

Evaluation and Optimization of Equipment Equipping Efficiency of Agricultural Machinery Purchase Subsidy in Jilin Province

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Abstract: The scope of agricultural machinery purchase subsidy is getting wider and wider, the subsidy fund of some provinces is tight, the structure of subsidy fund use in some provinces does not match the structure of agricultural industry in the province, and many other problems, it is necessary to study the effect of the use of the central financial funds of the agricultural machinery purchase subsidy, the funds of the subsidy for the purchase of agricultural machinery are used for the purchase of agricultural machinery, and this dissertation will be an example of the province of Jilin, and evaluate the efficiency of the equipment equipment in the province of Jilin and optimize, so as to be able to guide the specific implementation of the subsidy for the purchase of agricultural machinery of other provinces in the country to serve as a reference, and increase the efficiency of the subsidy for the purchase of machinery.

Keywords: Efficiency, Acquisition subsidies, Agricultural Machinery.

1. Introduction

China's finance began to set up a special fund for subsidizing the purchase of agricultural machinery from 1998, amounting to 20 million yuan per year [1]. Through five years of implementation statistics, the special fund has played a significant role [2]. To 2004, the People's Republic of China Agricultural Mechanization Promotion Law was promulgated, the purchase of agricultural machinery subsidies into the scope of legal protection, the state began to implement the policy of subsidies for the purchase of agricultural machinery, and the investment has increased year by year, as of the year 2015, the total annual investment of 23.7 billion yuan of central financial funds [3-4]. The implementation of the national agricultural machinery subsidy policy has greatly promoted the development of agricultural mechanization and

improved the international competitiveness of agriculture [5-6]. Although the development of agricultural machinery subsidies for more than ten years has made remarkable achievements, there is still a certain gap from fully meeting the needs of China to achieve comprehensive full-scale agricultural mechanization and agricultural modernization. At present, Jilin Province is in the realization of agricultural modernization of this important period, the level of agricultural machinery industry or pull, or constraints on the pace of agricultural modernization, this uncertainty is more prominent. Agricultural machinery industry has reached a critical point where it must adapt to the needs of the times, timely transformation and upgrading [7-8]. As a catalyst for the development of agricultural mechanization, how to implement the policy of subsidies for the purchase of machinery, the state subsidies for agricultural machinery used in the right place, is of great significance.

Table 1. Machine Ownership in Jilin Province, 2015

Categories	Machine items	Number of machines (10,000)
power machine	Below 20 hp	52.16
	Above 20 hp	64.64
	Deep Pine Cultivator	3.92
Tillage machinery	Tillers	0.52
	Mechanical plow	62.78
	Rotary plow	26.44
	Harrow	24.44
	Seeder	54.27
Planting and fertilizing machinery	Rice planting machinery	5.21
	Fertilizer deep applicator	23.8
	Mulching Machine	1.03
Field management machinery	Motorized spraying (powder) machine	1.34
	Combined Harvester	6.32
Harvesting machinery	Cutting and drying machine	0.27
	Other Harvesting Machines	1.61
	Motorized Thresher	15.73
Post-harvest machinery	Grain dryers	0.13
	Seed Processing Machinery	0.19

2. Agricultural Equipment and Subsidies

2.1. Holdings of major machinery

The level of agricultural mechanization in Jilin Province in

2015 was 82.49, of which the levels of machine plowing, machine sowing and machine harvesting were 96.84%, 88.96% and 56.89% respectively. The main technical modalities include plowing and preparation of the land, sowing, field management, harvesting and post-harvest handling. The ownership and subsidy levels of major machinery are shown in Tables 1 and 2.

Table 2. Subsidies for various types of machines in Jilin Province, 2015

Categories	Machine items	Number of machines (units)	Total subsidized funds (million yuan)	Percentage (%)
power machine	Wheeled tractors over 20 hp	32386	47259.52	33.71
Tillage machinery	Deep pine machine	724	251.14	0.18
	Seeding machine	3072	5262.05	3.75
Planting and fertilizing machinery	Rice transplanter	8127	5774.82	4.12
	Seedling tray seeding equipment (including bed soil treatment)	901	305.59	0.22
Field management machinery	Spray bar sprayer (including tractor, self-propelled, hanging spray bar sprayer)	83	138.64	0.10
Harvesting machinery	Grain harvesting machinery	3077	9097.63	6.49
	Forage crop harvesting machinery	133	174.71	0.12
Post-harvest machinery	Corn harvesting machinery	14435	69887.48	49.85
	Grain dryer	185	1379.92	0.98
	Grain cleaning machine	327	673	0.48

3. Evaluation of Agricultural Machinery Subsidized Equipment and Facilities

From Table 2, it can be seen that the level of machine plowing > machine sowing > machine harvesting in Jilin Province in 2015, and the level of machine harvesting is only 56.89%. Therefore, among the three major links of plowing, planting and harvesting, machine harvesting link is the weak link, and from the subsidy table in 2015 (Table 2), it can be seen that the subsidy for maize harvesting machinery accounted for about 50% of the subsidized machinery in the province, which has a great role in improving the level of machine harvesting, and is conducive to helping Jilin Province to realize the whole mechanized operation more quickly.

Corn from sowing to harvest the production process is long, and the harvest time is relatively short, to make the fruits of production labor particles back to the warehouse, reduce mold losses, to ensure that a good yield, a good harvest, timely drying for the grain producers is crucial, only the development of mechanical drying is a good yield, a good

harvest to ensure the conditions. Corn by the influence of climatic conditions, high moisture at harvest, when not timely drying, mold will occur. Of course, you can also sell wet corn directly, but this creates a very limited value, in order to increase the income of farmers, improve the labor enthusiasm of farmers, so for grain drying machinery subsidies should be appropriately increased, and the subsidies for grain dryers in 2015 for 13.8 million yuan, accounting for only 1% of the total amount of subsidies (Table 2), in order to achieve the acceleration of agricultural machinery during the "thirteenth five-year" period, the total subsidy amount of 13.8 million yuan. To achieve the goal of accelerating the overall development of agricultural mechanization during the "13th Five-Year Plan" period, the subsidy for the weak link of post-production treatment of grain should be increased.

The amount of subsidies for power machinery also accounted for 33% of the total amount of subsidies (Table 1), is relatively large relative to other types of machinery subsidies, but from the line graph (Figure 2) can be seen, the tractor's operating area of a single machine declined year by year, so after the tractor subsidies can be considered appropriate to reduce.

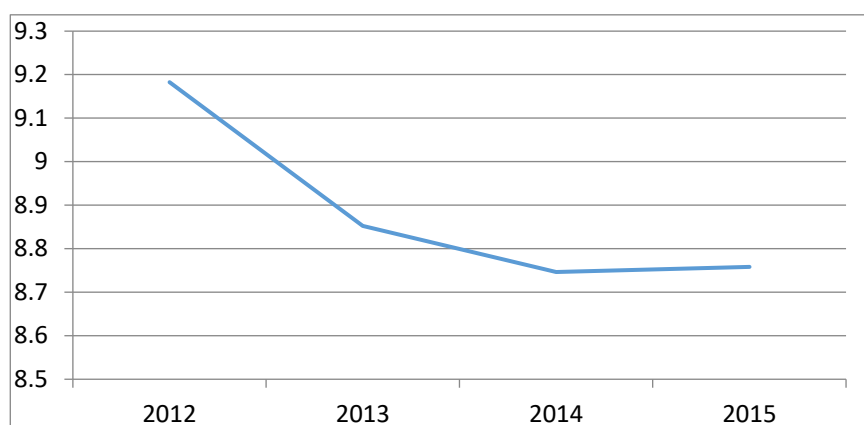


Figure 1. Area operated by a single tractor in Jilin, 2011-2015

Note: Single-machine operating area = total operating area×number of operations / tractor ownership (Jilin for a year, take the number of operations for 1; due to the harvesting machinery is basically self-propelled and according to the subsidies to self-propelled year by year to the development of backpacks and traction accounted for a relatively small proportion of self-propelled harvesters do not need tractor traction, it is ignored here, remember the total area of operations = area of mechanized ploughing + area of mechanized sowing)

4. Optimization of Equipping

Since there is no current query on the appropriate time for each agricultural mechanization production operation in the whole Jilin Province, given that the natural conditions of the whole Jilin Province do not vary much, the appropriate time for the agricultural mechanization production operation in Yushu City, Jilin Province, is used instead of that in Jilin Province for the calculation. And because corn accounts for a large proportion of agricultural production in Jilin Province,

corn is used as an example.

4.1. Variable Settings

Corn agronomic profit: 1500 yuan/ha

Construct a linear programming model for the tractor and supporting implements, and the detailed variables of the supporting units are set as follows:

X1---tractors X2---tillage machinery
 X3---planting machinery X4---field management machinery
 X5---Harvesting machinery X6---post-harvest handling machinery

The variable for the number of operating unit shifts is set as follows:

X7---Tractor+tillage machinery operating unit shifts
 X8---Tractor + seeding machinery number of operating shifts
 X9---Number of tractor + harvesting machine work shifts
 X10---Number of tractor + post-harvest handling machinery operating shifts

The data are presented in the table 3-5.

Table 3. Agricultural machinery operation project time and its productivity

No.	Item	Date of Operation	Number of shifts that can go down to the ground	Shift productivity*number of shifts variable (hm ²)
1	Tillage	4.10-4.20	10*2*0.8=16	7 X ₇
2	Seeding	4.22-5.4	13*1*0.75=9.75	10 X ₈
3	Aerial plant protection	7.9-7.16	8*1*1=8	100
4	Harvesting	10.16-10.28	13*1*0.8=10.4	9 X ₉
5	Straw collection	10.24-11.13	20*1*0.8=16	13 X ₁₀

Table 4. Variable costs of aircrew operations

No.	Item	Auxiliary units	fuel cost (yuan/ hm ²)	Payroll (yuan/ hm ²)	maintenance cost (yuan/ hm ²)	Overall (yuan/ hm ²)
1	Tillage	Tractors, Tillage machinery	340	19	240	599
2	Seeding	Tractors, planting and fertilizing machinery	110	20	210	340
3	Aerial plant protection	Tractors, field management machinery	—	—	—	238
4	Harvesting	Harvesting machinery	265	125	100	490
5	Straw collection	Post-harvest machinery	100	15.3	100	215.3

Table 5. Annual fixed costs

machine	prices	Annual fixed costs (yuan/unit)
Tractors	187725	10050
Tillage machinery	123000	6520
Planting Machinery	56800	3017
Field management machinery	—	—
Harvesting machinery	260000	13701
Post-harvest machinery	17000	1035

4.2. Model

(1) Operating area constraints:

$$\sum W_{s(k)} X_{s(k)} \geq A_k \dots \dots \dots (k = 1, 2, \dots, 5)$$

In the formula:

k---operation number

S (k)---operation unit variable number associated with the kth operation

Ak---operational area associated with the kth operation

Xs (k)---shift variable of the skth operation unit

Ws (k)---shift productivity of the skth operation unit

The calculation process is as follows:

Plowing operation: $7 X7 \geq 3674370$

Sowing operation: $10 X8 \geq 4054260$

Aerial plant protection operation harvesting operation: $9 X9 \geq 2368420$

Straw collection operation: $13 X10 \geq 2368420$

(2) Tractor Equipage Constraints:

Prepared by model and stage of operation

$$\sum X_{s(i)} \geq M X_i \dots \dots \dots (i = 1, 2)$$

The equation indicates that the sum of the number of shifts required for each operation for a particular type of tractor at a given stage shall not be greater than the maximum number of shifts that can be provided by that type of tractor. In the formula,

i---Tractor variable number

S (i)---Variable number of tractor units of type i used at a given stage

Xi---Number of tractors of type i

Xs (i)---Number of operating shifts for unit Si

M---Maximum number of shifts for operations and combinations of operations that can be performed by tractor type i

Tilling stage: $X7 \leq 16X1$

Sowing stage: $X8 \leq 9.75X1$

Harvesting stage: $X9 \leq 10.4 X1$

Straw collection phase: $X10 \leq 16X1$

Harvesting and straw collection phases, with intersecting time periods, therefore: $X9 + X10 \leq 29 * 0.8$

(3) Constraints on the availability of implements: the sum of the number of shifts required for each operation of the tractor shall not be greater than the maximum number of shifts that can be provided by its supporting implements.

Tillage machinery: $X7 \leq 16X2$

Planting machinery: $X8 \leq 9.75X3$

Harvesting machinery: $X9 \leq 10.4X5$

Post-harvest processing machinery: $X10 \leq 16 X6$

4.3. Objective function equation

(1) Revenue = crop agronomic profit - change in cost of machinery operations - annual prescribed cost of machinery and equipment

(2) Variable cost of machinery operations = $7 * 599 * X7 + 10 * 340 * X8 + 9 * 238 * X9 + 13 * 215.3 * X10$

(3) Annual fixed cost of machinery and equipment = $10050 * X1 + 6520 * X2 + 3017 * X3 + 13701 * X5 + 1035 * X6$

Benefit = $1500 * 2368420$ - Variable cost of machinery operation - Annual fixed cost of machinery and equipment

Through Lingo11.0 programming calculation and solution can be obtained, the number of machinery required for corn

operations in Jilin Province is as follows (machines in units of 10,000 units, and the results of the solution are rounded to the nearest whole number):

X1= 55	X2= 62
X3=50	X4= 10
X5=21	X6=16
X7= 700	X8=450
X9=212	X10=245

5. Research Gaps and Further Ideas

When calculating the operating area of a single tractor, it is assumed that all harvesting machines are self-propelled and do not need to be towed by a tractor, which should be multiplied by a certain coefficient to minimize the error.

There are many factors affecting the implementation of subsidies for machine purchasing, including social economy, natural environment, subsidy mechanism, etc. Although mentioned in this thesis, the discussion is not very sufficient, only for the analysis and optimization of this piece of equipment, and the follow-up needs to be further detailed and in-depth analysis.

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