Study on the relationships between farming mechanization degree and labor demand

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Abstract

In this paper, based on existing literature, the relationship between planting industry mechanization degree and labor demand was made a further study. To improve the agricultural mechanization theory and the surplus rural labor force estimates theory. Provide theoretical reference of scientifically estimate the quantities of the labor force in planting industry and surplus labor. Firstly, analysis and point out the deficiencies in the literature [1], it is not considered the impact of planting structure on the farming labor demand. Further analysis indicates a linear alternative relationship while replacing farming workforce with farming units with the same type. The separability of mechanization degree was also proposed and proved. A model of relations between the farming mechanization degree and labor demand was established, and by using the model, it's not only the current amount of labor demand in a particular area can be calculated, but also the amount of labor demand in the various moment in future could be calculated through forecasting mechanization degree and sown areas for the variety of crops in the future. The issues of getting the indicators of the arable land the labor can be burdened when the mechanization degree is 0 and 100% is also discussed. Finally, an example was presented for demonstration purposes.

Keywords

Planting industry,mechanization degree, labor force,relationship, model.

1. Introduction

Mechanization degree is the percentage of mechanical work amount completed in the total amount of work[1-4] . The relationships between farming mechanization degree and labor demand is the basic isscue in the development of agricultural mechanization, and it is also the baisc of scientific estimate of farming labor amount and rural surplus labor amount[5-16]. This problem is first proposed in isscue[1], carried out a systematic study, and obtained the original results. However, isscue[1] does not consider the impact of crop planting structure on labor demand, when it establishes the relation model between the degree of farming mechanization and the labor demand. This has a certain gap between the actual production. As the area of arable land burden by a labor is different between planting a crop and planting a variety of crops, because the peak periods of operation of different crops are different, the area of arable land burden by a labor planting a crop is less than planting a variety of crops. So, the calculate results in accordance to the model given by isscue[1] is more than the actual needs of labor amount. To solve this problem, the author Conducted a study of the improvement and gave an improved model. On this basis, on this basis, discussed the problem of indicators obtaining of an average labor's affordable area of arable land when the Mechanization degree is zero, and when it is 100 percent. Finally, gave a samle calculation. This study aimed to

explore the establishment of the relationship model between farming mechanization degree and labor demand, to discuss the problem of indicators obtaining of an average labor's affordable area of arable land, to promote the development of agricultural mechanization theory and rural surplus labor estimation theory, to provide the reference of sciencal estimation of farming labor amount and rural surplus labor.

2. The replacement relations between the agricultural machinery and labors

With the increasing degree of agricultural mechanization, the needs of labor amount engaged in planting continue to reduce, there is a direct replacement between the two relations[5-10].

Assuming a planting unit can be used to reduce the amount of labor as c, then with the same type of 2 units of labor decreased number of 2c. Similarly available, with the same type of m units of the labor force decreased number of mc. So, this alternative meets this relationship.

$$l(m) \propto cm \tag{1}$$

In this formula, l(m)——the reduction of m units of labor.

Based on the above analysis, we can draw the following conclusions: There is the linear alternative relations when using the same type of unit labor to alternate.

In addition, according to the law of development of mechanization, the power of dynamic mechanical is increasing[1][4], however, it is a gradual historical process, in a relatively short period of time, you can assume that it is basically unchanged.

3. Separability of mechanization degree

Separability refers to the so-called nature, assuming that there are 100 million hm2 farmland, the degree of mechanization is 60 percents, then we can abstrcat it into 60 million hm2 cultivated land whose degree of mechanization is 100 percents, 40 million hm2 cultivated land whose degree of mechanization is 0 percents or all done by human and animal. Then we demonstrate such nature. Assuming the area of arable land is s, the degree of mechanization is x, according to the definition of the degree of mechanization, the area done by mechanization s′, it can be calculatied by this formula:

$$s' = s \cdot x \tag{2}$$

Then the area done by human and animal is s″, it can be calculatied by this formula:

$$s'' = s - s' = s(1-x) \tag{3}$$

Taking the above data into (2) and (3), the above nature is proved. Then we prove the Separability of the degree of mechanization.

4. The construction of relationship model between the of mechanization degree and labor demand

Based on the above results, asscuming the degree of farming mechanization is x(%). When the degree of farming mechanization is zero, the demand of labor number is a, When the degree of farming mechanization is 100 percents, the demand of labor number is b . The area of arable land is s(hm2). The degree of farming mechanization is x, the labor number of planting is L（x）, 0 of degree of mechanization, is all the work done by human and animal. Mechanization level of 100%, means all the operations are done by machinery. According to the Separability of the degree of mechanization, we can establish the following mathematical model

$$L(x) = as(1-x) + bsx \quad 0 \leq x \leq 100\% \tag{4}$$

In this formula, $as(1-x)$ is the labor amount when the work done by human and animal, bsx is the labor amount when the work done by mechanization.

In the actual calculation, in order to facilitate the data accessment, we can use the indicators of an average labor's affordable area of arable land, then the relationship of the amount of labor required

per hectare of crops and an average labor's affordable area of arable land can be definited to this foma:

$$a = \frac{1}{A} \tag{5}$$

$$b = \frac{1}{B} \tag{6}$$

In this formula, A(hm2)——an average labor's affordable area of arable land when 0 degree mechanization. B(hm2) ——an average labor's affordable area of arable land when 100 percents degree mechanization.

Taking the formula (5) and (6) into formula (4), by simplification, then

$$L(x) = \frac{s}{A} + (\frac{s}{B} - \frac{s}{A})x \quad 0 \leq x \leq 100\% \tag{7}$$

This formula is the improved relationship model between degree of farming mechanization and labor demand amount in this paper. In this model, A,B is comprehensive index value, they consolidates the regional characteristics, plant structure, natural conditions, farming patterns, meteorological factors, and many other factors. So, the foma(7) takes into account of a variety of factors, it overcomes the shortage given by the isscue[1] which does not consider the impact of planting structure. During the application process, the value of A and B is the key in this model, and the value is reasonable whether or not is directly affect the results.

By using the model, it's not only the current amount of labor demand in a particular area can be calculated, but also the amount of labor demand in the various moment in future could be calculated through forecasting mechanization degree and sown areas for the variety of crops in the future.

5. Obtaining the burden arable land per labor

Where, the obtain burden arable land of per labor is the arable land of per labor when mechanization degree is 0 and 100%, that is the A value and B value in this article, To scientifically determine the arable burden land of per labor, we must be thoroughly investigated in the actual production, because of regional agricultural production, the estimation of planting demand labor number should be based on regional characteristics, at frist, the estimated area should be divided into several agricultural production zones according to the type of agricultural production. Such as Heilongjiang province can be divided into wheat and soybean producing areas, cereals producing areas, maize and rice growing areas . Different regions because of the different planting structure, natural conditions and different weather conditions and other factors, the labor burden of arable land may be somewhat different.

A value and B value obtained in two ways, one is the direct investigation the value of A and B from farmers, The other is survey to farmers labor burden of arable land under the current mechanization degree in the different mechanization degree in towns and villages , then to the mechanization degree and labor burden of arable land available for linear regression, re-use regression model calculated the value A And B values, Regardless of using which acquisition method ,the survey sample must be sufficient, the need for statistical tests, if the statistical test is not passed, the number of survey sample should be expanded until the statistical test passed.

In the survey, it is necessary to design a good survey form in advance; Second, we must clear that the the arable land of per labor is determined by the the busiest time of job , that is determined by when the largest number of labor input ; third, if there has necessary seasonal workers, the employment of the workforce should be counted in the number of labor demand.

6. Sample Calculation

An area currently has a arable land area of 1,620,000 hectares, the mechanization degree is 80%, when the degree mechanization of 0 and 100%, the arable burden land of per labor available in Table 1.

Table 1 Cultivated area, mechanization degree, the arable land of per labor when mechanization degree is 0 and 100% in one place

arable land /hm^2	mechanization degree /%	the arable land of per labor when mechanization degree is 0 /hm^2	the arable land of per labor when mechanization degree is 100%/hm^2
640000	80	1.5	6.6

Substituting the cultivated area, the degree of mechanization and the arable burden land of per labor when mechanization degree is 0 and 100% into equation (7),then calculation and available farming labor demand numbers in the region.

$$L(x)=\frac{s}{A}+(\frac{s}{B}-\frac{s}{A})\ x$$
$$=\frac{1620000}{1.5}+(\frac{1620000}{6.6}-\frac{1620000}{1.5})\times 0.\ 8=412364$$

In addition, the assumption that according to the survey the changes of mechanization degree and the cultivated area in the region from 2005 to 2014 as shown in Table 2.

Table 2 The mechanization degree and cultivated land in one place from 2005 to 2014

year	mechanization degree /%	arable land //hm^2
2005	60.0	1610000
2006	62.6	1544000
2007	65.1	1505330
2008	67.5	1496000
2009	69.9	1474400
2010	72.1	1473370
2011	74.3	1461140
2012	76.3	1460000
2013	78.2	1458080
2014	80.1	1457200

For the degree of mechanization from 2005 to 2014 regressing,obtained the regression model

$$\hat{x}=\frac{1}{1+0.757e^{-0.112t}} \quad (8)$$

Correlation coefficient r=0.996>r0.05, test value F＝1010.618>F0.05.

Where: t is the time variable, while t get 1,2., ..., 10 respectively in 2005, 2001, ... 2014.

For the arable land from 2005 to 2014 regressing,obtained the regression model

$$s=1442540.90-\frac{175526.30}{t} \quad (9)$$

Correlation coefficient r=0.989>r0.05, test value F＝369.249>F0.05.

According to equation (8), (9) ,respectively forecasting the degree of mechanization and the cultivated land area from 2015 to 2025 in the region , then according to equation (7), obtained the planting labor demand number, the predicted results and calculation results in Table 3.

Table 3 The forecasting value of mechanization degree, cultivated land, plant industry labor demand quantity from 2015 to 2025

year	mechanization degree /%	arable land //hm2	the demand of farming labor / person
2015	81.9	1458497.8	356979
2016	83.5	1457168.1	344643
2017	85.0	1456042.9	333200
2018	86.4	1455078.5	322635
2019	87.6	1454242.7	313011
2020	88.8	1453511.3	304100
2021	89.9	1452866	295981
2022	90.8	1452292.4	288567
2023	91.7	1451779.1	281807
2024	92.5	1451317.2	275656
2025	93.3	1450899.3	270067

7. Conclusion

（1）Firstly, we analysis and point out the deficiencies in the literature [1], it is not considered the impact of planting structure on the farming labor demand;

（2）A model of relations between the farming mechanization degree and labor demand was established, and by using the model, it's not only the current amount of labor demand in a particular area can be calculated, but also the amount of labor demand in the various moment in future could be calculated through forecasting mechanization degree and sown areas for the variety of crops in the future;

（3）Giving the two methods of arable land of the per burden labor can be obtained , and proposed the problem that should pay attention to when the arable land of the per burden labor obtain;

（4）Giving the calculation example that calculated between the farming mechanization degree and labor demand relationship the in the current and future.

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