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A STUDY ON THE RELATIONSHIP BETWEEN TOBACCO ECONOMIC CHARACTERISTICS AND TOBACCO PLANTING INCOME BASED ON SHORT PANEL DATA OF 25 COUNTIES IN SHAANXI PROVINCE OF CHINA DURING 2015-2019

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Abstract: Based on the data for the economic traits of tobacco leaf in 25 counties of Shaanxi province in China from 2015 to 2019 obtained from Tobacco Science Research Institute of Shaanxi Province, a two-way fixed effect model was used to explore the influence of flue-cured tobacco economic characteristics on tobacco cultivation income. The empirical study showed that the large tobacco growers in Shaanxi Province lack the scientific and technological power matching with the scale of land management, the planting area and the unit yield; all these have significant negative effects on the tobacco cultivation income. The increase of tobacco planting income can be promoted by increasing the unit output value, total yield and purchase price of tobacco leaves. Based on the research findings, it can be concluded that the government in Shaanxi should encourage tobacco growers to choose the land management scale, suitable for them and is also in line with their own tobacco science and technology power. Besides, the cultivation technology training of tobacco growers needs to be strengthened, so as to improve the potential of tobacco growers.
Keywords: Tobacco economic characteristic, tobacco planting income, short panel data, fixed effect model.

INTRODUCTION

"Three Rural Issues" has always been a fundamental problem related to the national economy and people's livelihood. Since the implementation of the reform and opening up policy, the CPC Central Committee has issued 22 No. 1 central documents on the theme of "Three Rural Issues", and made specific arrangements for rural reforms and agricultural development and promoted the construction of a new socialist countryside. In No. 1 central document of 2020, the CPC Central Committee and the State Council focused on the following important tasks: ensuring the realization of a well-off society on schedule by focusing on the two important historical tasks of winning the battle against poverty and making up the short board of the "Three Rural Issues". It is necessary to strengthen the industry development to alleviate poverty, stimulate the endogenous driving force of the poor people, and ensure the stable production of agriculture resulting in increased supply and farmers income. Tobacco planting income is the main source of business income for farmers in Shaanxi province, China. Although the growth of operating income is the slowest, it plays a strong role in increasing farmers' income as it is considered as the largest source of income for farmers (Pan and Wang, 2018). Tobacco planting is an important part of poverty alleviation in Shaanxi province. The State and the Shaanxi Tobacco Monopoly Bureau jointly play a positive role to raise the tobacco growers' income. In recent years, Yang Peisen, the deputy director of the State Tobacco Monopoly Bureau, attended a National Conference on increasing farmers' income for four consecutive years, and he repeatedly stressed that promotion of farmers' income is an important historical task, and thus there is an urgent need to promote high-quality development in rural areas, implement poverty alleviation and complete targeted poverty alleviation tasks (Dai *et al*., 2017). Shaanxi Branch of China Tobacco Corporation has formulated an implementation plan for the poverty alleviation of tobacco growers in the whole province. Due to this vital step undertaken by the Bureau, improvement in quality of tobacco leaves and hence increased income of the tobacco growers has been witnessed. It has also helped to consolidate the industrial foundation and mitigate the prevalent poverty of the tobacco growers. In this new situation, although stabilizing the income increase is the first priority of the tobacco industry, at the same time, efforts should be made to improve the yield and quality of tobacco leaves, ensure that the income of the

tobacco growers continues to increase, and contribute to the local targeted poverty alleviation(Li, 2019).

Based on the relevant data of more than 10,000 farmers in 25 counties of Shaanxi province from 2015 to 2019 provided by Tobacco Science Research Institute of Shaanxi Province, this paper used the panel econometric model to empirically analyze the impact of economic characteristics of tobacco leaf on tobacco planting income generation, in order to help tobacco companies and farmers to accurately implement policies to improve tobacco quality and farmers' income, which has a strong guiding significance for promoting industrial base and helping poverty alleviation.

MODELESTABLISHMENT

***Selected variables*:** Cultivated land is the most basic and irreplaceable production factor of field planting industry (Li, 2015). To some extent, the scale of tobacco growers' land management affects the output rate of cultivated land and the economic benefits of tobacco growers. Li (2012) analyzed the production, input and income of 337 tobacco growers in the Henan tobacco planting area. The results showed that the scale of tobacco growers' land management is one of the important factors affecting the land output rate and tobacco growers' production behavior. Likewise, Zhang and Liu (2015) investigated 100 tobacco grower householderes in Enshi Prefecture. After measuring the income gap of tobacco growers by the Gini coefficient, he found that the size of cultivated land is the main factor affecting the income gap of tobacco growers. Li (2019) also found that the output value and yield of tobacco affects the income of tobacco growers to some extent. Research of Wu (2015) showed that the income of tobacco growers in China is directly affected by the purchase price of tobacco leaves.

Tobacco is a kind of an important agricultural product. The quality of tobacco directly affects the quality of cigarettes (Hu et al., 2008). Therefore, it is necessary to grade tobacco. The classification of tobacco refers to the classification of the same group of tobacco leaves according to their quality. The purchase price of tobacco leaves is regulated by the national standard. When purchasing and grading, it is low or not high (Zhu, 2019). The quality of tobacco leaves produced by tobacco growers may be good or poor, so the cultivation income of tobacco growers is affected by the proportion of premium, medium and inferiorgrade tobacco (Shi and Li., 2014). In addition, the quality of tobacco leaves also relates to the position of tobacco leaves, so the proportion of upper, middle and lower tobacco also affects the income of tobacco growers.

On the basis of literature review, 11 influencing factors were selected in this study as shown in Table 1. Using the panel data of farmers' tobacco planting income and related indicators in 25 counties of the Shaanxi province from 2015 to 2019, a short panel data regression model was constructed by Stata16.0 software. The panel data model has the characteristics of time series and cross-section data (Tang and Yuan,2019), which not only makes up the limitations of the time series model in sampling interval, but also reflects the gradual change of farmers' tobacco planting income with time.

Table 1. A list of influencing factors of total income of tobacco growers

Index	Variable code
Planting area / hm^2	PA
Average price / Yuan·kg^{-1}	AP
Unit output value / Yuan·hm^{-2}	OV
Unit yield / kg·hm^{-2}	YI
Total yield / kg	TY
Proportion of premium tobacco leaves / %	SSR
Proportion of medium tobacco leaves / %	MSR
Proportion of inferior tobacco leaves / %	ISR
Proportion of upper tobacco leaves / %	USR
Proportion of middle tobacco leaves / %	CSR
Proportion of lower tobacco leaves / %	LSR

Data sources: The data used in this study included cultivated land area, unit output value, unityield, total output, average price, proportion of premium, medium and inferiortobacco and proportion of upper, middle and lower tobacco leaves of more than 10,000 households in 25 counties of the Shaanxi province provided by Tobacco Science Research Institute of Shaanxi Province. In addition, considering that most of the variables are proportional variables, and in order to reduce the possible heteroscedasticity and volatility, all the variables were treated logarithmically.

Selection of research methods: The panel data used in this study generally used a fixed-effects model or a random-effects model. In this study, a robust Hausman test was first performed. Because the results show that the *p*-value is 0.0000, the null hypothesis was strongly rejected, and this study was more suitable for establishing a fixed-effects model. There are two basic models of the fixed effects model: Individual-specific fixed effect model and Time fixed effects model.

Individual-specific fixed effect model:

$$Y_{it}=\beta_0+ X_{it}\beta+ Z_i\delta+u_i+\varepsilon_{it} \quad (i=1,\ldots,n;\ t=1,\ldots,T) \qquad (1)$$

Time fixed effects model:

$$Y_{it}=\beta_0+ X_{it}\beta+ Z_i\delta+u_i+\lambda_t+\varepsilon_{it} \quad (i=1,\ldots,n;\ t=1,\ldots,T) \qquad (2)$$

Among them, i is the serial number of the sample, t is the time span of the study, Y is the interpreted variable, X_{it} is affected by both the individual sample and time, and Z_i is the individual feature that does not change with time. ($u_i+\varepsilon_{it}$) is called compound disturbance term. Among them, the random variable u_i represents the individual effect of individual characteristics, which is not related to other explanatory variables; ε_{it} is a disturbance term affected by both individual

and time, which does not relate to u_i. λ_t only relates to time, but not to individuals. According to the results of the individual fixed effect test and time fixed effect test of the model, the two-way fixed effect model was established in this study.

$$Y_{it}=\beta_0+\beta_1 InPA_{it}+\beta_2 InTY_{it}+\beta_3 InYI_{it}+\beta_4 InOV_{it}+\beta_5 InAP_{it}+\beta_6 InSSR_{it}+\beta_7 InMSR_{it}+\beta_8 InISR_{it}+\beta_9 InUSR_{it}+\beta_{10} InCSR_{it}+\beta_{11} InLSR_{it}+u_i+\lambda_t+\varepsilon_{it} \quad (3)$$

In the formula, Y is the income of tobacco farmers in tobacco planting county i in the period 2015-2019.

EMPIRICAL TEST AND RESULT NANLYSIS

Descriptive analysis:Descriptive statistics of the desired variables employed in the study are reported in Table 2. In the past five years, the average tobacco planting income of farmers was 61,160.91 Yuan, and the income difference among farmers is large. The skewness coefficient describes the degree to which the distribution of economic index parameters deviate from symmetry in different regions. The skewness coefficient is equal to 0, which represents the symmetric distribution; the skewness coefficient is greater than 0, indicating that the distribution is skewed to the right. The skewness coefficient is less than 0, which means the distribution is skewed to the left. The kurtosis coefficient reflects the degree of flatness at the top of the distribution curve of economic index parameters of tobacco leaves in different regions. The kurtosis coefficient =0 is a normal distribution, the value greater than 0 is more pointed than the normal distribution, and the value less than 0 is flatter than the normal distribution. Among them, only the kurtosis of tobacco planting income and yield per unit is approximately equal to 0. Therefore, tobacco planting income can be regarded as a normal distribution with distribution to the right and yield per unit as a normal distribution with distribution to the left.

Cluster analysis: Cluster analysis is a multivariate statistical analysis method that can search for valuable connections between data from given data, and is widely used in economic society (Yang and Liu, 2012). In this study, the SPSS 25.0 software was used for data analysis. Based on the index of tobacco planting income, systematic clustering was conducted for 25 counties in Shaanxi province (Fig.1). Meanwhile, variance analysis was conducted for the clustering results (Table 3).

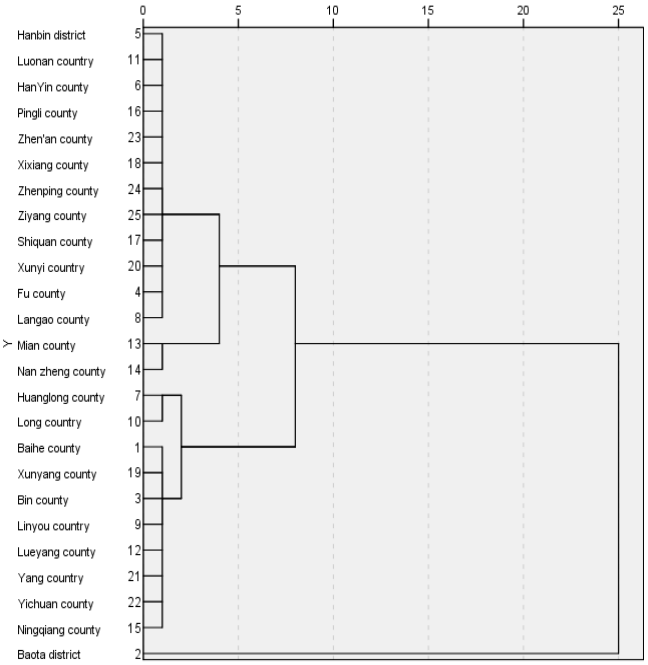

Figure 1. A regionally classified pedigree map using an average join

According to the results of cluster analysis, 25 counties can be divided into 3 categories by taking into account the distance between different classes and the number of county-level in each category. The first category is Baota district, whose tobacco plantation income far exceeds that of other

Table 2. Descriptive statistics of tobacco leaf economic indicators from 2015 to 2019.

Variable	Samples	Mean	Standard Deviation	Minimum	Maximum	Skewness coefficient	Kurtosis coefficient
Y	98	61160.91	15231.44	29151.83	101662.90	0.25	0.01
PA	98	1.43	0.34	0.94	2.72	1.32	1.96
TY	98	2639.83	591.80	1155.15	4313.62	0.42	0.25
OV	98	41512.43	7651.11	26446.32	55604.99	-0.10	-0.89
YI	98	1864.52	247.74	1159.66	2447.37	-0.26	-0.02
AP	98	21.95	2.08	16.28	26.57	-0.17	-0.14
SSR	98	32.16	12.50	6.26	60.49	-0.27	-0.70
MSR	98	61.81	13.60	30.97	91.55	0.30	-0.68
ISR	98	6.03	4.90	0.00	20.72	0.93	0.48
USR	98	35.23	9.76	5.82	57.49	-0.74	1.03
CSR	98	48.85	12.25	21.56	86.79	0.78	1.20
LSR	98	15.92	5.22	5.14	30.10	0.48	0.28

regions. The second category comprised 14 counties of Hanbin district, Luonan county, Hanyin county, Pingli county, Zhen'an county, Xixiang county, Zhenping county, Ziyang county, Shiquan county, Xunyi county, Fu county, Langao county, Mianxian county, Nanzheng county, whose tobacco planting income is lower than that of the first category. Category 3 is the other 10 counties with the lowest income from tobacco cultivation.

Table 3. Gross output value and variance analysis of each cluster in different regions from 2015 to 2019.

Category	Mean	N	Minimum	Maximum
1	85265.94	1	85265.94	85265.94
2	64898.40	14	60531.71	74483.42
3	50702.09	10	45486.71	55203.85
F			64.843	
P			<0.001	

The variance analysis was used to analyze if there was a difference in the total output value of tobacco leaves among the three categories, and the *P* value was far less than 1%, which was statistically significant, indicating that the total output value of tobacco leaves of different categories differed greatly. The total output value of tobacco leaves of category 1 was 1.68 times that of category 3. Among them, the first type of tobacco planting area is Baota district of Yan 'an. Flue-cured tobacco has been listed as the first of the four pillar industries of Yan 'an, namely tobacco, fruit, sheep and potato, making a positive contribution to economic development. However, by comparison with the growth condition of all tobacco planting zones in Shaanxi province, Yan'an region belongs to the sub-suitable areas for tobacco production (Wang, 2012), but tobacco growing income in Baota district is higher than that from the other regions. This may be related to Yan'an tobacco leaf production startegy, although some tobacco planting county has low level of standardization of production (Gong, 2017), but Yan'an actively explored the promotion for Yan'an tobacco planting area "planting large, family farms, cooperatives" three kinds of leaf tobacco production organization way set-up is given a priority to with cultivation of professional investors, family farms and production cooperatives as the auxiliary production organization system (Gong, 2015). Tobacco growers tend to grow more, therefore, tobacco growing income is higher in Baota district. The county areas of category 2 tobacco plantation are mainly concentrated in southern Shaanxi, and the tobacco plantation income is relatively high, which is consistent with the fact that southern Shaanxi is the most suitable tobacco plantation area (Wang, 2012). The county areas of category 3 tobacco plantation are mainly concentrated in Guanzhong, northern Shaanxi and some parts of southern Shaanxi, with the lowest tobacco plantation income. This is because Guanzhong and Yan'an are the second-most suitable areas, wherein tobacco plantation is limited to a certain extent.

Panel data regression results: First, individual effect on the panel data was tested. The P value of F test is 0.0000, which means that the fixed effect model was more suitable for this study than the mixed regression model. However, because the test does not use cluster robust standard error, the results of *F* test are not fully effective. Therefore, the LSDV method was further used to investigate. From the results illustrated in Table 4 the fitting degree of the model reached 0.9976, and more than half of the individual dummy variables were significant at different levels, that is, there had been an individual effect.

Table 4. The results obtained by the LSDV method

County	Significance	County	Significance
Baota district	-0.0021	Nanzheng county	0.0046
Bin county	-0.0642***	Ningqiang county	0.0166
Fu county	-0.0607*	Pingli county	0.0097
Hanbin district	0.0288**	Shiquan county	0.0198**
Hanyin county	-0.0543*	Xixiang county	-0.0019
Huanglong county	0.0631***	Xunyang county	-0.0742***
Langao county	0.0434**	Xunyang county	0.0039
Linyou county	-0.0054	Yang county	-0.0497*
Long county	-0.0392*	Yichuan county	-0.0083
Luonan county	-0.0206**	Zhenan county	0.0135
Lueyang county	-0.0387**	Zhenping county	0.0539***
Mian county	0.0535***	Ziyang county	0.0446***

Note: *, ** and *** represents the significance at 10%, 5% and 1% respectively

The individual effect of the panel data model (FE) usually has a fixed effect model and random effect model (RE), when making an empirical analysis using the steady Hausman test carried out on the model selection; the inspection results of *F* value as 0.0000, rejected to use the random effects of the original assumption, therefore, this study adopts the fixed effect model.

The individual fixed effect model takes into account variables that are affected by individuals but not affected by time. However, there may be variables that are not affected by individuals but affected by time. Therefore, we need to consider if there is a time fixed effect. The fixed time effect was tested. The *P* value of the *F* test result was 0.0026, which is very significant at the 1% level of probability. It rejects the null hypothesis of "no time fixed effect" and considers that the model includes time fixed effect. Therefore, the bidirectional fixed effect model was used to carry out regression. According to the regression results (Table 5), the planting area had an obvious negative effect on the tobacco planting income, which was significant at the significant level of 5%. Although the scale of land can improve the degree of mechanization and tobacco quality to some extent, it is not very useful to increase the income of tobacco growers simply by expanding the scale of tobacco cultivation. It can be seen

Table 5. Regression analysis using the fixed effects model.

Variable	Individual fixation effect	Time fixed effect	Bidirectional fixation
PA	-0.272**(0.0895)	-0.326**(0.108)	-0.324**(0.106)
TY	1.190***(0.0834)	1.282***(0.106)	1.294***(0.104)
OV	1.019***(0.101)	0.956***(0.0933)	0.950***(0.106)
YI	-1.224***(0.109)	-1.274***(0.102)	-1.258***(0.104)
AP	0.146(0.122)	0.213(0.110)	0.233*(0.111)
SSR	-0.00182(0.0125)	0.00909(0.0104)	0.00298(0.0110)
MSR	0.0198(0.0270)	0.0130(0.0238)	0.00710(0.0250)
ISR	0.00347(0.00333)	0.000234(0.00186)	-0.000954(0.00184)
USR	0.0293(0.0339)	0.0110(0.0289)	0.00773(0.0295)
CSR	0.0455(0.0284)	0.0273(0.0306)	0.0167(0.0305)
LSR	0.0191(0.0114)	0.00360(0.0112)	0.00577(0.0140)
Number of samples	86	86	86
Degree of fitting R^2	0.9956	0.9965	0.9967

Note: *, ** and *** represents the significance at 10%, 5% and 1% respectively

Table 6. Production status of tobacco growers of different sizes.

PA	House-holds	Average household area (mu)	Y	OV	YI	TY	AP	SSR	MSR	ISR	USR	CSR	LSR
<10	317	7.48	26137.53	49398.44	2140.33	1070.10	22.95	43.29	47.92	8.79	34.38	50.30	15.32
10-20	6010	14.54	47184.12	45731.72	2009.97	1961.51	22.57	41.91	51.49	6.60	34.59	50.11	15.29
20-30	4641	22.88	68989.05	43002.58	1907.35	2913.35	22.30	41.12	51.79	7.09	35.68	49.92	14.40
30-40	1213	32.20	98942.21	43743.47	1912.40	4110.23	22.64	42.81	50.26	6.93	36.74	49.50	13.76
40-50	447	43.25	124558.68	40873.41	1827.65	5255.96	22.08	42.16	49.18	8.66	40.19	45.27	14.55
>50	102	70.61	202558.16	41384.82	1873.20	8805.23	21.98	38.66	52.21	9.13	44.95	44.35	10.70

from Table 6 that with the increase of planting area, the proportion of per unit yield, per unit output value and the proportion of premium tobacco leaves generally decline. Therefore, the right scale of cultivation is the key to increase the income from tobacco cultivation. The yield per unit also had a significant negative effect on tobacco planting income, which was significant at the 1% probability level.

This is with our usual cognitive discrepancy, the data (Table 6) analysis showed decline with increasing per unit area and cost of production. Specifically, the small and large mass yield of tobacco growers income has affected. It is suggested that measures should be taken to increase per unit cost of production of tobacco growers.

The influence coefficient of output value on tobacco planting income was 0.950, which was significant at the 1% probability level. It shows that the increase of unit output value can promote the tobacco planting income, and the unit output value relates to the unit yield, the quality of the tobacco produced and the purchasing price of tobacco leaves. Therefore, by promoting the scientific management of tobacco field and improving the quality of tobacco production, the output value of tobacco can be improved to increase the income of tobacco growers. The total output had a positive effect on tobacco planting income, and its effect coefficient was higher than that of unit output value, and was significant at the 1% probability level. From the panel data, the current factor affecting tobacco planting income is the total output of tobacco, which indicates that the total output of tobacco can be increased to increase the income of tobacco growers, but at the same time, tobacco demand needs to be considered to achieve the most satisfactory effect. The average price has a positive effect on tobacco planting income at the significance level of 5%, indicating that the increase of tobacco purchasing price has a certain promoting effect on tobacco planting income. Therefore, the state of tobacco monopoly administration can fully mobilize the enthusiasm of farmers to plant tobacco by scientifically setting an appropriate flue-cured purchase price, and achieving the balance between supply and demand, while increasing the income of tobacco growers to complete the purchase plan (Zhang *et al.*, 2007). At the same time, tobacco growers can improve the quality of tobacco production to hunt more revenue.

In addition, the research model shows that the proportion of upper, middle, and lower tobacco leaves had no significant effect on tobacco planting income, which is speculated to be due to the small difference in tobacco purchase prices among different grades, which do not offer a quality advantage.

Conclusion: Based on the theoretical analysis, this paper used data of more than 10,000 tobacco growers in 25 counties of Shaanxi province from 2015 to 2019 for cluster analysis, and

constructed a two-way fixed effect model to explore the influence of tobacco leaf economic traits on tobacco planting income. The study showed that the income of tobacco growers is not balanced among the counties in Shaanxi, and there is a big gap among some counties. The large tobacco growers in the Shaanxi province lack the tobacco scientific and technological power matching with the scale of land management and the planting area as well as unit yield, which significantly and negatively affected the tobacco planting income. The increase of unit output value and total yield of tobacco leaves could promote the planting income of tobacco growers. Raising the purchase price of tobacco leaves can raise the revenue of tobacco cultivation to a certain extent. In general, moderate scale planting and improving tobacco quality are the fundamental measures to promote tobacco growers' income. Based on the above conclusions, this paper puts forward the following recommendation:

Pay attention to the exchange of tobacco planting experience and share advanced experience: The counties of Shaanxi province should pay more attention to the exchange of tobacco cultivation experience, especially learning the more advanced level of tobacco leaf production management and production organization, and need to adopt the local conditions, and choose the appropriate production organization and ecological conditions for tobacco planting.

***Choose the land management scale which is suitable for the local scientific and technological power and advocate the moderate scale planting*:** Scale is the basic characteristic of large-scale production. Scale planting will produce scale economy, bring better economic income and increase the income of tobacco growers. At the same time, the moderate scale of tobacco leaf planting can guarantee the uniformity and stability of tobacco leaf quality, facilitate the effective promotion of mechanized planting, improve the land yield rate and guarantee the economic benefits of tobacco growers. In the final analysis, the scale of land management should commensurate with the local scientific and technological power of tobacco. Small planting scale of tobacco is not suitable for mechanized planting. Besides, it will lead to reduce the income of tobacco growers and decline their enthusiasm. However, large planting scale of tobacco will lead to extensive production and high production costs, which is difficult to obtain the expected benefits. Therefore, the local scientific and technological power of tobacco production should be taken into consideration before determining the planting scale of tobacco.

***Expand the ranks of professional tobacco growers and improve their quality comprehensively*:** The tobacco growers in each county in Shaanxi province are generally with low education, high age and unstable, which are not conducive to the long-term development of tobacco cultivation. The Shaanxi provincial government and Tobacco Monopoly Bureau should both regularly conduct training for professional tobacco growers in order to enhance the quality of professional tobacco growers and strive to cultivate the ranks of professional tobacco growers with culture, technology and managerial experience. The Tobacco Monopoly Bureau also needs to expand the team of tobacco assistants, strengthen the investment and training of tobacco assistants and strive to depute tobacco assistants to each tobacco-growing village. Tobacco assistants can carry out relevant training and check on each production link of flue-cured tobacco, so as to improve the enthusiasm of tobacco growers and improve the quality and output of tobacco.

Improve the production technology of key links of flue-cured tobacco: There are key links in the production of flue-cured tobacco including seeding, seedling cultivation, soil tillage and ridging, transplanting, field management, mature picking, three-stage baking, grading, and sales. To improve the quality and yield of tobacco leaves, we must improve the production technology in these aspects simultaneously, reduce the labor intensity, reduce the number of labors and improve the availability of technology. For example, the seedling link must vigorously implement the reasonable close planting and keep suitable number of leaves. In the field management link, we must implement soil conservation technology, increase the input and application of farmyard manure. In addition, we must implement balanced nutrition technology, precise fertilization, balanced tobacco plant nutrition to improve the quality of tobacco.

***Increase subsidies to tobacco growers for the purchase of machinery and increase the degree of mechanization*:** The mechanized cultivation of tobacco plant is more conducive to saving labor costs, reducing the labor intensity of tobacco growing, reducing the difficulty of growing tobacco, attracting young tobacco growers to join, and injecting young labor into tobacco cultivation. Therefore, it is necessary for the government to increase the subsidies for machinery purchase of tobacco growers, advocate machinery planting and increase the degree of mechanization.

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