**Table 1. Achievements of soap horn industry development models.**

|  |  |
| --- | --- |
| **Connotation of development model** | **Achievement** |
| Product innovation with three interlocking links | Developed five series of saponin cleaning products, natural saponin stock solution Dish-washing liquid, laundry detergent, soapy rice three gel face and other domestic exclusive products |
| The revenue from soap horn cleaning products reached 8.6 million yuan in 2019, and the revenue exceeded 13 million yuan in 2020. |
| Developed a soap rice series of nutritional foods, with a revenue of 3.9 million yuan in 2020. |
| Innovative model of tripartite collaboration | The school enterprise cooperation has become a supporting unit for the provincial engineering technology research center of natural plant cleaning technology in Henan Province. |
| Establish an advanced natural plant cleaning industry technology research and development base. |
| Obtained a county (city) innovation guidance plan project in Henan Province, with a funding of 500000 yuan. |
| Development model of integrating three industries | Establish a standardized planting base for three varieties, covering an area of 900 acres, while also establishing a seedling breeding base, covering an area of 104 acres. |
| Holding a standardized soap horn planting base of 2160 acres and a breeding experiment base of 510 acres. |
| A soap horn cleaning solution production factory consisting of extraction workshop, cleaning solution production workshop, and packaging workshop, with laboratories and inspection and analysis rooms. |
| Preliminary construction of an ecological planting and product experience ecological sightseeing park for soap horn. |

Note: The data in the table was sourced from the poverty alleviation summary report of Henan Hanyi Daily Chemical Technology Co., Ltd.

**Table 2. The determination criteria of coordination degree.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Coordination degree** | **0.8< *H* ≤ 1** | **0.6 <*H* ≤ 0.8** | **0.4 < *H* ≤ 0.6** | **0 < *H*≤ 0.4** |
| Grade | Very collaborative | Compare coordination | General coordination | Uncooperative |

**Table 3. Indicator analysis of enterprise innovation and farmer benefits in soap horn industry.**

| **Indicator type** | **Indicator selection** | **Indicator characterization** | **Average value**  **(2016)** | **Average value**  **(2017)** | **Average value**  **(2018)** | **Average value**  **(2019)** | **Average value**  **(2020)** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Input indicators | Farmer work input | day | 1664 | 2392 | 6500 | 9672 | 19032 |
| Government and enterprise joint investment funds | ten thousand yuan | 2000 | 1000 | 62 | 78.42 | 137.8 |
| Various government financial incentives | ten thousand yuan | 4 | 4.25 | 5.3 | 5.5 | 5.5 |
| Annual guidance frequency of universities | frequency | 1 | 3 | 3.3 | 5.6 | 7.2 |
| University research funding | ten thousand yuan | 8000 | 9000 | 7500 | 10100 | 12000 |
| The highest education level of senior managers | 1=Primary school and below  2=Junior high school  3=High school and technical secondary school  4=University and junior college  5=graduate student | 4 | 4 | 4 | 4 | 4 |
| Frequency of enterprise meetings | frequency | 5 | 9 | 11.6 | 11.6 | 11.8 |
| Annual R&D investment of enterprises | ten thousand yuan | 150 | 195 | 225 | 207.6 | 223.8 |
| Output indicators | Enterprise market share | % | 0.10 | 1 | 1 | 2 | 2 |
| Number of signed contracts | number | 5 | 20 | 10.8 | 18.3 | 20.8 |
| Per capita annual income of farmers | ten thousand yuan | 0.6875 | 0.6825 | 0.7993 | 0.8455 | 0.8595 |
| Number of beneficiary farmers | number | 150 | 275 | 293 | 386 | 467 |
| Annual skill training frequency | frequency | 8 | 4 | 4 | 4.1 | 6.4 |
| Satisfaction of farmers | 1=very dissatisfied  2=dissatisfied  3=generally satisfied  4=Satisfied  5=very satisfied | 4 | 4 | 4 | 4 | 4.75 |
| Average yield per mu | ten thousand yuan | 4360 | 5610 | 7180 | 8570 | 10900 |
| Enterprise sales | ten thousand yuan | 670 | 1100 | 1510 | 2160 | 2360 |
| Honor level related to schools and enterprises | 1=Enterprise level  2=County level  3=prefecture level  4=Province level  5=National level | 4 | 6 | 9 | 15 | 24 |
| Contribution rate of enterprise innovation | % | 15 | 22 | 39 | 49 | 63 |

**Table 4. Synergy analysis of input and output indicators in enterprise development.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Indicator type** | **Indicator selection** | **Indicator characterization** | **Standard deviation** | **Average value** | **Synergy(H)** |
| Input indicators | Government and enterprise joint investment funds | ten thousand yuan | 319.8750 | 2560 | 0.8750 |
| Various government financial incentives | ten thousand yuan | 0.64992 | 4.91 | 0.8676 |
| Annual guidance frequency of universities | frequency | 2.1581 | 4.02 | 0.4631 |
| Farmer work input | day | 6296.5967 | 7852 | 0.1981 |
| University research funding | ten thousand yuan | 1609.2234 | 9320 | 0.8273 |
| The highest education level of senior managers | 1=Primary school and below  2=Junior high school  3=High school and technical secondary school  4=University and junior college  5=graduate student | 0 | 4 | 1 |
| Frequency of enterprise meetings | frequency | 2.6138 | 9.8 | 0.7333 |
| Annual R&D investment of enterprises | ten thousand yuan | 27.4729 | 200.28 | 0.8628 |
| Output indicators | Enterprise market share | % | 0.7167 | 1.22 | 0.4126 |
| Number of signed contracts | number | 6.1183 | 14.98 | 0.5916 |
| Per capita annual income of farmers | ten thousand yuan | 0.0760 | 0.77486 | 0.9019 |
| Number of beneficiary farmers | number | 107.1922 | 314.2 | 0.6588 |
| Annual skill training frequency | frequency | 1.6322 | 5.3 | 0.6920 |
| Satisfaction of farmers | 1=very dissatisfied  2=dissatisfied  3=generally satisfied  4=Satisfied  5=very satisfied | 0.3 | 4.15 | 0.9277 |
| Average yield per mu | ten thousand yuan | 2284.0368 | 7324 | 0.6881 |
| Enterprise sales | ten thousand yuan | 633.4350 | 1560 | 0.5940 |
| Honor level related to schools and enterprises | 1=Enterprise level  2=County level  3=prefecture level  4=Province level  5=National level | 7.2277 | 11.6 | 0.3769 |
| Contribution rate of enterprise innovation | % | 17.49997 | 37.6 | 0.5346 |

Note: “Honor level related to schools and enterprises”=.