile land and enough of natural resources like underground water availability and weather conditions, the yield may be increased with little attention to the sector from government and nongovernment institutions. Iraq and Algeria have secured 6th and 7th positions respectively with 40752.4 and 48173 tons per hectare.

**Table  No. 3. Yearly and Average production of dates in tons in top seven countries (2010-2014)**

| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
|  | Egypt | Iran | Saudi Arabia | Algeria | Iraq | Pakistan | Oman |
| 2010 | 1352954 | 1023126 | 991546 | 644741 | 567668 | 524041 | 276405 |
| 2011 | 1373570 | 1053870 | 1008105 | 724894 | 619182 | 557279 | 268011 |
| 2012 | 1400072 | 1086600 | 1031082 | 789357 | 655450 | 524612 | 281000 |
| 2013 | 1328468 | 1148500 | 1095158 | 848199 | 676111 | 526749 | 308400 |
| 2014 | 1465030 | 1156996 | 766800 | 934377 | 662447 | 537204 | 328392 |
| Average | 1384019 | 1093818 | 978538.2 | 788313.6 | 636171.6 | 533977 | 292441.6 |

**Source:** Online database of Food and Agriculture Organization (www.fao.org)

Table no. 3 classifies the top seven countries in terms of their production of dates in tons in the same time period from 2010 to 2014. In terms of the production in tons, Egypt ranks first with an average production of 1384019 tons from 2010 and 2014, followed by Iran with an annual average production of 1093818 tons. Saudi Arabia, Algeria and Iraq stand at 3rd, 4th and 5th positions with annual average of 978538.2, 788313.9 and 636171.6 tons respectively from 2010 to 2014. Pakistan ranks at 6th position with average annual production 533977 tons followed by Oman with 292441.6 tons average annual production.

## 2.     Date Production in Pakistan

As already mentioned before the total area under cultivation for dates is 90724.6 hectares with an average annual production of 533977 (tons) Pakistan becomes the 6$^{th}$ largest dates fruit producing country all over the world (FAO 2011). The major areas where dates are produced in Pakistan include Sindh, Baluchistan and some parts of Punjab and Khyber Pakhtunkhwa.

According to the government statistics, out of total area under harvest in Pakistan, 32.5 percent of the area falls in the Khairpur district. Table no. 4, presents the subdivision wise distribution of area under harvest of dates in the district Khairpur.

According to table no. 4, more than 30 percent of the area under harvest in the district is of the subdivision of Khairpur followed by Kingri subdivision where 26.26 percent of the area of the whole district is under harvest for date palm fruit.

Due to the hot and harsh climatic conditions of district Khairpur the date palm (Phoenix dactyliferous L.), grows well and its multiple usage, high nutritional composition as well as environmental advantages make it a good choice for small and medium farmers as a source of livelihood. The dry, hot climate makes the fruit very sweet, supple and juicy (Markhand et al. 2010).

**Table No. 4.  Area of Date Palm Cultivation in District Khairpur 2013-14 (Hectares and Acres)**

| Taluka/Subdivision | Cultivated Area | | |
|---|---|---|---|
| | Acres | Hectares | % |
| Khairpur | 23164 | 9374.15 | 31.81 |
| Kot Diji | 12938 | 5235.83 | 17.77 |
| Kingri | 19118 | 7736.79 | 26.26 |
| Gambat | 10397 | 4207.52 | 14.28 |
| Sobho Dero | 4532 | 1834.04 | 6.22 |
| Thari Mirwah | 2243 | 907.71 | 3.08 |
| Naro | 212 | 85.79 | 0.29 |
| Faiz Ganj | 205 | 82.96 | 0.28 |
| **Total Area (in Acres)** | **72809** | **29464.80** | **100** |

**Source:** Agriculture Department Khairpur District(Sindh Agriculture Department 2014).

Present study has been conducted in three subdivisions of the district namely; Khairpur, Kingri and Kot Diji. These three subdivisions or talukas cover more than 75 percent of the area under harvest in the district for date production. The other subdivisions have been skipped from the study because of the long distances and the financial costs associated with the data collection. In Sindh date palm trees are spread over an area of 32,000 hectares and annual production is more than 250,000 tons. Some researchers have found more than 300 varieties of dates in Khairpur district, so it is considered a biodiversity centre of date palm (Abul-Soad 2011). In Khairpur date palm is cultivated over 22,310 hectares and its annual production is 158775 tons. The main cultivated and producing areas of Khairpur district are Ahmed Pur, Baberloe, Garhi Mori, Kot Diji, Kot Banglo, Kingri, Pir Jo Goth and Therhi etc (Markhand et al. 2010). Famous Dates varieties of Khairpur namely Aseel, Karblain, and Kupro are also considered as best varieties of Sindh.

The rest of the paper is organized as follows. Next section is dedicated to the review of the related theoretical, conceptual and empirical literature followed by discussion on the selected research technique and data collection procedure and quality. Then regression results and estimations would be presented and interpreted. Last section is presenting the conclusion and summary of findings.

## 3.     Land holding and distance to market

According to the Agriculture census of Sindh (Sindh Agriculture Department 2014), the land farm size is divided into three categories; small, medium and large. According to the data, the farm size distribution in Khairpur district entails 55 percent of small size farms, 42 percent of medium size farms and the 2.7 percent of the large farms. The total number of hectares of the size of farm area as given is 69430 hectares. (Ali & Jehangir, 1990). As the cultivable areas in the province are reaching the limit of cropping waste, there a chance remains of the use of culturable waste. The same report claims that there is approximately half a million hectares land that is categorized as the culturable waste but can be cultivated in the province.
The culturable waste area in the khairpur district is approximated as 2757 hectares or (0.5%) of the total cultivable area (172884 hectares). The study has revealed a negative impact on the farm cropping intensity due to farm size. This means higher is the farm holding size in terms of hectares; the lower would be the cropping intensity. Present study expects the same result from the analysis.
Transport system in a country plays a vital role in agriculture and rural development. Presence of logistic facilities gives a confidence to the farmers to take their product and crop to market and gain their profits. The general belief of agro-economists is that poor infrastructure inside the province and absence of farm linking to market roads is the basic reason of backwardness and poverty in the province. It is still unbelievable that in today's modern world the main sources of conveyance and logistics available and sustainable for farmers are animal driven carts and tractors. Because of rough and narrow pavements and bad roads, farmers suffer losses; therefore they are coerced to sell their product to the local trader at a much marginalized rate. This creates a discouraging and demotivating situation for the farmers. Importance of the farm to market roads for agriculture sector can be realized from the fact that all rice mills, petrol pumps, flour mills and other hubs of commercial activities are built along the roads. If roads which are not in good conditions and they are not maintained and managed properly through periodical budgets, all agro industry related activities will drop significantly and rural areas will suffer from poverty. Present study has taken the farm to market distance as an independent variable to check if the distance in kilometers from field to the market has any impact on the produce of the farmers.

## 4.     Review of Related Literature

More than 2000 date's varieties have been reported throughout the world Abdrabo (2013). Some famous historians and scholars are of the view that pre-historically the evidences of the date palm have been found in Indo-Pak subcontinent among them some have quoted that the date palm in north western India spread due to soldiers of Alexander who utilized date fruit as a food and through seeds of dates the trees were grown. Later, due to the troops of Muslim commander Muhammad Bin Qasim initiated the concentrated growth of date in the Indus Valley and Makran region. After excavations of

Moen-jo-Daro (a historical place) the seed stones of dates were also found, which is also indication that the date palm was cultivated here back in 2,000 BC. (Shar, M. U., 2011). Date palm is considered for cultivation in arid and semi-arid and hot climatic regions in the world because of specific requirement for the growth of this fruit. According to the report produced by FAO Plant Production and Protection Paper No. 156 Rev. 1, the suitable combinations of temperature, rain, humidity, light and wind are the most critical environmental factors that determine the region of the date production. It is believed as an important life time crop in most of the world's deserted areas. Keeping in view the criteria for suitability of regions for date production, Pakistan's southern parts like Khairpur (Sindh), Turbat (Baluchistan) or Multan (Punjab) are among the most suitable areas for dates cultivation (Zaid & De Wet 2002). The important dates producing areas in Pakistan are Khairpur and Sukkur in Sindh, Makran and Panjgoor in Baluchistan, D. I. Khan of Khyber Pakhtunkhwa and Jhang, Muzafargarh, Bahawalpur and D. G. Khan from Punjab provinces (Markhand et al. 2010).

Date palm is considered as a multi-purpose tree because it is a rich source of food, shelter (katcha huts), timber products and even all of its parts can be utilized as food, firewood and other byproducts. It is also referred as traditional tree in various countries. Date plantation has remained a big source of earning for the livelihood of the agriculture growers and laborers. Though the top 7 countries as mentioned in the previous tables 1, 2 and 3 are producing almost 90 percent of the dates of the world, nevertheless due to the technical limitations, lack of awareness and non-availability of scientific machinery the post-harvest activities in this important crop suffer a lot, which results in noncompliance with the international regulations and standards for export. Further, the lack of trained labour in the sector also affects the export sector badly (El Hadrami & Al-Khayri 2012).

The Aseel, Dhakki and Begum Jhangi varieties are famous and considered as the best of all date varieties grown in Pakistan. Some authors have investigated that this crop is profitable for growers; but huge investment is required for cultivation of date palm and the poor farmers and growers requires financial resources. Resulting the cultivation and production of the date trees could be increased significantly, this fruit also needs proper categorizing, packaging, storage and transport facilities. Furthermore, the marketing facilities are not developed in the growing areas. There is a strong need to establish modern marketing system to earn higher income for growers (Haider et al. 2013).

(Baloch 2014) researched on economics of date palm production and its development in district Kech, Balochistan province of Pakistan. The study was carried out in 2012-13 by interviewing 64 date palm producers along with a good number of market agents/middlemen to analyze marketing of date palm through a questionnaire using the technique of randomly selected respondents. The data showed that notable production with high quality dates are produced from Turbat and Panjgoor and among the 7-8 good varieties a Begum Jhangi is the highest in cultivation and production of the area. The study showed that among the initial costs the purchase of date palm suckers were found highest followed by fertilizer/FYM and cultivating charges. On the other hand among the marketing expenses the transportation charges were the highest. The total price of Rs.3500/per mound (40kg) was estimated and net income per hectare found Rs.61474 in the area with the benefit ratio of PKR 1:1.27 per hectare.

(Nasir, A. M., & Rahim 2013), investigated regarding the impact of lack of finance on the development of date processing unit in Kech Balochistan through a qualitative study by collecting primary data using data reduction method to find out the way and collected information from different intellectuals using the disproportionate stratified random sampling. As per the theoretical framework a model in which finance is the independent variable and development of date processing unit is dependent variable. This study also

ranked the problems and evaluated that 100 percent growers are facing farm to market infrastructure high transportation costs at highest level. On the other hand there are the lowest market facilities, non-availability of quality seed and shortage of water, lack of date processing facilities and problem of cold storage were ranked at number two. Availability of quality pesticides, high fertilizer and farmyard manure, expenses and availability are also major problems; although the training facilities to growers regarding production, host-harvest handling of fruit, soil testing are also needed. Results show that the most of the high quality date palm producing varieties have yield potential of 40-50 kilograms and average fruit productions is 22 kg per tree and the overall average date palm fruit yield was estimated at 77.29, mounds per hectare, while the production of Hillawi, Aseel and Shamran varieties found up to 81 kg, 79 and 71 kg per plant, respectively at evaluation by (Ahmed 2012). (Ibupoto, 2006), researched that majority (35 percent) of growers showed non-availability of seeds, (20 percent) replied that offshoots are costly, remaining (18.33 and 16.67 percent) showed financial problems and thought similarity in cultivated and recommended varieties, respectively among the respondents in the study area.

(Haider et al. 2013), studied three varieties, Aseel, Dhakki (Pakistan) and Deglet Nour (Algeria) for the effect of different biochemical attributes of date fruits during three edible stages, Using Completely Randomized Design (CRD) experiments, the data was analyzed statistically by one-way analysis of variance (ANOVA) and means were compared for significant differences using Duncan's Multiple Range (DMR) at (p=0.05). The results showed that after observing four internationally accepted stages of development after pollination i.e. Kimri, Khalal, Rutab and Tamar. The dates are mainly harvested, marked and consumed at last three maturing stages. Though, the fruits of three date palm cultivars Aseel, Dhakki (Pakistan) and Deglet Nour (Algeria) were harvested at khalal, rutab and tamar stage to determine total phenolic contents, antioxidant activity, total sugars (sucrose, glucose and fructose) and soluble protein contents. The suggestions of the farmers clearly depict uncertainty in their minds and mistrust on government policies. Nearly all the farmers suggested insurance policy on crop damage and credit facility for date palm farmers, respectively. 91.67 percent suggested the announcement of support price by the government, 73.33 percent suggested effective dissemination of improved production technologies among growers, 68.33 percent had suggested a facilitated extension office for the farmers to get their problem solved, and 48.33 percent suggested demonstration of modern production technologies and involvement of city government to improve the situation. However, among other suggestions came from the growers, the major ones were: improvement in extension services, monthly coordination meeting of extensionists, researchers and farmers, weekly visit of extension officers, crop monitoring by the extension workers, launching campaign for growers to cultivate recommended varieties, trainings of the growers, establishment of storage facilities, training in export quality fruit production and announcement of awards for growers producing quality fruits of date palm.

(Atta 2011) in his study "to explore the date palm market chain and its role in food security and livelihoods of farmers in the South Punjab" has expressed that in the semi-arid and dry areas the tree date palm has great importance due to its natural capability to provide healthful food having carbohydrates, vitamins, minerals along with fuel, shelter and manufacturing of various handicrafts. This study was conducted in 4 union councils among the 34 rural UC's of District Dera Ghazi Khan and purposively selected 3 villages from each union council at random. Ten (10) respondents having at least 20 date trees in the field were selected as respondents from each village through simple random sampling technique. The 120 respondents were interview randomly whereas qualitative data were

carried out through key informants and focus group interview. The respondents of qualitative data were selected through snow ball and convenient sampling techniques. The qualitative data were analyzed using content analysis technique. The study evaluated that people of area were getting handsome profit by preparing various products locally and utilizing the fruit within household and marketing its fruit, getting more profit to improve the living standard as this tree has great potential to improve economic conditions and food safety for growers. His results emphasized to provide training opportunities to farmers. Researcher recommended the government to finance the growers and provide improved varieties for growth of date palm and enhancement of income of date farmers (Atta 2011). Some authors evaluated that the processing, categorizing, sampling and packing of dried dates (*Chuhara*) by women in rural areas of Khairpur Sindh indicated the significant opportunity for empowering rural women. This study was conducted randomly selected 100 women processors from the study area. Data analysis was done using descriptive statistics, Net Farm Income (NFI) and Data Envelopment Analysis (D.E.A) models (Phulpoto et al. 2012).

## 5.      Theoretical literature

It is generally believed that the agriculture reforms from infrastructural development and construction of roads coupled with land reforms are considered as prerequisite for the growth. According to Asian Development Bank Institute Study (Setboonsarng 2008), rural infrastructure and complementary support services have very important role in eradicating poverty. Further the conventional development and growth theories claim two types of interventions to fight rural poverty, which is available in its worst forms in developing countries. These two approaches are "top down" and "bottom up". The bottom up approach is when the farmers are motivated to improve their agriculture produce and send their children for education to work for other sectors. Mechanization and monetization of agriculture sector with easy loan facilities makes it possible for agriculture in the country. From top-down approach, the agriculture can be considered as a major part of the whole macro economy. Improved manufacturing and services sectors may be expanded to accommodate those who are leaving farms for jobs in non-agriculture sector. In this way the worthwhile markets may be made better accessible for the agriculture produce. Farm to market roads are indeed the intersection point where the two approaches meet each other (Shahani 2015). This is so because these roads facilitate greatly the movement of goods and workers saving time and financial costs.

Another study has developed an inverse link between farm size and the productivity (Byiringiro 1995). The study has been suggestive that the farmers may be facing various productivities of inputs as the size of their holding varies. That may be due to the higher efficiency of the small farms due to low labour opportunity cost and decreasing returns to scale. Other studies have supported the notion and put the things differently. For instance, in India (Bardhan, Parnab 973) have concluded that small farms have higher land productivity but lower labour productivity using more labour intensive techniques.

## 6.      Research Methodology

Ordinary least squares approach using multiple regression method is applied on the primary data collected through self-administered questionnaire. The questions were asked directly from the farmers in the three selected talukas (Khairpur, Kingri and Kot Diji) of Khairpur district. Convenient and purposive sampling technique is used for selecting the sample of the respondents. The key purpose behind having a respondent to present

questionnaire is that the respondent needs to be the holder of maximum 5 acres or less of the land with date production. Total of 202 farmers were presented the questionnaires.

**Research Instrument:** Self-administered questionnaire containing 35 questions was distributed among the farmers having less or equal to the 5 acres of land under harvesting of dates in the three talukas of Khairpur district. The benchmark of 5 acres is assumed as the other researchers have been taking on the basis of revenues from 5 or less acres of land etc. These studies are  (Atta, 2011), (Nawaz, 1989), (Ibupoto, 2006) and (Abbas, 2010). However, due to heterogeneous nature and importance of variables, 19 items as part of dependent and independent variable have been included in regression equations. The numbers of items are presented in table 5 below with the reliability of each item through Cronbach's Alpha test.

**Table No. 5.  Statistical Analysis of 19 most important factors among other 35 factors on which the data is collected from respondents. And Cronbach Alpha of each item.**

| Item-Total Statistics | | | | |
|---|---|---|---|---|
| List of Important Factors Analyzed | Scale Mean if Item Deleted | Scale Variance if Item Deleted | Corrected Item-Total Correlation | Cronbach's Alpha if Item Deleted |
| optimal_production | 47.1980 | 132.976 | .150 | .684 |
| know_abt_Dtpalm | 48.8366 | 139.620 | .151 | .682 |
| land_holding_acres | 48.6188 | 130.486 | .323 | .667 |
| Trees_contrct_land | 46.4455 | 108.089 | .365 | .666 |
| Trees_own_land | 47.0495 | 125.699 | .209 | .683 |
| cost_per_tree | 46.4554 | 126.518 | .158 | .694 |
| Lit_growers | 48.2426 | 136.642 | .144 | .682 |
| cost_flower_t_harvest | 47.3168 | 128.765 | .228 | .676 |
| Variety | 45.4752 | 134.340 | .085 | .694 |
| other_income | 48.4851 | 139.933 | .097 | .684 |
| Dates_exp | 48.7030 | 136.777 | .203 | .678 |
| markets_to_sell_dates | 48.1337 | 137.599 | .123 | .683 |
| source_info_dtplm | 48.3960 | 141.842 | .009 | .686 |
| offshoots_growth_orchards | 48.2822 | 128.034 | .310 | .666 |
| sell_planting_offshoots | 48.5149 | 136.540 | .199 | .678 |
| Total_Income | 47.5198 | 116.957 | .638 | .629 |
| workers_unskilled | 47.8465 | 121.494 | .678 | .636 |
| workers_skilled | 47.8069 | 126.992 | .544 | .652 |
| wage_exp_total | 47.9802 | 115.870 | .731 | .622 |

**Table No. 6.   Reliability Analysis of Important Items**

| Reliability Statistics | |
|---|---|
| Cronbach's Alpha | N of Items |
| .733 | 19 |

The values of Cronbach's Alpha are more than 0.73 which is not very promising in the sets of primary data that is because of the heterogeneity of the questions; nevertheless it is still in acceptability range and shows internal consistency in the data items. This will also lead to the reliable results and estimates.

## 7. Model and Variables

The study is based on two models. First model is about the estimation of the determinants of optimal production through first regression equation. The general form of the equation is given here:

$$Opt\_\Pr od = f(dis\tan ce\_farm\_markt, Trees\_own\_land, Trees\_contrct\_land$$

$$Opt\_\Pr od = \alpha_0 + \alpha_1 dis\tan ce\_farm\_markt + \alpha_2 Trees\_own\_land + \alpha_3 Trees\_contrct\_land \text{ ------- I}$$

In equation I the dependent variable is optimal production and 3 independent variables; namely Distance from Farm to Market, Trees Own Land, Trees Contract Land. The assumed signs for the independent variables are negative, positive and negative.

Second model is about the empirical determination of the major source of farmer's income. Two independent variables have been taken. One is the income of the farmer from date production and income from the intercropping. The model is given as follows:

$$Total\_Income = f(inc\_\text{int} ercropping, Tincome\_sell\_dates)$$
$$Total\_Income = \alpha_0 + \alpha_1 inc\_\text{int} ercropping + \alpha_2 income\_sell\_dates \text{ ------------------------------ II}$$

The two equations are estimated separately using OLS approach.

## 8. Results

Table no. 7 presents the summary of regression results of the first model on optimal production and the causal link of factors affecting the optimal production.

The model results are significant as all the (P) values are less than 0.5 (5%) that ensure the degree of significance of all coefficients having less than 5% chance of error. $R^2$ represents the percentage change in the dependent variable explained by the change in the independent variables. The value is not very high nevertheless; it is sufficiently large to establish the causal link. Further, production of dates is part of the agriculture sector and is not restricted to the given three variables. The F-Statistics is also significant at less than 5% p value and the value of F-stat is high, it means the strength of model is good.

**Table No. 7. Summary of regression results of Optimal Production, distance, trees in own and contract land.**

| | Unstandardized coefficients with t (sign.) | Standardized Coefficients | Adjusted $R^2$ | F-Statistics | Corr. 0.516 (0.000) |
|---|---|---|---|---|---|
| Constant | 1.915 (0.000) | | 0.517 | 212.147 (0.043) | |
| distance_farm_markt | -0.039(0.042) | 0.041 | | | |
| Trees_own_land | 0.06 (0.003) | 0.133 | | | |
| Trees_contrct_land | 0.024(0.032) | 0.070 | | | |

Farm to market distance has a negative sign as an independent variable. That indicates that the optimal production has a negative relation with the farm to market road. The larger the distance from farm to market, the lower would be the production. This is working as the demotivating factor for the farmers to reduce the production. Second variable is about the link between optimal production and the tree owned by the farmer. This has assumed positive sign. This means higher the number of trees owned by the farmers, higher would be the estimated dates production. Even in case of trees on contract the link is positive but lower beta value suggests that the trees owned land is the most significant factor affecting the optimal production of the dates.

**Table No. 8. Summary of regression results of Total Income, income from intercropping and income from sale of dates**

| | Unstandardized coefficients with t(sign.) | Standardized Coefficients | Adjusted $R^2$ | F-Statistics |
|---|---|---|---|---|
| **Constant** | 0.462 (0.0125) | | 0.293 | 42.671 (0.000) |
| inc_intercropping | 0.225(0.015) | 0.146 | | |
| income_sell_dates | 0.895 (0.000) | 0.520 | | |

Dependent Variable: Total Income

Second model estimations summary is presented in table no. 8. The model is used to estimate the impact of income earned from dates and other source (intercropping). The estimated beta value for income from sale of dates is larger (0.520) than that of the income from inter cropping (0.146). However the unstandaridized coefficients have assumed positive signs. Both independent variables have positive impact on the household income of farmers. The magnitude of impact of income from sale of dates is larger than the income from inter cropping.

After running regression, all the (p) values are significant at 0.05. $R^2$ is 0.300. It means 30 percent of the total change in dependent variable can be explained by the change in independent variables, the value is small because the income of farmers is not only determined by these two independent variables but also they have other sources of income like, jobs/shops etc as identified during survey. F-Statistic is also significant; its value is low it means there are also other factors that impact on Total Income of the farmers.

The production of dates in this region is statistically negatively dependent on distance in kilometers from farm to market.

Further, the impact of land acquired on contract by the farmers is having a significant but weak impact on the total production of dates. This is due to the additional cost incurred on the farmers in terms of contract rent that is a substantial amount as part of the total cost per tree/acre.

The dominant factor as per beta standardized coefficients affecting the total production of dates is the amount of land owned by the farmer.

In addition to the regressions analysis and estimation of the two regression equations having total production and total income, correlation coefficient using Pearson Correlation coefficient approach is estimated between Total Income and Optimal Production. As mentioned earlier there is a positive and significant correlation between total income and optimal production.

## 9.      Conclusion

The study has used two regression models; one is about estimation of optimal production regressed on the farm to market distance, ownership of trees of the contracted trees and second is about the source of income of the farmers. Two independent variables have been included in the second model i.e., income from sale of dates and income from intercropping. In the first model, the coefficients of the two independent variables have assumed the expected signs. Optimal production has a negative estimated link with the farm to market road and positive link with the trees either owned or contracted. The beta standardized values suggested the own trees factor is the most important factor affecting the optimal production. Second is the farm to market road that negatively affects the optimal production. Third is the contracted tree affecting the optimal production positively.

Second model estimates suggest that the sale of dates is the predominant source of income for date's growers. This suggests that the farmers are growing dates not as a minor source of their livelihood but they are fully engaged in this crop and their living manly depends upon the date palm production.

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