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Research Article

Sample Farmers Analysis of Factors Influencing Production of Economic Forest Products

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This paper focuses on the scale efficiency of dried fruit economic forestry production in Shandong Province. Based on the analysis of the basic characteristics of the production of economic forest products by the sample farmers, the main factors influencing the production of economic forest products by the sample farmers were further analyzed using the optimal scale regression method. Factor analysis is a statistical method that uses a few factors to describe the association between many indicators or factors, reflecting most of the information of the original data with fewer factors. It provides some suggestions for farmers' production activities and government decision making.

1. Introduction

Optimal scale regression quantifies the different values of the categorical variables, thus converting them into numerical forms for statistical analysis. Based on a questionnaire survey on the production and management of economic forest products such as chestnut, walnut, jujube, and ginkgo, the variables are specifically defined as (1) La, labour input for economic forest management; (2) Cap, capital input for economic forest management; (3) Area, area of economic forest management; (4) Frac, degree of forest land fineness (how many pieces); (5) Age, age of operator; (6) Edu, operator's education level (1 = elementary school; 2 = junior high school; 3 = high school; 4 = college; 5 = university and above); (7) Cad, whether the operator is a village cadre (1 = yes; 2 = no); (8) Tra, whether the operator has received technical training (1 = yes; 2 = no); (9) Co, whether the operator is a member of a professional cooperative (1 = yes; 2 = no); (10) Inc, household income (1 = very rich; 2 = relatively rich; 3 = upper middle class; 4 = lower middle class; 5 = relatively poor); (11) Site, standing conditions of economic forestry operations; (12) Outp, total economic forestry output (yield) (2017); and (13) Pri, selling price of economic forestry products (unit price in 2017, yuan/catty). A total of 510 questionnaires were distributed to survey the production and operation of economic forest products such as chestnut, walnut, jujube, and ginkgo, and 502 valid questionnaires were distributed to different economic forest product production areas, including 212 jujube, 118 chestnut, 116 walnut, and 56 ginkgo and other economic forests [1–3]. Factor analysis was used to determine the weight values of each indicator, and optimal scale regression analysis was used to determine the importance of factors affecting the production of economic forest products by farmers. The analysis was carried out.

2. Optimal Scale Regressions of Economic Forest Product Production by Sample Farmers

2.1. Correlation Analysis of Factors Influencing the Production of Economic Forest Products by Farm Households. The research data are mostly categorical variables and the accuracy is poor if linear regression analysis is used. In the survey on the sample farmers of chestnut, walnut, jujube, and gingko economic forest product production, most of the 13 variables (question items) involved were categorical variables; therefore, the linear correlation coefficient could not accurately determine the relationship between different

Table 1: Correlation coefficients of factors influencing the production of economic forest products by farm households.

Influencing factors	Labour inputs	Capital inputs	Business area	Finesse	Age	Education level	Is it a cadres
Labour inputs	1.000	0.237	0.244	0.024	0.328	0.048	−0.194
Capital inputs	0.237	1.000	0.297	−0.016	−0.078	0.258	−0.211
Business area	0.244	0.297	1.000	0.015	0.175	0.071	−0.151
Finesse	0.024	−0.016	0.015	1.000	−0.001	0.007	0.025
Age	0.328	−0.078	0.175	−0.001	1.000	−0.346	−0.081
Education level	0.048	0.258	0.071	0.007	−0.346	1.000	−0.040
Is it a cadres	−0.194	−0.211	−0.151	0.025	−0.081	−0.040	1.000
Training or not	−0.042	0.013	−0.037	0.041	0.114	−0.384	0.115
Whether to join a cooperative	−0.021	0.019	−0.105	0.009	0.055	−0.343	0.088
Household income	−0.118	−0.058	−0.121	0.018	−0.084	−0.015	0.208
Site conditions	0.062	0.112	0.038	0.024	−0.042	0.116	0.014
Unit price	0.045	−0.009	−0.047	−0.004	0.091	−0.008	−0.142
Total production	0.093	0.229	0.191	−0.005	−0.027	0.186	0.023
Dimension	1	2	3	4	5	6	7
Eigenvalue	2.184	1.803	1.530	1.157	1.090	1.000	0.889

Missing values were imputed with variable mode.

Table 2: Correlation coefficients of factors influencing the production of economic forest products by farm households.

Influencing factors	Training or not	Whether to join a cooperative	Household income	Site conditions	Unit price	Total production
Labour inputs	−0.042	−0.021	−0.118	0.062	0.045	0.093
Capital inputs	0.013	0.019	−0.058	0.112	−0.009	0.229
Business area	−0.037	−0.105	−0.121	0.038	−0.047	0.191
Finesse	0.041	0.009	0.018	0.024	−0.004	−0.005
Age	0.114	0.055	−0.084	−0.042	0.091	−0.027
Education level	−0.384	−0.343	−0.015	0.116	−0.008	0.186
Is it a cadres	0.115	0.088	0.208	0.014	-0.142	0.023
Training or not	1.000	0.613	0.141	−0.077	0.046	−0.031
Whether to join a cooperative	0.613	1.000	0.144	−0.071	0.044	−0.056
Household income	0.141	0.144	1.000	0.335	−0.014	0.118
Site conditions	−0.077	−0.071	0.335	1.000	0.001	0.073
Unit price	0.046	0.044	−0.014	0.001	1.000	−0.031
Total production	-0.031	−0.056	0.118	0.073	−0.031	1.000
Dimension	8	9	10	11	12	13
Eigenvalue	0.749	0.702	0.561	0.514	0.446	0.374

Missing values were imputed with variable mode.

variables; here, the correlation coefficient between different variables calculated mainly using the correlation coefficient formula in the scale regression is shown in Table 1 [4].

From the calculation results in Table 1 and Table 2, it can be seen that the total production of economic forest products produced by farmers has the largest correlation coefficient of 0.229 with capital input (Cap), followed by the area of economic forest operation (Area) with a correlation coefficient of 0.191. The third is the operator's education level (Edu), with a correlation coefficient of 0.186. The fourth is the farm household income (Inc) with a correlation coefficient. In terms of the magnitude of the eigenvalues of the scale regression correlation coefficients, among these influencing factors, labour input in economic forest management (La) with an eigenvalue of 2.184 is the most important factor in economic forest management, followed by capital input (Cap) with an eigenvalue of 1.803 and area of economic forest management (Area) with an eigenvalue of 1.530. The third, fourth, and fifth are, respectively, the degree of fine fragmentation of forest land (Frac), operator's age (Age), and operator's education (Edu) with eigenvalue magnitudes of 1.157, 1.090, and 1.000. Therefore, both from the correlation analysis of the scale regression and from the ranking of the eigenvalue magnitudes of the scale regression, the area of economic forest management (Area), operator's education (Edu), etc. all have a greater impact on the production of economic forest products by farm households [5–9].

In addition, the two-dimensional plot of the influence of important factors for the correlation analysis of the factors affecting the production of economic forest products by farmers is shown in Figure 1. The table of loading coefficients before and after rotation of the scaled regression of important influencing factors is shown in Table 3.

It can also be seen from Table 2 that in dimension 1 and dimension 2, both before and after rotation, labour input (La), operator's education level (Edu), area of economic forest operation (Area), degree of fine fragmentation of

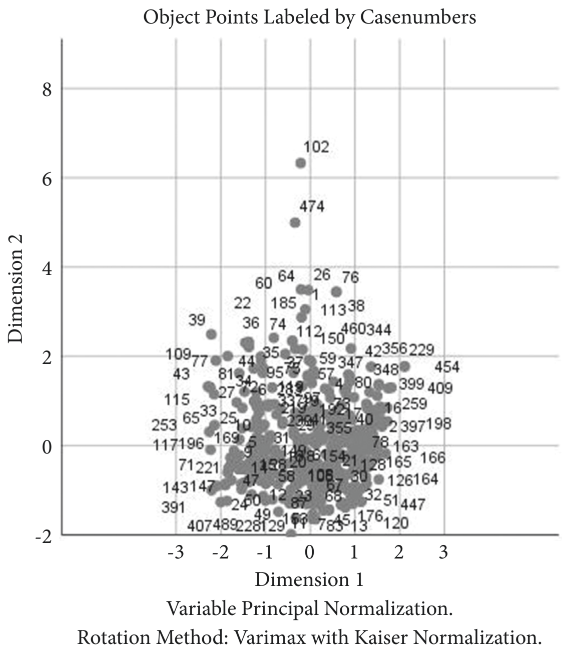

FIGURE 1: Two-dimensional diagram of the impact of important factors.

TABLE 3: Loading coefficients before and after rotation for the scale regression of important influences.

Influencing factors	Component loading dimension		Rotated component loading dimension	
	1	2	1	2
Labour inputs	0.318	0.617	0.151	0.678
Capital inputs	0.444	0.396	−0.088	0.588
Business area	0.423	0.503	−0.004	0.657
Finesse	−0.049	0.019	0.050	−0.017
Age	−0.131	0.624	0.500	0.395
Education level	0.672	−0.386	−0.763	0.133
Is it a cadres	−0.341	−0.376	0.021	−0.507
Training or not	−0.676	0.393	0.770	−0.131
Whether to join a cooperative	−0.669	0.352	0.739	−0.158
Household income	−0.328	−0.191	0.130	−0.357
Site conditions	0.276	0.096	−0.151	0.250
Unit price	−0.031	0.172	0.133	0.112
Total production	0.336	0.136	-0.171	0.320

Variable Principal Normalization. a. Rotation Method: Varimax with Kaiser Normalization. The Rotation failed to converge in 3 iterations (convergence = 0.000).

forest land (Frac), operator's age (Age), and capital input (Cap) have important effects on the total production of economic forest products produced by farm households. Therefore, to improve the efficiency of economic forest product production by farmers in Shandong Province, it is necessary to strengthen the management of these factors [10–13].

TABLE 4: Optimal scale regression analysis.

Variance	Sum of squares	df	Mean squared	F	Sig.
Return	161.505	17	9.500	13.702	0.000
Residuals	324.495	468	0.693		
Total	486.000	485			

Dependent variable: total production grouping; predictors: labour input, capital input, area of operation subdivided, education, age, whether cadre, whether training, whether joining cooperative, household income, standing conditions, and unit price.

2.2. The Importance of Factors Influencing the Production of Economic Forest Products by Farm Households. Further optimal scale regression analysis was conducted on the importance of the factors influencing the production of economic forest products by farmers. The multivariate correlation coefficient R of the optimal scale regression equation calculated with the grouped production of total production of economic forest products by farmers as the dependent variable and other influencing factors as independent variables was 0.576 and $R^2 = 0.332$. The ANOVA table for the optimal scale regression equation is shown in Table 4.

As can be seen from Table 4, the significant level of F-value of the optimal scale regression ANOVA Sig. is less than 0.01, indicating that the regression equation presents a level of significance.

Table 5 shows the analysis of the correlation coefficients for the optimal scale regression, and the final equation, based on the beta coefficients in standardized coefficients, is

$$\begin{aligned} Out\,pg = {} & 0.130La + 0.292Cap + 0.246Area + 0.023Frac \\ & + 0.201E\ du + 0.034Age \\ & + 0.179Ca\ d + 0.151Tra + 0.028Co + 0.120Inc \\ & - 0.153Site - 0.03Pri. \end{aligned} \tag{1}$$

According to the importance coefficients (Importance) of the optimal scale regression in Table 5, it can be judged that the influencing factor capital input (Cap) has the highest importance in the equation, followed by the area of the farmer's economic forest operation (Area), the operator's education level (Edu), etc. Therefore, the optimal scale regression can further determine that the capital input (Cap) of economic forestry operations, the area of economic forestry operations of farmers (Area), and the education level of operators (Edu) are the main influencing factors affecting the production efficiency of economic forestry products of dried fruits of farmers in Shandong Province [14].

3. Factor Analysis of Factors Affecting the Productivity of Economic Forest Products of a Sample of Farmers

3.1. Mathematical Model

3.1.1. Characteristics of Factor Analysis. The number of dependent variables is less than the number of original

Table 5: Correlation coefficients for optimal scale regression.

Influencing factors	Standardized Beta	Coefficients Error	df	F	Sig.
Labour inputs	0.130	0.056	2	5.277	0.005
Capital inputs	0.292	0.062	1	22.538	0.000
Business area	0.246	0.054	1	20.677	0.000
Finesse	0.023	0.030	1	0.577	0.448
Age	0.201	0.046	2	19.361	0.000
Education level	0.034	0.041	1	0.709	0.400
Is it a cadres	0.179	0.040	1	19.843	0.000
Training or not	0.151	0.058	1	6.796	0.009
Whether to join a cooperative	0.028	0.034	1	0.659	0.417
Household income	0.120	0.039	3	9.494	0.000
Site conditions	−0.153	0.045	2	11.729	0.000
Unit price	−0.030	0.015	1	3.996	0.046

Dependent variable: total production grouping.

indicator variables, serving to classify the original indicators and reduce the computational effort.

Factor analysis does not reduce the original variables; it reorganizes and constructs them based on information from the original variables, reflecting the vast majority of the original information.

There is no linear relationship between the dependent variables, which is more convenient for variable analysis.

Factor variables that synthesize and reflect information on the original variables can be renamed and are explanatory.

The mathematical model for factor analysis is

$$\begin{cases} x_1 = a_{11}F_1 + a_{12}F_2 + \cdots + a_{1m}F_m + a_1\varepsilon_1 \\ x_2 = a_{21}F_1 + a_{22}F_2 + \cdots + a_{2m}F_m + a_2\varepsilon_2 \\ \cdots\cdots \\ x_p = a_{p1}F_1 + a_{p2}F_2 + \cdots + a_{pm}F_m + a_p\varepsilon_p \end{cases}, \quad (2)$$

where $x_1, x_2, \cdots, x_p$ represent the P original variables, which are standardized variables with mean zero and standard deviation 1, and $F_1, F_2, \cdots, F_N$ is an m-factor variable, with m less than P, expressed in matrix form as

$$X = AF + a\varepsilon, \quad (3)$$

where F is the factor variable or common factor, A is the factor loading matrix, a_{ij} is the factor loading, which is the loading of the i-th original variable on the j-th factor variable, and ε is the special factor.

3.2. Factor Analysis of Factors Influencing the Productivity of Economic Forest Products of Farm Households. Based on the definition of variables from the previous optimal scale regressions for the analysis of influences on the production of economic forest products such as chestnuts, walnuts, dates, and gingko by farmers, further factor analysis of different influences was carried out using the statistical software SPSS 21.0 to find the influences on the paths to increase the production of different economic forest products [15].

To ensure that the selected objectives are credible and valid, the KMO test and Bartlett's sphericity test were applied to the selected objectives. The KMO test analyzes whether there is a biased correlation between the variables, and in general, when the KMO value is below 0.5, then factor analysis is not appropriate. The calculated value of KMO for this study is 0.609 (Table 6), which is greater than the standard required by 0.5 and therefore suitable for factor analysis.

The total variance explanation table for the 13 variables calculated for the study is shown in Table 7, and the gravel plot for the six factors extracted is shown in Figure 2.

Therefore, the calculation results from Table 7 show that after extracting the 5 factors, the cumulative variance contribution of the 5 factors after rotation is 71.779%, and the variance contribution of the first to the sixth factor is 22.888%, 17.494%, 12.187%, 10.718%, and 8.491%, respectively. These five factors were able to provide a good description of the information of the original 13 variables. It can also be seen from Figure 2 that the variation tends to smooth out after the 5th eigenvalue; therefore, the selection of 5 factors is appropriate. The further rotated results of the factor loading matrix calculated using the method of extreme variance are shown in Table 8.

The results in Table 8 show that the first factor, after rotation, basically reflects "training or not," "membership in cooperative or not," "household income," "cadre or not," etc. The second factor basically reflects "capital input," "area of operation," "total production," etc. The third factor reflects "labour input," "age," etc. The fourth factor reflects "household income," "land conditions," etc. The fifth factor reflects "labour input," "capital input," etc. The sixth factor reflects "fragmentation," "labour input," etc. Thus, these factors reflect specific paths and methods to improve the efficiency of economic forest products of farmers. The scatter plot of the calculated output factor loadings is shown in Figure 3.

Finally, the calculated factor score matrix is shown in Table 9.

Table 6: Significant coefficients for optimal scale regression.

Influencing factors	Correlations			Importance	Tolerance	
	Zero order	Partial	Part		After transformation	Before transformation
Labour inputs	0.229	0.143	0.118	0.089	0.826	0.788
Capital inputs	0.390	0.301	0.258	0.343	0.781	0.762
Business area	0.342	0.266	0.225	0.253	0.841	0.839
Finesse	0.020	0.028	0.023	0.001	0.995	0.994
Age	0.189	0.195	0.162	0.114	0.651	0.645
Education level	−0.004	0.036	0.029	0.000	0.739	0.717
Is it a cadres	0.103	0.201	0.168	0.055	0.885	0.870
Training or not	0.134	0.137	0.113	0.061	0.562	0.554
Whether to join a cooperative	0.063	0.026	0.021	0.005	0.570	0.575
Household income	0.107	0.133	0.110	0.039	0.837	0.801
Site conditions	−0.074	−0.171	-0.142	0.034	0.853	0.843
Unit price	-−0.058	−0.035	-0.029	0.005	0.948	0.959

Dependent variable: total production grouping.

Table 7: KMO and Bartlett's test results.

Factor	Initial eigenvalue			Sum of squares of extracted loads			Rotation squared and load capacity		
	Total	Percentage variance	Cumulative percentage	Total	Percentage variance	Cumulative percentage	Total	Percentage variance	Cumulative percentage
1	2.975	22.888	22.888	2.975	22.888	22.888	2.779	21.377	21.377
2	2.274	17.494	40.382	2.274	17.494	40.382	2.028	15.597	36.974
3	1.584	12.187	52.569	1.584	12.187	52.569	1.629	12.534	49.508
4	1.393	10.718	63.287	1.393	10.718	63.287	1.6	12.306	61.815
5	1.104	8.491	71.779	1.104	8.491	71.779	1.295	9.964	71.779
6	0.798	6.138	77.917						
7	0.732	5.633	83.549						
8	0.539	4.149	87.698						
9	0.444	3.416	91.114						
10	0.375	2.887	94.001						
11	0.327	2.516	96.517						
12	0.253	1.944	98.461						
13	0.2	1.539	100						

The extraction method is principal component analysis.

Thus, based on the factor score matrix in Table 9, the factor equation for the pathway to improve the efficiency of the farmers' forest products was obtained as

$$\begin{cases} F_1 = -0.069La + 0.116Cap + 0.037Area + 0.0002Frac - 0.021Age - 0.224E\ du + 0.03Ca\ d \\ +0.477Tra + 0.474Co + 0.077Inc - 0.098Site + 0.013Outp + 0.053\mathrm{Pri}, \\ F_2 = 0.17La + 0.445Cap + 0.404Area - 0.022Frac - 0.085Age + 0.178E\ du - 0.074Ca\ d \\ +0.106Tra + 0.081Co - 0.045Inc + 0.02Site + 0.3170utp - 0.123\mathrm{Pri}, \\ F_3 = 0.469La - 0.104Cap + 0.057Area + 0.005Frac + 0.63Age - 0.275E\ du - 0.013Ca\ d \\ -0.043Tra - 0.11Co - 0.034Inc + 0.104Site + 0.0390utp - 0.067\mathrm{Pri}, \\ F_4 = 0.047La - 0.034Cap - 0.071Area - 0.006Frac + 0.037Age + 0.046E\ du + 0.119Ca\ d \\ -0.011Tra - 0.005Co + 0.567Inc + 0.591Site + 0.1110utp + 0.162\mathrm{Pri}, \\ F_5 = 0.022La + 0.105Cap - 0.043Area - 0.012Frac - 0.058Age + 0.065E\ du - 0.509Ca\ d \\ +0.007Tra + 0.057Co - 0.04Inc + 0.115Site - 0.262Outp + 0.708\mathrm{Pri}, \\ F_6 = 0.096La + 0.008Cap - 0.039Area + 0.985Frac - 0.049Age + 0.082E\ du + 0.035Ca\ d \\ +0.008Tra + 0.025Co - 0.027Inc + 0.017Site - 0.034Outp + 0.012\mathrm{Pri}. \end{cases} \quad (4)$$

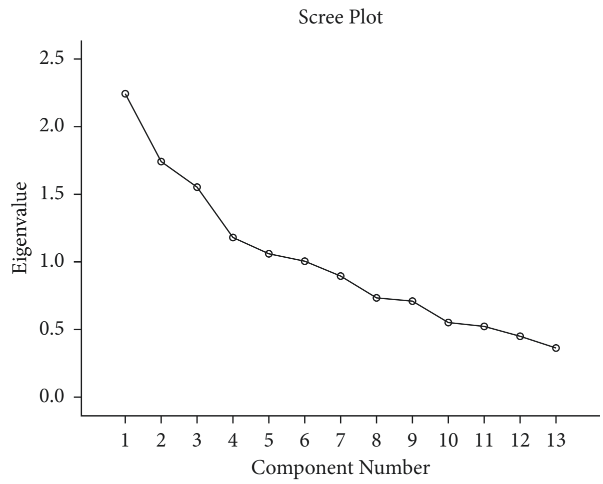

Figure 2: Gravel map.

Table 8: Results after rotation of the factor loading matrix.

	Factor composition					
	1	2	3	4	5	6
Zla: labour input	-0.097	0.374	0.661	0.006	0.136	0.105
Zcap: capital input	0.054	0.789	-0.072	-0.013	0.178	0.014
Zarea: operating area	-0.047	0.722	0.116	-0.073	0.032	-0.032
Zfrac: fine fragmentation	0.029	-0.030	0.019	-0.008	-0.020	0.991
Zage: age	0.110	-0.116	0.866	-0.033	0.024	-0.041
Zedu: education level	-0.544	0.395	-0.413	0.093	0.071	0.075
Zcad: is an officer	0.125	-0.224	-0.123	0.228	-0.643	0.037
Ztra: training or not	0.882	0.039	0.039	0.021	-0.017	0.018
Zco: to join a cooperative or not	0.868	0.000	-0.050	0.030	0.027	0.035
Zinc: household income	0.188	-0.080	-0.122	0.798	-0.139	-0.026
Zsite: site conditions	-0.155	0.132	0.071	0.789	0.092	0.017
Zoutp: total production	-0.044	0.543	0.017	0.202	-0.269	-0.028
Zpri: unit price	0.082	-0.117	0.010	0.139	0.792	0.008

Extraction method: principal component analysis; rotation method: variance maximization.

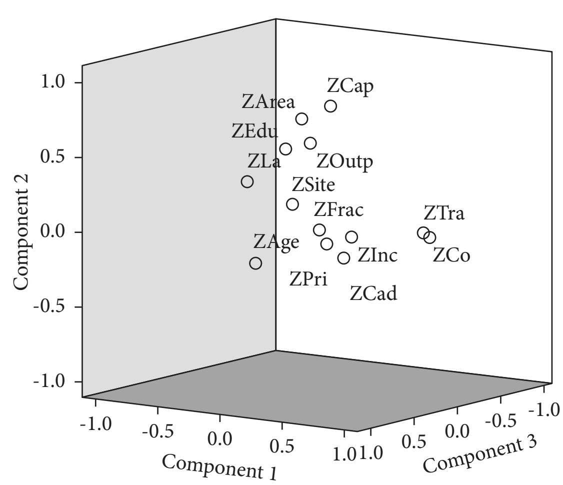

Figure 3: Composition diagram for rotation space.

Table 9: Factor score matrix.

Factor composition						
Zla: labour input	−0.069	0.170	0.469	0.047	0.022	0.096
Zcap: capital input	0.116	0.445	−0.104	−0.034	0.105	0.008
Zarea: operating area	0.037	0.404	0.057	−0.071	−0.043	−0.039
Zfrac: fine fragmentation	0.0002	-0.022	0.005	−0.006	−0.012	0.985
Zage: age	−0.021	-0.085	0.630	0.037	−0.058	−0.049
Zedu: education level	−0.224	0.178	−0.275	0.046	0.065	0.082
Zcad: is an officer	0.030	−0.074	−0.013	0.119	−0.509	0.035
Ztra: training or not	0.477	0.106	−0.043	−0.011	0.007	0.008
Zco: to join a cooperative or not	0.474	0.081	−0.110	−0.005	0.057	0.025
Zinc: household income	0.077	−0.045	−0.034	0.567	-0.040	-0.027
Zsite: site conditions	−0.098	0.020	0.104	0.591	0.115	0.017
Zoutp: total production	0.013	0.317	0.039	0.111	−0.262	−0.034
Zpri: unit price	0.053	−0.123	−0.067	0.162	0.708	0.012

Extraction method: principal component analysis; rotation method: variance maximization.

Accordingly, it can be seen from the above factor equation that in the first factor F_1 whether to train (Tra) and whether to join a cooperative (Co) play a relatively large role. This also suggests that training of producers and membership of cooperatives should be strengthened as factors influencing the efficiency of production of economic forestry products by farmers. In the second factor F_2, area and capital input play a greater role. In the third factor F_3, labour input (La) plays a greater role. In the fourth factor F_4, Inc and Site play a greater role. In the fifth factor F_5, labour input (La) and capital input (Cap) play a greater role.

In the sixth factor F_6, land fragmentation (Frac) plays a greater role. Therefore, in order to improve the production efficiency of economic forestry products of farmers, these factors should be taken into account in order to find ways to improve the production efficiency of different economic forestry products.

4. Conclusions

This paper analyzes the data of the sampled farmers mainly using optimal scale regression analysis and factor analysis and analyzes the important factors and major factors affecting farmers' economic forestry production. This study mainly analyzes the micro-level farmers' survey data, details the method and questionnaire design and content of the sample farmers' survey, analyzes the data obtained based on the questionnaire survey in terms of the basic situation of the sample farmers, the degree of farmers' participation in economic forest products production technology, the participation of farmers' professional cooperatives, and the basic characteristics of the production of economic forest products of the sample farmers, and conducts statistical tests on the indicators of farmers' total input cost, average annual income, and net profit after fruiting for walnut, jujube, chestnut, ginkgo, and other dried fruit economic forest products. The analysis was also conducted on the total input costs, average annual returns, and net profit after fruiting of walnut, jujube, chestnut, ginkgo, and other dried fruit economic forest products. The analysis mainly focuses on the application of economic forestry production technology, economic forestry management methods, land characteristics of economic forestry plantations, market costs of economic forestry products and the costs and benefits of different types of economic forestry plantations, etc. to lay the foundation for the later empirical analysis.

In addition, this study also analyzed the importance of the factors affecting the production of economic forest products by using the optimal scale regression analysis and found that the capital input (Cap), the area of economic forest management (Area), and the education level (Edu) of the operator have an important role in affecting the production of economic forest products by farmers. This paper also analyses the factors influencing the production efficiency of economic forestry products of farmers and finds that "Training or not (Tra)," "membership of cooperatives (Co)," "area of operation (Area)," "capital input (Cap)," "labour input (La)," "household income (Inc)," "site conditions (Site)," and "land fragmentation (Frac)" are all important factors influencing the production efficiency of economic forestry products of farmers and that these factors should be taken into account when looking for ways to improve the production efficiency of economic forestry products of farmers. "Site" and "Frac" are important factors that affect the production efficiency of economic forest products of farmers.

Data Availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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