



**发展菌草业 造福全人类**

**Develop Juncao Industry to Benefit All Humankind**

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**China National Engineering Research Center of Juncao Technology**

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# I

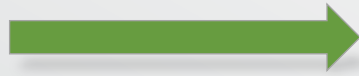
## 什么是菌草？

## What is Juncao?



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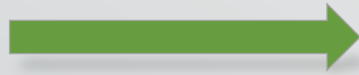
菌



真菌、菌菇  
mushrooms or fungi

c a o

草



草本植物  
grass or herbaceous plant

为了破解“菌林矛盾”，1983年林占熺研究员开展了“以草代木”栽培食药菌研究，于1986年发明了菌草技术。

Research on Juncao technology ‘using grass to replace wood’ to grow edible and medicinal mushrooms started in 1983, and firstly succeeded in 1986.



菌草技术发明人林占熺

Inventor of Juncao Technology- Prof. Lin Zhanxi

菌草：

- “菌”与“草”交叉的、新的研究领域
- 草品种的一个新类别
- 一类新开发利用的农业资源

形成菌草技术体系

**Juncao:**

- A **new research field** that covers fungi & herbaceous plant.
- A **new category** of grasses.
- A **newly developed agricultural resource**.

- Juncao technology
- Juncao technical system
- Juncao industry





建设了中国**唯一**的国家菌草工程技术研究中心。

The **China National Engineering Research Center of Juncao Technology** was established in Fujian Agriculture and Forestry University.





## II

# 茵草技术的研究与应用

# Research & Application of Juncao Technology



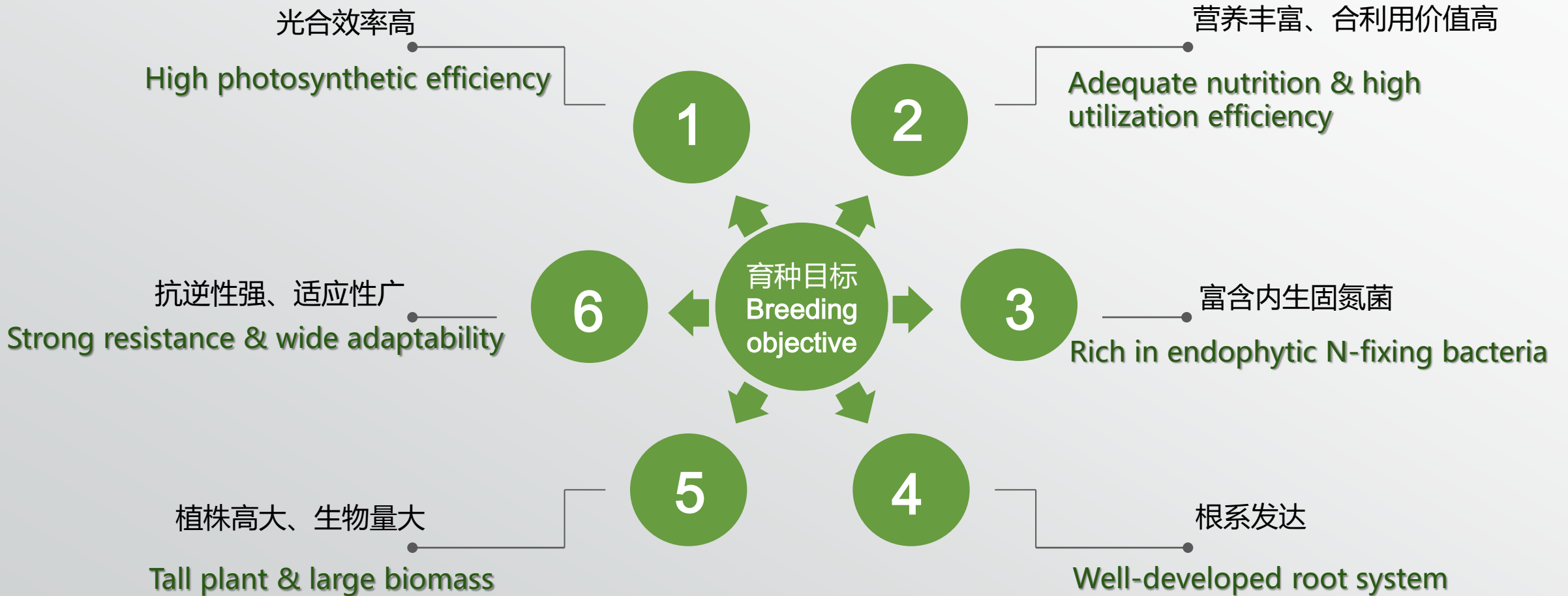
上世纪80年代，以筛选野生资源丰富的草本植物为主要目标。90年代起，以适宜不同气候条件下可规模栽培的草种为主要目标。

**In the 1980s:** wild grasses, agricultural byproducts

**Since the 1990s:** Juncao grass species adapted to different climate conditions and planted at a large scale









人工栽培的巨菌草鲜草年产量最高达**853**吨/公顷  
(巴布亚新几内亚东高地省葛罗卡市)

The highest annual yield of fresh Giant Juncao grass (*Pennisetum giganteum* Lin.) reaches **853** tons/hectare recorded in Goroka, Eastern Highland province, Papua New Guinea.

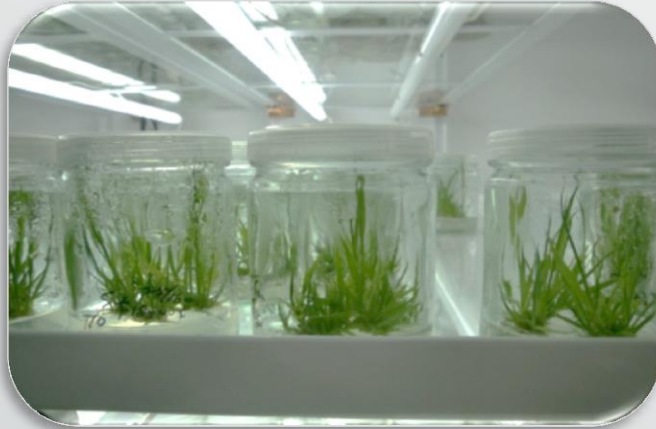




● 巨菌草  
Giant Juncao Grass

筛选后的巨菌草和绿洲1号与青贮玉米、苏丹草、红高粱、紫花苜蓿在干旱地区进行对比试验

Planting experiment in dry area comparing Giant Juncao grass with Oasis No.1, Silage corn, Sudan grass, Red sorghum and Alfalfa



组培和繁育  
Tissue culture & propagation



扦插育苗 Cutting propagation

## 2.2 菌业 Mushroom Industry



已筛选适用“以草代木”栽培的食药菌品种**56种**，开辟了菌业可持续发展的途径。例：栽培香菇，若菌草替代**50%**木屑原料，年可节约木材**1000万m<sup>3</sup>**。

**56** kinds of edible and medicinal mushrooms are cultivated. Eg. Xianggu (shiitake/*Lentinula edodes*) cultivation, if Juncao grass replaces **50%** wood, **10 million m<sup>3</sup>** wood will be saved per year.



Growing *Lentinula edodes* with Juncao Grass  
(**500g of dry substrate produce 350-400g of fresh mushrooms**)



Growing *Ganoderma lucidum* with Juncao Grass  
(**Spent mushroom packs can be used as feed additives**)



1公顷菌草（鲜草300-500吨），可生产鲜菇120-150吨，不仅产量高，而且质量好，可持续发展。生产方式灵活，即可千家万户小农户参与，也能企业大规模投资生产。菌菇深加工产品如功能性食品、保健品与药品等大大提高附加值。

➤ **High yield, good quality, and sustainable development.**

1 ha land with yield of 300-500 tons of fresh grass can produce 120-150 tons of mushrooms, valued at 360,000-450,000 USD (1kg fresh mushroom USD 3.00) .

➤ **Flexible production methods**

Suitable for large-scale production and small farmers.

➤ **High value-added products**

Deep-processing mushroom products such as tonic food products, health care products and medicines.





菌草菇粗蛋白含量高

Higher crude protein level of Juncao mushrooms produced with grass substrate

A comparison of crude protein content of mushrooms cultivated with Juncao & other raw materials

Varieties	Raw materials		Protein ratio 蛋白质含量比
	Juncao formula	Other formula	
<i>Tremella fuciformis</i> 银耳	15.74 ( <i>Neyraudia reynaudiana</i> )	13.74 (Cotton seed hulls)	1.14
<i>Dictyophora indusiata</i> 竹荪	22.79 ( <i>Dicranopteris dichotoma</i> , <i>Neyraudia reynaudiana</i> )	18.53 (Bamboo shavings)	1.23
<b><i>Lentinula edodes</i></b> 香菇	<b>32.836 (<i>Dicranopteris dichotoma</i> , <i>Miscanthus floidulus</i>)</b>	<b>28.787 (Wood chips)</b>	<b>1.14</b>
<i>Auricularia polytricha</i> 毛木耳	8.212 ( <i>Dicranopteris dichotoma</i> , <i>Miscanthus floidulus</i> )	7.997 (Wood chips)	1.02
<i>Auricularia auricula</i> 黑木耳	17.832 ( <i>Dicranopteris dichotoma</i> , <i>Miscanthus floidulus</i> )	9.861 (Wood chips)	1.81

# 2.2 菌业 Mushroom Industry



**Milling**



**Packaging**



**Sterilization**



**Inoculation**



**Incubation/spawn run**



**Mushroom Fruiting**





菌草的粗蛋白含量高，适口性好，可饲喂家禽家畜如牛、羊、鹅、鹿、兔、猪、竹鼠、鱼等。

High content of crude protein, good for poultry and livestock such as cattle, sheep, geese, deer, rabbits, pigs, bamboo rats, fish and etc..

检测指标 Test Index		结果 Results (% DM)
水分moisture content		78.8
干物质 dry matter		21.2
蛋白质 protein	粗蛋白 crude protein	15.4
	可溶性蛋白 soluble protein	6.4
	氨态氮 ammonia nitrogen	1.12
	酸性洗涤不溶蛋白 acid detergent insoluble protein	0.95
	中性洗涤不溶蛋白 neutral detergent insoluble protein	3.76
纤维 fiber	酸性洗涤纤维 acid detergent fiber	38.7
	中性洗涤纤维 neutral detergent fiber	63.9
	木质素 lignin	3.27

检测指标 Test Index		结果 Results (% DM)
碳水化合物 carbohydrate	醇溶性碳水化合物 alcohol soluble carbohydrate	4.9
	水溶性碳水化合物 water soluble carbohydrate	5.9
	淀粉 starch	1.5
	脂肪酸 fatty acid	45.6
	总脂肪酸 total fatty acid	1.7
	不饱和脂肪酸 unsaturated fatty acid	1.05
	粗脂肪 crude fat	3.72
矿物质 mineral	灰分 ash	12.64
	钙 Ca	0.36
	磷 P	0.4
	钾 K	3.38
	镁 Mg	0.25



## 巨菌草 VS 青贮玉米 Giant Juncao grass vs Silage corn

品种 Variety	鲜草产量/产值 Yield of fresh grass (t/ha, Yuan)	粗蛋白产量 Crude protein (t/ha)	年耗水量 Water consumption (t/ha per year)	肉牛饲料成本 Cost of cattle feed (Yuan/head)
巨菌草 Giant Juncao grass	300/105,000	25.2	2700-3300	3200
青贮玉米 Silage corn	90/31,500	10.5	5250-6000	4500

## 巨菌草 VS 臂形草 Giant Juncao grass vs Arm grass

斐济 **Legalega** 研究站试验结果，生长8个月的巨菌草的粗蛋白含量是 **12.74%**，当地的传统牧草臂形草只有 **5.40%**。

**Fiji Legalega** research station test:

**Crude protein content:**

8-mth Giant Juncao grass **12.74%**

local Arm Grass **5.40%**





巨菌草青贮后pH为3.94，  
巨菌草在肉牛、羯羊的DM和CP瘤胃有效降解率分别为  
46.80%、49.29%和59.52%、57.89%，**达到中上等牧草  
标准。**

在甘肃农民合作社，青贮巨菌草、青贮玉米饲喂牛，每头  
牛日增重分别为1.1kg、1.16kg。

**青贮巨菌草饲喂牛的增重效果与青贮玉米相近。**

- pH of silaged Giant Juncao grass = 3.94
- The effective degradation rate of DM and CP in the rumen of beef cattle and wether are 46.80%, 49.29%, 59.52% and 57.89%, respectively, which reaches the middle and upper forage standard.
- In the Farmers' Cooperative of Gansu province, silaged Giant Juncao grass and silaged corn are fed to cattle, and the daily gain of each cattle are **1.1kg and 1.16kg** respectively. The weight gain of cattle fed with silage Giant Juncao grass is similar to that of silage corn.



巨菌草收割

Harvest of Giant Juncao Grass



巨菌草打包

Packing of Giant Juncao Grass



巨菌草青贮包

Silage Pack of Giant Juncao Grass



种植一年生、多年生的菌草品种

Planting annual and/or perennial *Juncao* grass species



Desertification



Soil erosion - collapsing hill



Saline-alkali soil



Rocky desertification



Mine rehabilitation



Moving sand dune



种植巨菌草土壤流失率比种植玉米地减少97.05-98.9%，水量流失率减少80.0-91.9%。

The soil loss rate and water loss rate were reduced by 97.05-98.9% and 80.0-91.9% respectively.

栽培模式 Cultivation models	土壤湿重 Wet weight of soil (kg)	土壤干重 Dry weight of soil (kg)	与传统农作物相对减少土壤流失率 Reduce soil loss rate compared to traditional crops (%)
当地传统栽培农作物模式 model of local traditional crop cultivation	656.7	484.18	—
等高线巨菌草活篱笆套种农作物模式 Model of intercropping crops with Giant Juncao on contour line	27.18	20.25	95.80%
种植巨菌草模式 Model of planting JUNCAO	8.6	5.93	98.90%



卢旺达种植菌草治理水土流失  
Planting Juncao grass to control soil erosion in Rwanda



**菌草作为先锋植物建设菌草生态安全屏障：**防风固沙、保持水土：种植菌草**80~100**天能有效防风固沙，在高寒地区，2013年种植的菌草到2021年仍可有效固沙。

Demonstration of the **Ecological Safety Juncao Barrier** using Juncao grass as **pioneer plant** along **Yellow River**, successful wind-preventing and sand-fixing within **80 to 100** days





Location	Ulan Buh Desert
Growth period	115 days
Plant height	246.5cm
No. of tillers	68
Fresh weight above the ground	12.71kg
Fresh weight under the ground (root system)	11.04kg
The number of roots	618
The depth of root	121.5cm
Sand fixing surface area	18.85m <sup>2</sup>
Sand fixing volume	11.45m <sup>3</sup>





改良土壤：种植一年沙地有机质含量增加**58.97%**，沙地土壤微生物和昆虫种类和数量显著提高，第二年便可种植马铃薯、花生、西瓜等作物。

### Soil improvement:

1<sup>st</sup> year: the organic matter content of sandy land increased by **58.97%** , significantly enriches its soil microbes and insect species;

2<sup>nd</sup> year: other economic crops such as potato, watermelon, and peanuts could be planted.







每公顷土地年产出**450**吨鲜草计算：可以用来生产**160**m<sup>3</sup>板材或 约2万美元**45**吨的菌草纸浆。

Taking the yield of fresh grass as **450** tons per ha. per year, it will produce **160** m<sup>3</sup> of fiberboard or **45** tons of grass pulp .



## 2.6 生物质能源 Biomass energy



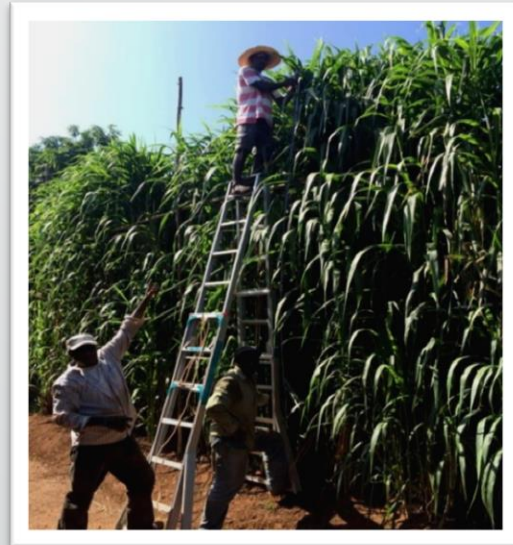
1公斤巨菌草（干物质）燃烧值为**3580** K cal，相当于0.716公斤原煤的燃烧值；可产沼气0.548立方米。

The combustion value of dry Juncao grass (Giant Juncao grass) is **3580** kcal/kg, equivalent to 0.716 kg raw coal; and it can generate 0.548 m<sup>3</sup> biogas.



52.5-60吨原煤

52.5~60 tons raw coal



1公顷巨菌草

1ha Giant Juncao grass



7.4万立方米沼气

74,000 m<sup>3</sup> biogas



### III

**南南合作，服务可持续发展目标**  
**South-South Cooperation (SSC),**  
**promote the implementation of SDGs**



农民种植菌袋7-10天后就有收入，10平方米土地年产1200公斤鲜菇。

Farmers can generate income in 7-10 days after planting mushroom substrate packs. 1,200 kilos fresh mushroom could be produced in a 10 square meters land in a year.

1公顷土地年产鲜草300-500吨，可生产120-150吨鲜菇，或饲喂30只牛/300只羊。

1 hectare land produces 300-500 tons fresh grass per year, which can grow 120-150 tons fresh mushroom, or feed 30 cattle / 300 goats.

福建农林大学已把菌草技术传播到106个国家，并与41个国家的71家机构建立合作关系。

Fujian Agriculture and Forestry University has disseminated Juncao Technology in 106 countries, and has established collaboration with 71 institutions in 41 countries.

菌草可栽培54种菌类，菌菇含粗蛋白30%~45%、粗多糖4%~7%以及多种有效物质，对人体健康多有裨益。

54 species of mushrooms can be cultivated with Juncao grass. The mushrooms contain 30%~45% crude protein, 4%~7% crude polysaccharides and a variety of effective substances, which are beneficial to human health.

一些菌草品种可作为先锋植物治理荒漠化。1个节的巨菌草种植100天后，约10-20个分蘖，其根系可固沙约15平方米。Some Juncao grass species are used as pioneer plants for desertification control. After 100 days of planting, 1 node of Jujuncao (means giant Juncao) grass will grow into a clump with about 10-20 tillers, and the root system can fix sand about 15 square meters.

举办了202期国际培训班，7817名学员来自100多个国家；为11个国家21人提供菌草专业研究生奖学金。Conducted 202 International Training Courses with 7,817 participants from over 100 countries, and offered postgraduate scholarships on Juncao Technology to 21 students from 11 countries.

1公顷菌草吸收约90吨二氧化碳。受极端气候影响情况下可快速恢复生产，并能减轻如飓风等带来的次生灾害的影响。1 hectare of Juncao grass can absorb about 90 tons of carbon dioxide. It can quickly resume production under the influence of extreme weather and can reduce the impact of secondary disasters such as hurricanes.

促进妇女的技术教育，提供就业，特别是增强了农村缺乏土地资源与知识技能的妇女的能力。Promote the technical education and employment of women, especially for those who are lack of land resources, knowledge and skills in the rural areas.

以草代木种菇，实现草、菌、畜循环生产。种菌草不使用杀虫剂、除菌剂、除草剂等。By planting mushroom with the Juncao grass instead of the wood, it can create a positive production cycle of grass, mushroom and livestock. Planting Juncao grass can be free from using pesticides, herbicides and fungicide.

菌草燃烧热值3580kcal/kg。每吨菌草干物质产沼气率548立方米。The caloric value of the combustion of Juncao grass is 3580 kcal/kg. The biogas production rate of Juncao grass is 548 cubic meters per ton of dry matter.

老年人、残疾人、失业者、失地者、孤儿、寡妇、单身母亲、管教所青年，乃至最贫困的人都从菌草技术生产活动中受益。The aged, disabled, jobless, landless, orphans, widows, single mothers, youths in correction center, and even "the poorest of the poor" have benefited from the Juncao Technology production activities.

1公顷菌草菇农场年产值约30万美元，可提供至少30个工作岗位。The annual output value of 1 hectare Juncao mushroom farm is about US\$300,000, which can provide at least 30 job opportunities.

福建农林大学为几千名发展中国家研究人员和学生提供菌种、草种、教材和技术信息，以支持研究活动。其海外示范基地为无数来访者提供技术咨询。

FAFU has provided mushroom strains, grass seedlings, teaching materials and technical information for thousands of researchers and students of developing countries to support their research activities. The overseas demonstration bases have also offered assistance to numerous visitors for technical consultation.





在福建农林大学培养菌草专业**24**名留学生。

为106个国家培训人数总计10704人次（研究人员，学生和农户）提供技术支持。

## Nurture technical personnels:

- **24** international students from Lesotho, Rwanda, South Africa, Nigeria, Ghana, Egypt, Tanzania, Kenya, Afghanistan, Malaysia and Palestine studied in FAFU
- FAFU provided training and technical support to **10,704** researchers, students and farmers from **106** countries including mushroom strains, grass seedlings, teaching materials and technical consultancy. Many of our trainees and students are active technical consultants or creating own business in their countries.
- Set up Juncao technology demonstration bases in **13** countries.





Demonstration Center or Base + Flagship sites: Farmers' Association or Cooperative + Individual Farmers

示范中心/基地+旗舰点/农民协会或合作社 +个体农户

Flagship site model in KwaZulu-Natal, South Africa

Activity	Jobs	Remarks
Juncao grass planting for 5 ha	25	<b>Raw material</b> Co-op
Juncao grass grinding and drying	10	
Substrate production	40	<b>Substrate production</b> Co-op
Substrate distribution	4	
Mushroom fruiting management & harvesting	310	<b>Fruiting management &amp; sales</b> Co-op
Grading, storage, packaging and processing	40	<b>Processing &amp; marketing</b> Co-op
Marketing and sales	15	
Spent substrate processing / gardening	5	
Security	3	
Site maintenance manager	2	
<b>Total employment opportunities</b>	<b>454</b>	

**10m<sup>2</sup> mushroom farming model**

=300kg fresh mushroom \* 4 seasons

=1,200kg fresh mushroom per year

10平方米菇农场模式：

1年栽培4季，每季300公斤，年产1200公斤



产业化扶贫：长期的政策、资金与技术的支持与投入带来的可持续发展-中国闽宁对口协作帮扶菌草技术项目为例

## Poverty alleviation by Juncao industry approach:

long term policy, financial and technical support bring the sustainable development to an ecological fragile district - the case of Juncao technology project for Fujian-Ningxia peer to peer support

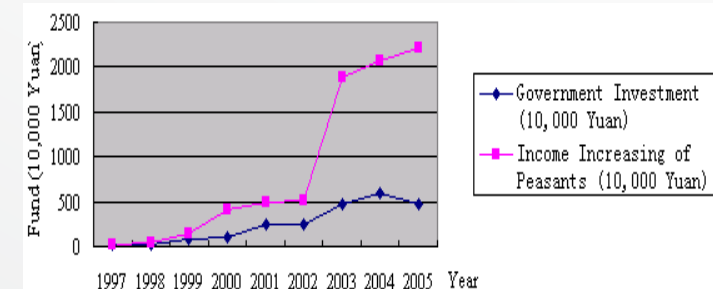


Fig. 1: Government Investment and Peasants' Income Increasing of Poverty Alleviation with JUNCAO Technology Project from 1997 to 2005



The government investment & farmers income of Juncao technology project (million Yuan)

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	Total
<b>Government investment</b>	0.15	0.30	0.74	1	2.5	2.46	4.81	5.89	4.76	22.61
<b>Peasants' income increase</b>	0.212	0.39	1.52	4.15	4.87	5.18	18.9	20.7	22.17	78.1

# 发展菌草业 造福全人类

Develop Juncao Industry for the Benefit of All Mankind

