

# A Study on Classification Evaluation Technology Diffusion of Occupational Tobacco Growers

Feng Wang<sup>1, a</sup>, Xiangdan Hu<sup>1, b</sup>, Jun Liu<sup>2, c\*</sup>

<sup>1</sup> Branch of Tobacco Company in Southwest Guizhou Province, Xingyi 562400

<sup>2</sup> Guizhou University of Finance and Economics, Guiyang 550025

<sup>a</sup>email: 479095320@qq.com, <sup>b</sup>email: 5267865@qq.com, <sup>c</sup>email: liujunsucceed@163.com

**Key words:** Occupational Tobacco Growers; Evaluation Technology; Technology Diffusion Model

**Abstract:** Based on classical technology diffusion model, classification Evaluation technology diffusion model of occupational tobacco growers is established. With the model, time path function is deduced. Through the depicting of function graphic, we can find it is S-shaped curve. The results show that the internal and external factor of different parts, and the differences of the total number of "potential adopters" lead to the differences of time path function of classification Evaluation technology diffusion of occupational tobacco growers in different areas, and the differences in different leaf tobacco production areas when marketing the technology.

## Introduction

In 2013, the State Tobacco Bureau put forward that the key of tobacco industry's sustainable development is to solve the problem of " who is responsible for the cultivation of tobacco," cultivate occupational tobacco growers, professional services team and workers of tobacco leaf industry, accelerate three separate of professional services in land ownership, operation and management<sup>[1]</sup>. In order to solve the problem that tobacco farmers continue to decline, areas have begun to cultivate occupational tobacco growers. But the understanding to occupational tobacco growers is different. Some areas put occupational tobacco growers understand "agricultural workers" in growing cooperatives. Some areas considered people who have high-level of planting is professional tobacco growers. Some areas considered people whose planting scale beyond a certain degree is occupational tobacco growers. These one-sided misunderstandings may mislead the cultivation of occupational tobacco growers, and make it become a formality. So what kind of farmers are occupational tobacco growers, how many types are there, how to assess them, what is the Evaluation standard, what is the difference between current farmers and them? Combined with the situation of mountain, we make discussion and applied research, hoping to provide reference for cultivation of occupational tobacco growers.

At home and abroad, literature about popularization of classification Evaluation technology diffusion of occupational tobacco growers is few. As so far, there are no scholars who formally proposed the concept of stage about classification Evaluation technology diffusion of occupational tobacco growers. Researches about development of classification Evaluation technology diffusion of occupational tobacco growers are more. Kenneth Hacker and Jan van Dijk (2013) analyzed the statistical data of tobacco growing farm between United States and Netherlands from 2004 to 2010. He thought the interplay of income, education and age have a variety of effects on the "knowledge gap", eventually lead to stage difference of classification Evaluation technology diffusion of

occupational tobacco growers<sup>[2]</sup>. Jos De Haan ( 2004 ) , by introducing six social participation (education participation, economic life participation, social life participation, family participation, cultural participation, political participation) and four kinds of resources (physical device, information consciousness, social culture, leisure time), put forward the gap of classification Evaluation technology diffusion of occupational tobacco growers and established "causal feedback loop" model which illustrate the process of classification Evaluation technology diffusion of occupational tobacco growers from the perspective of causal feedback<sup>[3]</sup>. Jayajit Chakraborty and M. Martin Bosman(2005), according to statistical data of income and knowledge level of tobacco growing area in several states of United States, combined with Lorenz Curve and Gini Coefficient, presented the development process of classification Evaluation technology diffusion of occupational tobacco growers<sup>[4]</sup>. Tim Turpin and Russel Cooper (2005), researched the differences of classification Evaluation technology diffusion of occupational tobacco growers between developing countries, discovered the difference of technology and government policy lead to the difference of popularization degree of classification Evaluation technology diffusion of occupational tobacco growers<sup>[5]</sup>.

### Classification Evaluation Technology Diffusion Model of Occupational Tobacco Growers

Technology diffusion refers to the process of a technology from the first commercial application, through a strong promotion, to general use, until be disqualified for backward. Since the concept of technology diffusion has been put forward, many scholars have studied the diffusion model and some classical technology diffusion model have been produced, such as Bass model cluster. These models assume that the potential number of users who can able to adopt new technologies is  $n$ . At the  $t$  moment, the number of users who adopt new technology is  $m_t$ . Model assumes that potential users will adopt the new technology after learning about it, and the information about new technologies is transmitted through the interaction among users. Information transmission rate is often  $w$ . The probability that a potential user encounters a adopted user is  $w(m_t/n)$ . At the  $t$  moment, the new increasing number of adopted users is  $dm_t = w(m_t/n)(n - m_t)dt$  <sup>[6]</sup>.

#### Basic Assumptions and Variables

Before establish the model, combined with the characteristics of classification Evaluation technology diffusion, this paper gives the following basic assumptions and description of relevant variables:

**Hypothesis 1** The total number of potential adopters is  $N$  ( $N > 0$ , It is generally equal to the region's total population). At the  $t$  moment, there are  $y(t)$  "potential adopters" who have adopted classification Evaluation technology of occupational tobacco growers, and there are  $\{N - y(t)\}$  who have not adopted the technology .

**Hypothesis 2** The number of initial adopters is more than 0,  $t = 0$ ,  $y(0) = T > 0$ , and  $T$  is integer.

**Hypothesis 3** Information began to spread from one external information sources, the

percentage of reaching  $N - y(t)$  adopters is  $a \times 100\%$  at each time. Among them,  $a$  ( $a < 1$ ) reflects a certain rate that external information reach at people who have not adopt, known as external influence coefficient, determined by external factors.

### Time Path Function of Classification Evaluation Technology Diffusion of Occupational Tobacco Growers

#### Derivation of Time Path Function

Starting from  $t$  time, within a time interval  $\Delta t$ , the existing people who not adopt is affected by the external and internal information sources.

(1) Within a time interval  $\Delta t$ , the increasing number of "adopted" caused by external information sources is  $\Delta y(t)^* = a\{N - y(t)\}\Delta t$ .

(2) Within a time interval  $\Delta t$ , the increasing number of "adopted" caused by internal information sources is  $\Delta y(t)^{**} = by(t)\{N - y(t)\}\Delta t$ .

If the effect that "not adopters" were told by external sources or internal information is equivalent, within a time interval  $\Delta t$ , the increased number of "adopted" is

$$\Delta y(t) = \Delta y(t)^* + \Delta y(t)^{**} = \{a + by(t)\}\{N - y(t)\}\Delta t \quad (1)$$

Both sides of equation (1) are divided by  $\Delta t$ , and take the limit, differential equation is obtained.

$$\frac{dy(t)}{dt} = \{a + by(t)\}\{N - y(t)\} \quad (2)$$

With equivalent transformation and integration, equation (2) becomes

$$y(t) = \frac{CN \exp[(a + bN)t] - a}{b + C \exp[(a + bN)t]} \quad (3)$$

In equation (3),  $C$  is constant term. With the initial conditions  $y(0) = T$ , we can get

$$T = \frac{CN - a}{b + C} \quad (4)$$

Then,

$$C = \frac{Tb + a}{N - T} \quad (5)$$

The equation (5) is substituted into equation (3), we can get the solution of differential equation (2)

$$y(t) = \frac{\frac{Tb + a}{N - T} N \exp[(a + bN)t] - a}{b + \frac{Tb + a}{N - T} \exp[(a + bN)t]} \quad (6)$$

So time path function of classification Evaluation technology diffusion of occupational tobacco growers is

$$Y(t) = \frac{1}{N} y(t) = \frac{1}{N} \frac{Tb + a}{b + \frac{Tb + a}{N - T} \exp[(a + bN)t] - a} \quad (7)$$

### Graph of Time Path Function

Equation (7) is elementary function, so it must be continuous. Its first order derivative is

$$Y'(t) = \frac{1}{N} \left\{ \frac{Tb + a}{N - T} \exp[(a + bN)t] (a + bN)^2 \right\} \left\{ b + \frac{Tb + a}{N - T} \exp[(a + bN)t] \right\}^{-2} \quad (8)$$

Similarly, the first order derivative of Function (8) is

$$Y''(t) = \left\{ (a + bN) - 2 \frac{C(a + bN) \exp[(a + bN)t]}{b + C \exp[(a + bN)t]} \right\} Y'(t) \quad (9)$$

The equation (8) is substituted into equation (9), we can get (10)

$$Y''(t) = \left\{ (a + bN) - \frac{2C(a + bN) \exp[(a + bN)t]}{b + C \exp[(a + bN)t]} \right\} \left\{ \frac{C}{N} \exp[(a + bN)t] (a + bN)^2 \right\} \left\{ b + C \exp[(a + bN)t] \right\}^{-2}$$

Order  $Y''(t) = 0$ , we can get turning point of equation (7), with hypothesis 2, hypothesis 3 and hypothesis 4, we know  $Y'(t) > 0$ . Then  $Y''(t) = 0$  is equivalent to

$$(a + bN) - 2 \frac{C(a + bN) \exp[(a + bN)t]}{b + C \exp[(a + bN)t]} = 0 \quad (11)$$

The solutions of equation (11) is  $t = t_{\text{inflection}} = \frac{\ln \frac{b}{C}}{(a + bN)}$ , Point  $(t_{\text{inflection}}, Y(t_{\text{inflection}}))$  is turning point of equation (7).

Equation (10) is elementary function, we can get its first order derivative is

$$(12) Y'''(t) = f^4 C \exp(ft) [b + C \exp(ft)]^{-3} \{ b - 2C \exp(ft) - 3C \exp(ft) [b - C \exp(ft)] \cdot [b + C \exp(ft)]^{-1} \}$$

And,  $f = a + bN$ .

With the judging theorem of concave convex, and  $Y''(0) = \left( \frac{ab + b^2 N}{b + C} \right) \left( \frac{C(a + bN)^2}{(b + C)^2} \right) > 0$ ,

on interval  $t \in [0, t_{\text{inflection}})$ ,  $Y'''(t) > 0$ , namely,  $Y''(t)$  is monotone increasing on interval  $t \in [0, t_{\text{inflection}})$ . So  $Y''(t) > 0$  on interval  $t \in [0, t_{\text{inflection}})$ , function (7) is concave.

In summary, the formula (7) can be made as shown in Figure 1, which is a S shaped curve. The proportion  $Y(t)$  of "adopted" accounted for "potential adopters" is actually determined by four parameters  $a$ ,  $b$ ,  $N$ ,  $T$ .

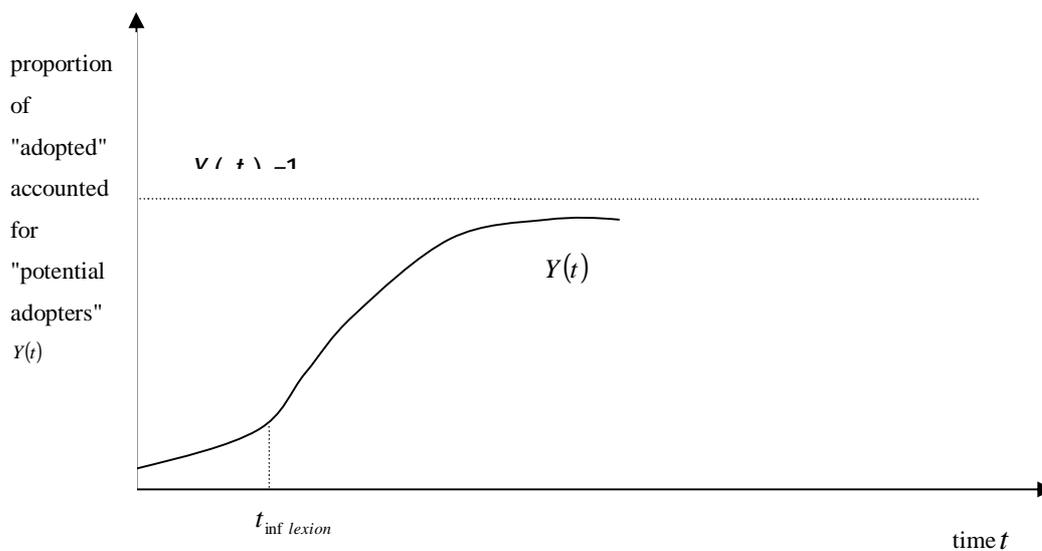


Fig. 1 Time Path Function graph of classification Evaluation technology diffusion

## Conclusion

First, the differences of external factors in different regions lead to different parameters  $a$ ; second, the differences of internal factors in different regions lead to different parameters  $b$ . In addition, the total number  $N$  of "potential adopters" and initially number  $T$  of users in different regions are generally different. Therefore, due to different parameters  $a$ 、 $b$ 、 $N$ 、 $T$  in different regions, time path function  $Y(t)$  is different. At the same time point, difference of function values show a difference between two regions. Over time, this difference will gradually expand, stable down and gradually reduce. This three-stage process of evolution is a universal regularity. This conclusions can explain the difference of classification Evaluation technology diffusion of occupational tobacco growers between different tobacco growing areas and different tobacco farm.

## Reference

- [1] Zhao Qiangshe. Research on cultivation path of professional farmers[J]. Journal of Socialist Theory Guide, 2009(3):56-58.
- [2] Kenneth Hacker, Jan van Dijk. The Digital Divide as a Complex and Dynamic Phenomenon [J].The Information Society, 2003, (19): 315-326.
- [3] Jos De Haan.A Multifaceted Dynamic Model of the Digital Divide [J]. IT& Society, 2004, 1(7): 66-88.
- [4] Jayajit Chakraborty, M. Martin Bosman. Measuring the Digital Divide in the United States: Race, Income, and Personal Computer Ownership [J]. The Professional Geographer, 2005, 57(3): 395-410.
- [5] Tim Turpin, Russel Cooper. Technology, Adaptation, and Public Policy in Developing Countries: the "ins and outs" of the Digital Divide[J]. Essay Review, 2005, (5): 419-427.

[6] Liang Dan, Research progress of technology diffusion [J]. Scientific research management, 2005, 26 (4): 29-34.

**Project Funding:** Research on evaluation of tobacco farmers classification and differential management in southwestern Guizhou (2011-15); Study on the mechanism of foreign assets of tobacco farmers cooperatives inclusive (2015-9); Guizhou Province Science and Technology Fund project ( Qiankehe J [2015] No. 2028); Science and technology project of China National Tobacco Corp Guizhou Branch (201224); National social science fund project (14CJL032)

**Author:** Feng Wang (1979-), male, Ph.D., Professor of Branch of Tobacco Company in Southwest Guizhou Province.