Original Contribution

A COMPARISON OF ENGINEERING ECONOMY OF POPLAR PLANTATION WITH CULTIVATION OF SOME AGRICULTURAL CROPS

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ABSTRACT

Wood and paper industries needed to plantation timbers including poplar timbers even in countries with forest resources. Discouragement of planate poplar distinguishes by the comparison of engineering economy of poplar plantation with cultivation of some agricultural crops. The main question is whether; do poplar cultivation is economic in compared to with some agricultural crops?

The methodology of research was analytical and approximate. The research question was tested by forecasting and engineering economy techniques. The results of the research indicate that the error percent of forecast for equaling the cash flow is insignificant. During the whole period of the study, agricultural crops have risked and their cultivation suffered loss for minimum one year. Approximately, select of poplar plantation is similar to farming of some crops economically. But the present worth and equal uniform cash flow (loss or benefit account) of poplar plantation was more than other crops. The rate of return (27.2% in price break even point for 15 years) profound effected by undervalue price and volume unreal estimate of poplar timber profound effect and the reason of discouragement of poplar plantation. Poplar plantation in the case of short period (12 years) is economic. Also it will be economic in longer periods if the purchase price becomes fair. But farmers have problem of earning his annual livelihood in short term yield period. Engineering economy assessment indicates that poplar plantation can be a replace for cultivation of some agricultural crops in typical regions and also it can not be a replace in other regions.

Keywords: Poplar plantation, Agricultural crops, Engineering economy, Forecasting.

INTRODUCTION

Poplar timber is used in Iran, overly. Paper and wood industries of Iran are highly depended of poplar timber even in sylvan provinces. These factories on the poplar timber (including particle board and plywood factories, sawmills and carpentry workshops) have lacked wooden raw materials, whereas new factories fore example; paper mills (in Maraghe and Kermanshah) were established and put into operation in provinces which planate poplars. Researchers (1, 2, 3) were observed, that the farmers are discouragement for polar planting and cultivation of other agricultural crops is interest and this subject is one of the reasons of

poplar timber lack. In other hand, other reasons of discouragement farmers' is the long term harvesting periods of poplar plantation and low selling and buying price, etc. So far there was not engineering economy assessment for this discouragement.

The main questions are as fallows: regarding the engineering economy criterions, do farmer should choose poplar plantation or cultivation of certain other agricultural crops? Which one is relatively at counterbalanced situation?
Considering the question, the hypothesis is created that economic crop are selected by farmers.

Review of literature
According to Asadi (1995), farmers discouragement for poplar plantation and a decline in poplar plantations are affected by different factors including brokers of wood purchasing, the lack of strong and active co-

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operatives, lack of training and promotion of poplar plantation, low revenue and long term harvesting period and that the price of poplar timbers not being increased along with other agricultural crops, absence of purchase guarantee and assurance for poplar timbers (1).

Bagheri (1995) mentioned that the problem for developing poplar plantations is in lack of appropriate instrument for estimating volume and weight of poplar tree that result in volume unreal estimate and undervalue payment by brokers and makes farmers more discouraged (2). Foruzanmehr (1993) stated that poplar plantation is less economic than cultivation of Wheat and Barley. According to him, there are some factors that cause revenue of poplar plantation is low, including the low price of poplar timber in proportion to other agricultural crops, long term harvesting period (the average harvesting period of 12 years), the lack of workshops and factories, and that the poplar plantation isn't supported by government organizations, lack of purchase guarantee, brokers and the lack of modern instruments for cutting and harvesting (3). Zahmatkesh (1994) stated that the country wood industries will not develop efficiently for the lack of raw materials (4). Engindeniz (2003) mentioned that the economical period for hybrid poplar plantation is equal 9 to 11 years. The length of this period is related to base on different factors including the properties of the region and cultivation space of poplar plantation. The most appropriate period length for cultivation will be decided by local investigations (5). Nienow et.al (1999) stated that the growth period for agro poplar is equal 5 to 8 years. If the selling price for the biomass of a willow is 14 $ a ton, the rate of return will be about 7 percent (6).

Anderson and Luckert (2006) stated that the government policy in western Canada for forestation and timber plantation provoked poplar plantation (7). The policies involved are: planting hybrid poplars in co owner lands (the real interest rate is about 5 percent), the selection of successful colonies in poplar plantation having the annual yield of 12 cubic meters in hectare (rate of return of 6.2 percent), the fast increasing in poplar plantation yield or annual harvesting of poplar tree. Clatterbuck and Hadeges (2004) have mentioned that the payback of timber plantation is longer than various agricultural crops. Interest and inflation rate affect their profitability (8). If the price of each board foot with different interest rate, changes from 2 to 3 $, the present worth and equal uniform annual value will increase considerably and rate of return will change from 11.6 to 18 percent.

Rabinson et.al (1995) pointed that break even point of wood chips price in Oregon region ranges between 89 to141 $ and efficiency yield period of poplar plantation ranges from 7 to 10 year (9). Increasing the growth period, break even point of price will increase. The risk of farming agricultural crops can result in loss. Hybrid poplars as fast-growing trees are good replace for some poor yield agricultural crops cultivated in lands with poor drainage capacity. The industry of forest products is the most important factor in poplar plantation in Oregon region. Poplar plantation for supplying wood chips has the harvesting period of 5 to 10 years and for other uses it will need longer harvesting period. Poplar plantation was useful in Oregon Region but there was no guarantee for farmer to benefit. Spinelli et.al (2005) stated that poplar plantation in France and Italy is considered as an important wood resource (10). Poplars plantations cover 240,000 hectares of France lands that annually produces 1.5 million cubic meters round wood. In Italy, poplar plantations with annual production of 1.8 million cubic meters cover 120,000 hectares of its lands.

Fast growing poplars as wood products harvested in short periods are similar to agricultural crops and they aren't similar to forest products and they have capital return limitation in long term harvesting periods. Agro poplar is highly profitable and it creates position not only for farmers but also for the public. Investing 2600 million dollars, it provides employment for more than 6710 people. 85 percent of North America required timber in future (2050) will be supplied with forestation and factories aware of this, will plant fast growing species with harvesting period of 5 or 7 years. New Zealand programs for promotion of forestation in 1960-1980 provoked using direct helps, encouraging for example: tax-free and giving loans (11).

Considering the review of literature, the aim of this study is comparing about the poplar plantation with cultivation of other agricultural crops and therefore, economic farming is distinguished by counterbalanced condition.

MATERIALS AND METHODS
Trend method is one of the time series analysis methods for quantitative forecasting that was

applied using Excel software. Mean absolute deviation (MAD), mean absolute percent error (MAPE) and Bias calculated for determination of forecasting precision (12, 13). Price indexes of some products compiled for years ago (14, 15) and then their price index forecasted for next years. Rate of increasing annual price (Inflation rate) that indicates the general trend for prices in certain during was calculated by single paying formula (16).

$$F = P\left(\frac{F}{P}, i, n\right) \quad \text{or} \quad i = \sqrt[n]{\frac{F}{P}} - 1$$

There is; n = number of period, I = rate of return, F = future worth and P = present worth. In other word, in present study, it was calculated as follow;
(Number of period or year, adjustment rate and F/P) *price index of base year (e.g. 2000) = price index of next years (2000, 2011 and 2014).

Revenue and cost of cultivation, protection and harvest of poplar plantation were surveyed in 2005 and time value of cash flow was counterbalanced on the basis of price index of forestation timbers and labor cost. Different revenues of poplar plantation in one hectare calculated on the basis of weight and volume methods of Bagheri (2), Mirsadeghi and et.al (17) and surveys in Hamadan, West Azerbaijan and Kurdistan provinces of Iran.

Yield and cost of cultivation, protection and harvest of some crops (Barley of the whole country and some poplar planting provinces , Pea, water Lentil and Soya) in each hectare (18) and the sale price in one kilogram (19) were compiled from 2000 to 2005 and forecasted for other required years. Yield, rate of return (I), present worth (P) and annual equal uniform cash flow (A) in each hectare for poplar plantation and

cultivation of some crops were calculated as fallow (16);
Yield = (benefit / cost) * 100

Rate of return is calculated on the basis of counterbalance of present worth (P) or Annual uniform equal (A) of costs and benefits.

$$P = F\left(\frac{P}{F}, i, n\right) = \frac{F}{(1+i)^n}$$

Present worth (P) or single payment formulas =

Annual uniform equal (A) or capital recovery formula =

$$A = P\left(\frac{A}{P}, i, n\right) = P\left(\frac{i(1+i)^n}{(1+i)^n - 1}\right)$$

Discount rate is calculated by rate of return and inflation rate. Equation of discount rate is as follow; $I = i + c + ic$.
I = rate of return and C = inflation rate. Discount rate is used for calculation of present worth and Annual uniform equal.

RESULTS

Price index trend of different plantation timbers and some crops is increment and both trend of plantation timber price and trend of some crops price would similarly increasing from 1997 to 2016 (**Figure 1 and Table 1**). The Inflation rate of plantation timber (2000 to 2014) is more than other crops (**Table 1**). Inflation rate of price index trend at study period is more than forecast period. So, selection of mentioned products selections is not on the basis of price high increase at future or present time but the selection on the basis of cost and the revenue generated during the same period results of preferred selection or the change in the criterions (for measuring the time value of money (**Figure 2 to 7**).
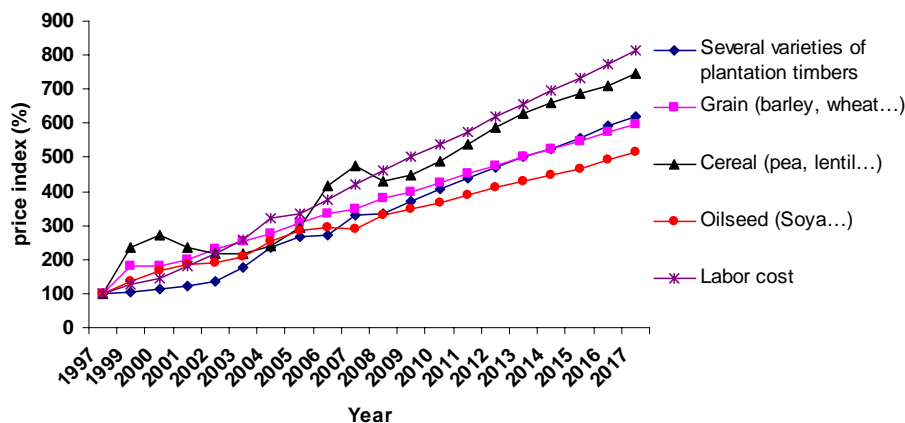

Fig 1. Price index trend of present (1997 to 2006) and future (2007 to 2016).

Table 1.*Inflation rate for 10, 12, 15 and 20 annual period. (%)*

Annual periods	Grain (barley, wheat…)	Cereal (pea, lentil…)	Oilseed (Soya…)	Poplar plantation	
				Several varieties of plantation timbers	Labor cost
2000 to 2009 (10 year)	7.97	7.49	7.01	12.89	11.54
2000 to 2011 (12 year)	7.56	7.85	6.82	12.04	10.81
2000 to 2014 (15 year)	7.01	7.36	6.32	10.74	9.81
1997 to 2016 (20 year)	19.6	22.28	17.78	20	23.32
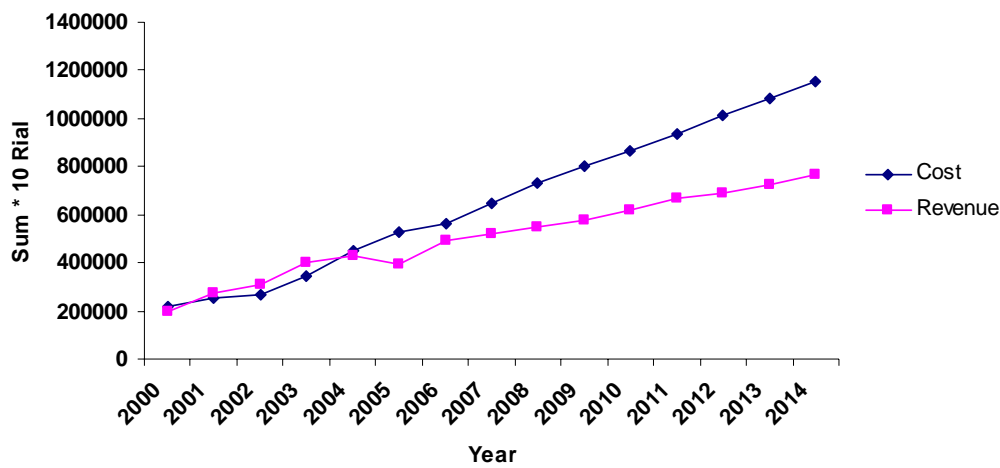
Fig 2. Cost and revenue of Barley in each hectare for Hamadan province from 2000 to 2014.
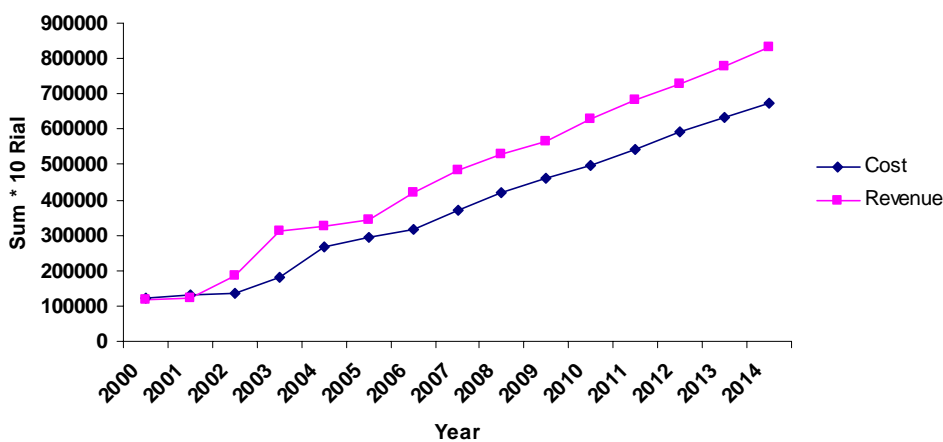
Fig 3. Cost and revenue of Barley in each hectare for Kordestan province from 2000 to 2014.
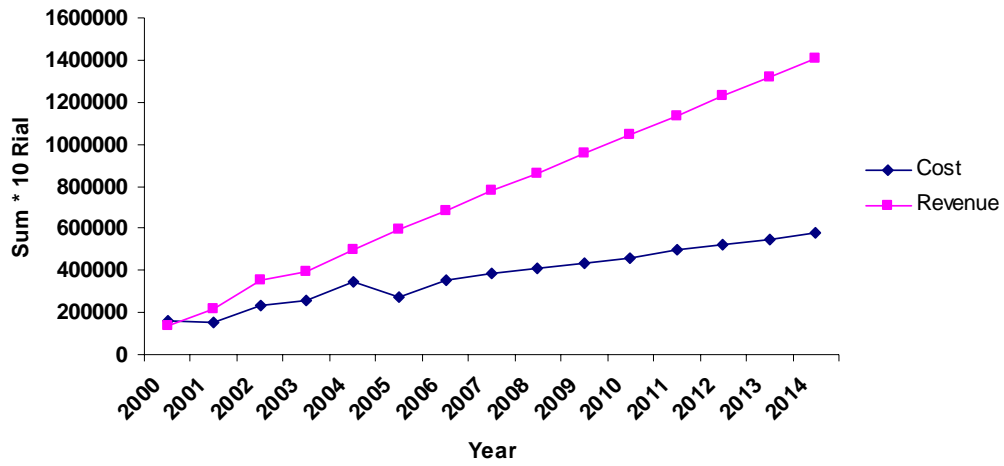
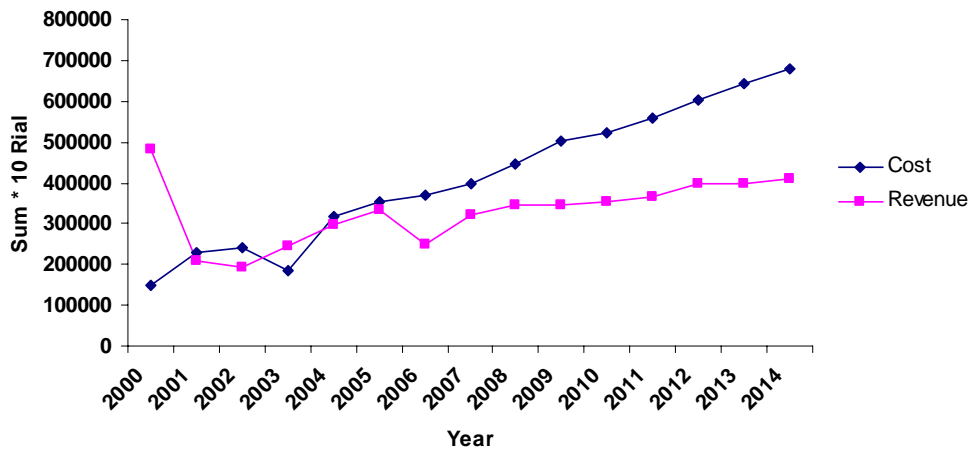**Fig 4**. Cost and revenue of Barley in each hectare for Kermanshah province from 2000 to 2014.

Fig 5. Cost and revenue of Pea in each hectare for all-provinces of Iran from 2000 to 2014.
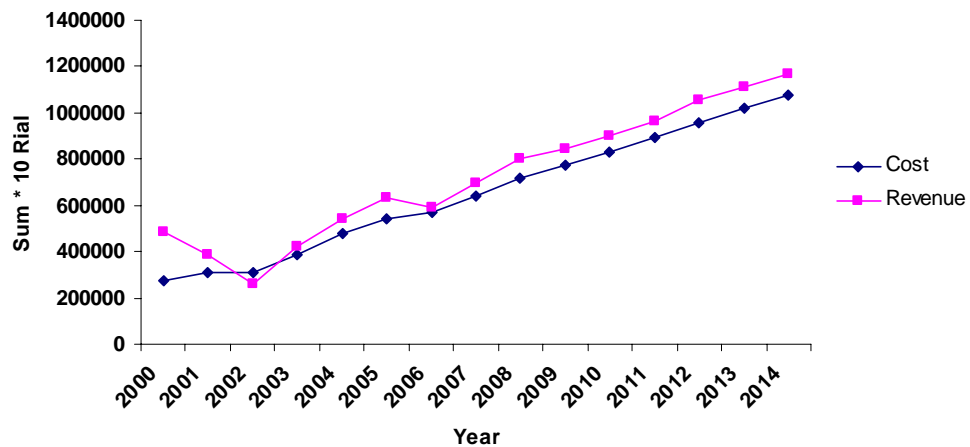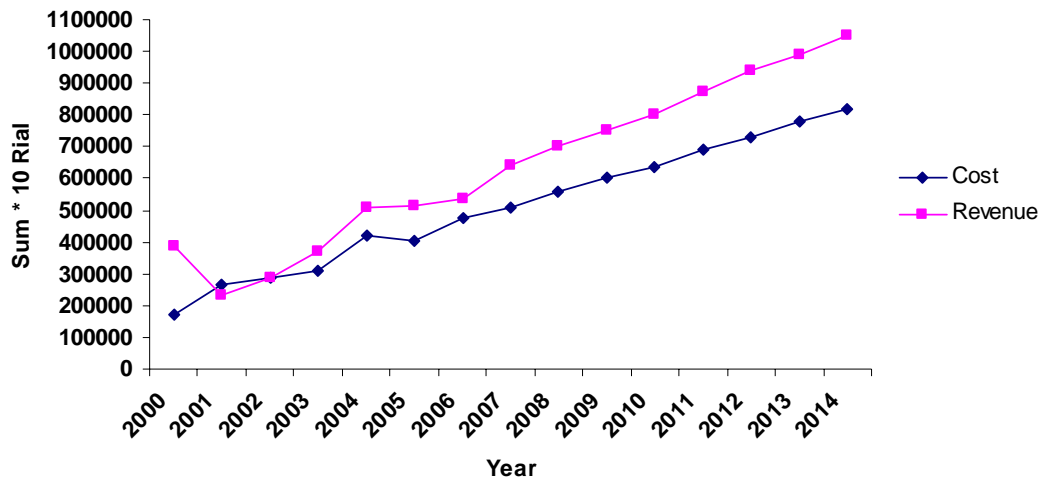

Fig 6. Cost and revenue of Soya in each hectare for all-provinces of Iran from 2000 to 2014.

Fig 7. Cost and revenue of Lentil in each hectare for all-provinces of Iran from 2000 to 2014.

Cost of cultivation, protection and harvest, and also revenue at one hectare of Barley, Pea, Lentil, Soya (present trend) from 2000-2005 compiled (18) and the future trend (2006-2014) is forecasted (Figures 2-7). Increasing the price trend of oilseeds is slower than other crops and also increasing price trend at labor cost (next Cereal) is more than other crops and two other crops are settled between them. Increasing annual revenue and cost rate of agricultural crops during the same period does not indicate the same trend and the increase in annual revenue rate is less than the cost.

The cultivating risk of certain agricultural crops even with high yield and present worth is distinct. During the mentioned agricultural periods, these crops suffered loss for minimum one period or even more. Farming of Pea in Iran provinces has the best yield **(Table 2)**, but its farming lost for the most periods. Yield, present worth (P) and Annual uniform equal (A) appertain to farming of Lentil and Soya are desirable quantitatively and farming of Soya was lost at only one year. The increscent of agricultural periods from 10 years to 12 or 15 did not affected by economical criterions of present worth and annual uniform equal. The economic value of Barley in poplar plant provinces is same as other investigated crops across the country **(Table 3)** and during the whole period of the study they are suffered loss for one to several years. It had the most yields in Kermanshah province with suffering loss for one year during at period of study and the least yield in Hamadan province with the most period of loss during at period of study. Economically criterions (P and A) appertain to farming of Barley in provinces of Kordestan and Kermanshah are more desirable than others provinces, but these criterions are negative in Hamadan province. Since, poplar plantation can replace for farming of Pea in Iran provinces and replace for farming of Barley in Hamadan province. In the cause of farming risk of agricultural crops, poplar plantation is replace for farming of agricultural crops totality **(Tables 2 and 3).**

Table 4 indicates that methods of volume estimating and pricing are unjust for farmers of poplar plantation and poplar timbers are inequitable trade by brokers of poplar timbers. Economical criterions (present worth (P), Annual uniform equal (A) and rate of return (I)) are present on the basis of several varieties of revenues and harvesting time periods of poplar plantation in **Table 4.** If farmers were sold poplar timbers for the sum of 500 - 1000 rial to one kg or farmers have been revenue equal of 601416670 rial to one hectare, they would loss at harvesting time periods equal of 15, 12 years and even 10 years. Economical criterions consist of yield, rate of return, present worth (P) and annual uniform equal (A) are present in tables 2, 3 and 4 for several varieties of farming crops and revenues of poplar plantation and harvesting time periods.

Table 2. *Yield, present worth (P) (2000) and annual uniform equal (A) for farming of some agricultural crops in each hectare. **

Varieties of crops	Loss years of farmers	Yield		Agriculture time period of 10 year		Agriculture time period of 12 year		Agriculture time period of 15 year	
		Cash flow of actual	Cash flow of actual and forecasted	P	A	P	A	P	A
Barley	2013 and 2014	18.135	9.232	1575188	386526	1499370	406314	1544581	397091
Pea	With the exception of 2000 and 2003	35.71	-4.649	1127932	280881	1715218	456833	1457161	378879
Lentil	2001 and 2002	30.518	27.079	3728389	928456	3177392	846271	3391356	881792
Soya	2002	20.738	13.54	3301656	786039	2978517	779536	3117066	778388

*Rate of return is equal of over 100% for these crops and it's too below for farming of Pea

Table 3. *Yield, present worth (P) (2000) and annual uniform equal (A) for farming of Barley in each hectare of some provinces. **

Province	Loss years of farmers	Yield		Agriculture time period of 10 year		Agriculture time period of 12 year		Agriculture time period of 15 year	
		Cash flow of actual (2000 to 2005)	Cash flow of actual and forecasted	P	A	P	A	P	A
East Azarbayjan	2000 and 2001	5.54	21.037	1221048	299626	681424	184659	935118	240406
West Azarbayjan	2005 to 2014	33.193	3.473	122297	300097	1556814	421881	1416431	364145
Ardebel	2001, 2002 and 2004	7.199	22.981	1172947	287823	650532	176288	890502	228936
Hamadan	2001, 2002 and 2003	0.099	16.107	-1833920	-450015	-869645	-235665	-1301360	-334563
Kordestan	2000 and 2001	23.802	25.118	2331320	572069	1819598	493093	2069073	531931
Kermanshah	2000	48.834	93.157	7770383	1906729	5448776	1476564	6529627	1678679

*Rate of return is equal of over 100% for this crop in Iran provinces (with the exception of two provinces) and it's too below in provinces of Hamadan and west Azarbayjan.

DISCUSSION

Error percent related to the forecast of counterbalanced cash flow is insignificant and the comparisons are reasonable.

The Inflation rate of plantation timber (2000 to 2014) is more than Agricultural crops including of Soy bean, Pea, Lentil and Barley, but their trend (Agricultural crops and Plantation timbers) are the same each other in 1997-2016 period. This is due to the lack of poplar timbers (plantation timbers) and consumers increasing demand in recent years (20) or fluctuate in poplar timbers price since 2004. But inflation rate of plantation timbers is similar to some crops in others periods. So, the results mentioned in review of literature (1, 2, 3) are true. Therefore, cash flow of poplar plantation adjusted by higher adjustment coefficient in proportion others cash flow. Probably price of these products with equal and same rate will increase in future (considering minor percent of error) but based on forecasts, the trend of their increase will be slower than before.

Table 4. *Rate of return, present worth (P) (2000) and annual uniform equal (A) for poplar plantation in each hectare.*

Economical criterions	Minimum	Maximum	Medium	Minimum	Maximum	Medium
Revenue 2005	163870830	327741670	245806250	425602080	507537500	466569790
P 2000 (10 year)	-25402340	-22751020	-24076690	860260	-4709970	-1924850
A 2000-2009	-7777460	-6965700	-7371580	263390	-1442060	-589330
I	15.3	22.49	19.75	32.21	30.27	31.13
P 2000 (12 year)	-45018560	-51459910	-48239240	-25701910	-38190360	-31946130
A 2000-2011	-13067620	-14937370	-14002500	-7460540	-11085590	-9273070
I	6.57	12.47	10.23	20.19	18.7	19.36
P 2000 (15 year)	-78385980	-98965860	-88675920	-67806830	-91698530	-79752680
A 2000-2014	-21571340	-27234800	-24403070	-18660020	-25234880	-21947450
I	Too low	3.76	1.96	9.79	8.67	9.17
Revenue 2005	515500000	687333330	601416670	859166670	1031000000	945083330
P 2000 (10 year)	9880790	13331080	11605950	44364970	47815250	4609010
A 2000-2009	3025210	4081590	3553400	13583260	14639640	14111450
I	35.65	35.71	35.68	44.97	43.08	43.92
P 2000 (12 year)	-19067130	-24920820	-21993960	6296650	442960	3369800
A 2000-2011	-5534650	-7233810	-6384230	1827740	128580	978160
I	22.9	23.01	22.96	30.18	28.78	29.4
P 2000 (15 year)	-64173160	-84431200	-74302170	-50282170	-70540210	-60411190
A 2000-2014	-17660060	-23234950	-20447500	-13837350	-19412240	-16624790
I	11.89	12	11.95	17.43	16.42	16.87
Revenue 2005	2103163070	2776187140	2439674420			
P 2000 (10 year)	169189440	222930660	196060230			
A 2000-2009	51801040	68254880	60027940			
I	62	61.86	61.94			
P 2000 (12 year)	98107850	129243750	113675750			
A 2000-2011	28477950	37515830	32996880			
I	43.26	43.22	43.24			
P 2000 (15 year)	0	0	0			
A 2000-2014	0	0	0			
I	27.17	27.19	27.18			

Trend of increasing of revenue and cost belong to poplar plantation and other cultivations is results of above subjects and pea farming was lost in provinces of Iran and Barely farming was profited in provinces of poplar plantation for example; Kermanshah, Kordestan and east Azarbayjan. Generally, revenue increment rate is lower, than cost increment rate for these crops and this rate is negative for Pea farming. In current situation, cultivation of agricultural crops is a competitor for poplar plantation and in this aspect; supportive crops like Soya and Barley will be good situation. Therefore, the diagrams for cost and revenue of different agricultural crops (figures 2-7) are showing profit or loss of farming them as the replace for the poplar plantation. The cost and revenue of a crop like Pea cultivated across the country and Barley in provinces like West Azerbaijan and Hamadan in present and future indicates that poplar plantation can be replace for them. Hence, if applying some methods that long term harvesting period is shortened (promoting hybrid poplars), the farmers will prefer poplar plantation to other crops. Of course, harvesting time periods of poplar plantation must be shorter than 12 years.

The Agricultural crops suffered loss for minimum one period or even more and this subject is indicated that their farming have risk. In the cause of economically criterions, risk of agricultural crops and theirs loss, poplar plantation can replace for farming of Pea in Iran provinces and replace for farming of Barley in Hamadan province. Also, poplar plantation is replace for farming of agricultural crops totality. In the cause of depreciation of poplar timbers and volume unreal estimate of poplar trees, poplar plantation has lost for

farmers. These heavy losses are showed by economical criterions.

These subjects are confirmed by reviews, because estimate of weight and volume for poplar trees weren't accurated by brokers and it is undervalue pay. If poplar timbers sold for the sum of justly (fore example; revenue equal of 945083330 Rial to one hectare), poplar plantation would profit for farmers. Probably, propagate of hybrid poplars are profit for farmers and if harvesting time periods of poplar plantation are shorter than 12 year, farmers will earn benefit. Rate of return at break even point was equaled of 27.2 % and break even point of revenue was equaled of 2439674420 Rial for harvesting time periods of 15 year in 2005. Therefore, poplar plantation can more profitable than others agricultural crops, but counterpoint, to earn a living for farmers. This assessment is showing that poplar plantation is as profit as farming of others crops and farmers can select both poplar plantation and farming of others crops. But problems of poplar plantation are as fallowed; to earn a living of annual for farmers, harvesting long periods or profit-making of long, the espousal of others agricultural crops by government organizations, absence of workshops and factories related to poplars timbers, undervalue pay, unreal estimate of weight and volume and others problems (1, 2, 3).

Economical time periods of poplar plantation is lower than 12 year in this research and this result is similar to study of Engindeniz.S (2003), approximately. Harvesting long periods of poplar plantation must short and poplar timbers should trade justly, theretofore, economical criterions would desire for farmers or rate of return would increase. In the cause of farming risk of some agricultural crops, poplar plantation is apposite replacement for them. If poplar timbers to be within easy reach of factories and workshops and also poplar plantation support by government organizations, wood and paper industry will thrive and poplar plantation will propagate in next years.

CONCLUSION

Approximately, select of poplar plantation is similar to farming of some crops economically. Poplar plantation at short period (12 years) is economic. But even at short term yield period it seems that the farmer has problem for earning his annual livelihood and therefore, farmers is select some of agricultural crops occasionally.

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