



南方多熟制稻作区水田 旋耕埋草机械化技术研究

(Research on the Mechanized Technology of Rotary Tillage
and Stubble-mulch for Paddy Field under Southern Multiple
Rice Cropping System)

华中农业大学

HUAZHONG AGRICULTURAL UNIVERSITY
WUHAN CHINA

二〇〇七年十月二十四日

南方多熟制稻作区水田旋耕埋草机械化技术研究

(Research on the Mechanized Technology of Rotary Tillage and Stubble-mulch for Paddy Field under Southern Multiple Rice Cropping System)

- 一、研究目的(Research Objective)
- 二、技术简介(Technology Introduce)
- 三、研究过程(Research Procedure)
- 四、推广前景(Developing Future)



一、研究目的(Research Objective)

(1) “可持续发展水稻生产”是我国粮食生产的重中之重

“Sustainable development of rice production” is the most important task of China’s grain production.

a) 我国水稻以占世界**21%**的种植面积获得了占世界**35%**的稻谷产量，堪称世界之最。(Only 21% of the world's cultivated area gains 35% of the world's total rice output. It's the most in the world!)

b) 我国水稻以占全国**28%**的粮食播面获得了占全国**40%**的粮食产量，堪称国内之最。(China rice acreage accounts for 28% of the country's total grain cultivation area ,while getting 40% of the country's total grain output. it's also the most in china!)

c) 南方水稻种植面积占全国水稻种植面积的86%。
(Southern rice acreage accounts for 86% of the nation's whole rice cultivation area .)

d) 长江流域水稻种植面积占南方水稻种植面积的71%，是我国乃至世界最大的优势农产品产业带，也是我国水稻生产机械发展的重点区域。 (The Yangtze River drainage area's accounts for 71% of the whole southern rice acreage , it's the largest advantage agricultural belt of China , even all over the world, and it's the most important area of the popularizing of rice production machinery .)

(2) “水田适度耕整、秸秆直接还田”是发展水田机械化保护性耕作的关键技术

“moderate tillage of paddy field, stubble returned to fields”is the key technology of the conservation tillage for paddy fields

- a) 前茬收获后残留秸秆（割茬）愈留愈高，传统的人、畜、机水田耕整技术难以适应现实作业环境。(Former crops' residues (stubble) higher and higher, the traditional paddy fields tillage technology such as human labor, animals labor, machines etc., are hard to adapt to the practical Operating environment.)

**b) “四面点火，八方冒烟”，就地焚烧秸秆屡禁不止，导致严重污染生态环境、危及生命财产安全、浪费大量秸秆资源、耕地表土焦化的不良现象随处可见。
(Burning stubble in paddy fields Frequently happened ,which resulting in serious environmental pollution, endangering lives and property, wasting a lot of stubble resources, destroying topsoil of arable land)**

- c) **化肥大量使用**导致水田土壤中的有机质含量逐年减少，土壤板结硬化，地力衰退，生产成本增加，农产品品质下降，**生态环境污染和肥分流失**。(Large-scale using of chemical fertilizer have resulted in the content of soil organic matter reducing year by year, hardening the soil, declining soil's fertility and quality of agricultural products, increased production costs, environmental pollution and fertilizer wastage and so on.)

- d) 南方水稻、小麦秸秆量**2.1亿吨/年**以上，约占全国**1/3**。(Every year, in southern, there are more than 210 million tons of rice and wheat's stubble, accounting for the 1 / 3 of the country.)



(3) “破解水田现代耕作难题”，南方多熟制水稻生产全程机械化发展迫在眉睫

“Solving the puzzle of modern tillage for paddy fields”

The entire process mechanization of multiple rice cropping system production must be solved Urgently

- a) 油一稻、麦一稻、双季稻、三季稻、肥一稻等多种种植制度长期并存，传统的水稻生产方式导致人工用工量多、农时季节紧、劳动强度大、农资投入高、经济效益低，严重影响水稻生产发展。(rape-rice rotation, wheat-rice rotation, two-harvest rice and three-harvest rice and green manure-rice.etc.having being coexisting at the same time for long, the traditional rice production methods result in wasting lots of employments, time tight in the farming seasons, high labor intensity, high input of agricultural materials, low economic efficiency, which has seriously affected the development of rice production.)

b) 全国现有水稻种植面积比1978年减少了12.8%，
与国家要求相悖，稻—稻连作面积一直呈下滑
趋势。(The available rice acreage at present
decreased by 12.8% in 1978 in china,
inconsistent with the national 's requirements ,
the rice - rice rotation area has been in a
steady downward trend.)

(4) “以机代牛”是促进农业血防综合治理的 重要举措

(“Using machine instead of cattle” is an important measure to promote schistosomiasis comprehensive treatment)

以机代牛 势在必行
“Using machine instead of cattle” should be imperative under the situation



二、技术简介 (Technology Introduce)



研制了一种新产品

—— 船式旋耕埋草机

二、技术简介(Technology Introduce)

- a) 本专利产品能实现水田的**保护性耕作**，实现**少耕浅耕、秸秆埋覆还田**，具有显著的经济效益、社会效益和生态效益。(This patented products will achieve conservation tillage of the paddy fields, no-tillage or minimum tillage, stubble returned to fields, which also has significant economic, social and ecological benefits.)

b) 本专利产品为多熟制水稻生产全程机械化**保护性耕作**提供一种**先进适用**的耕整地技术。

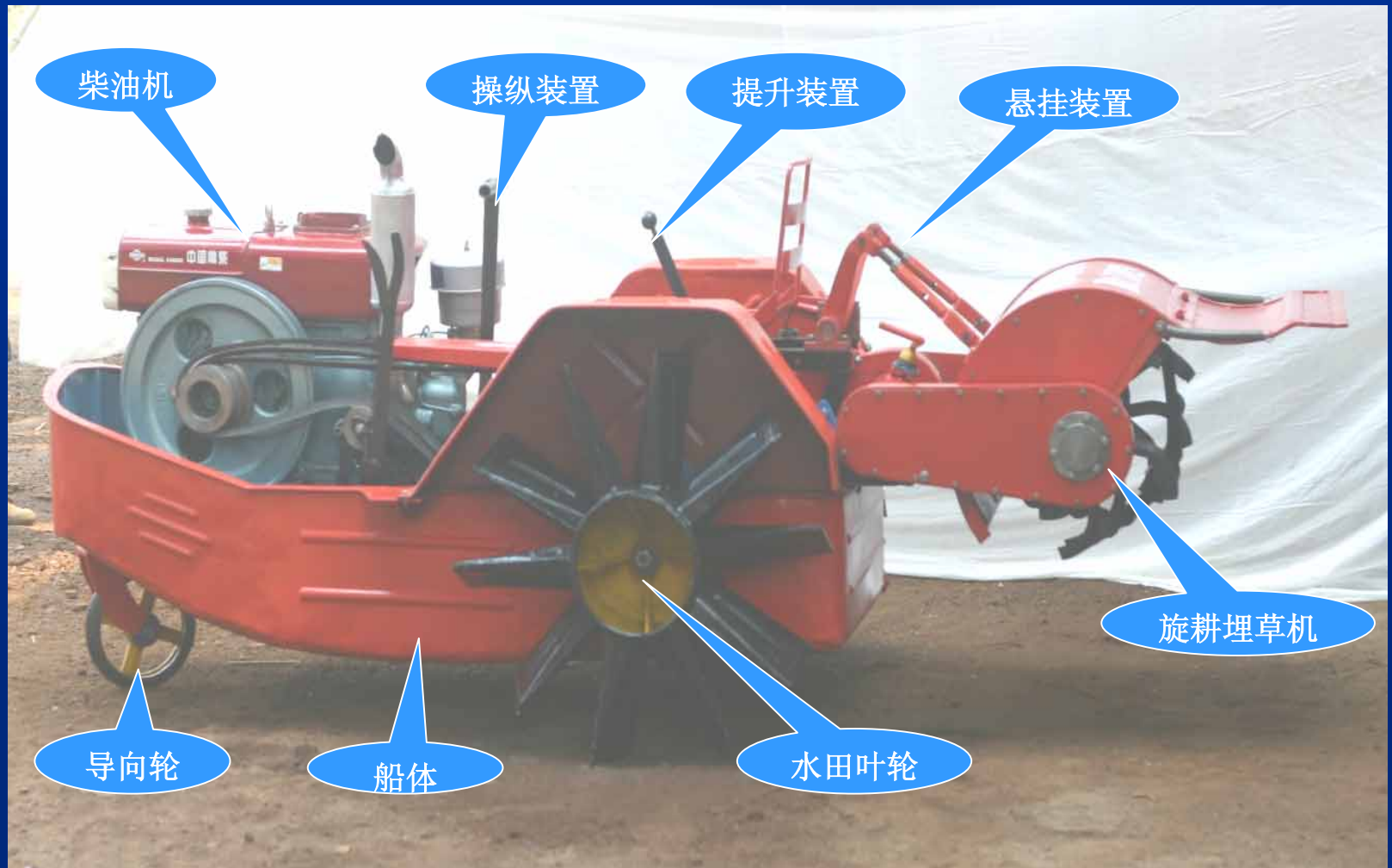
(This patented product provides an advanced and applicable tillage technologies for the multi-cropping system rice production full mechanization of conservation tillage.)

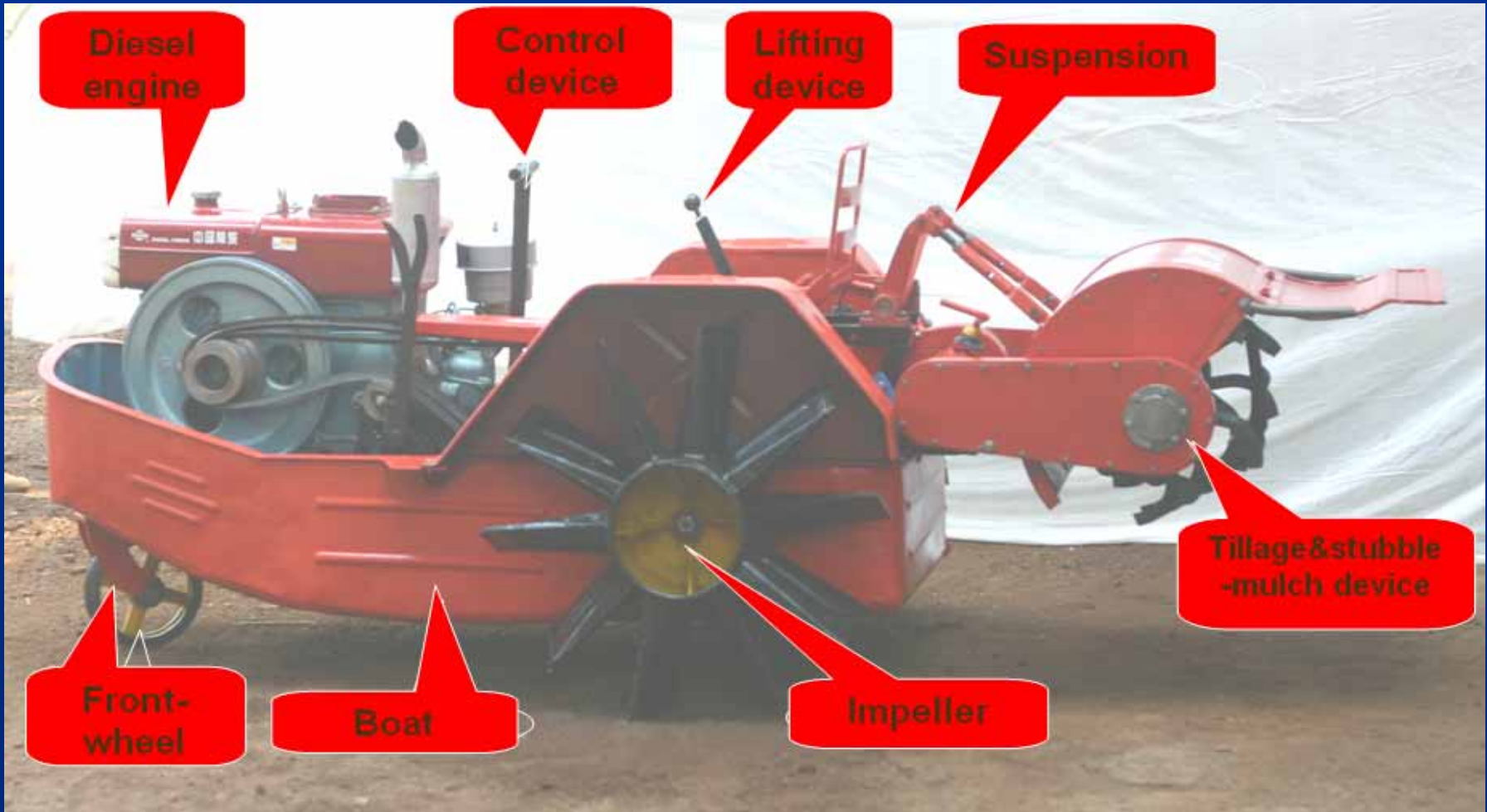
二、技术简介(Technology Introduce)

- c) 本专利产品为优质、高产、高效、可持续地发展我国水稻生产全程机械化，加快“以机代牛”步伐，提供新型的技术装备。(This patented products which can achieve high quality, high yield , high efficiency and sustainable development , provide a new technology and equipment for China's rice production mechanization, speed up the step of“machine instead of cattle".)

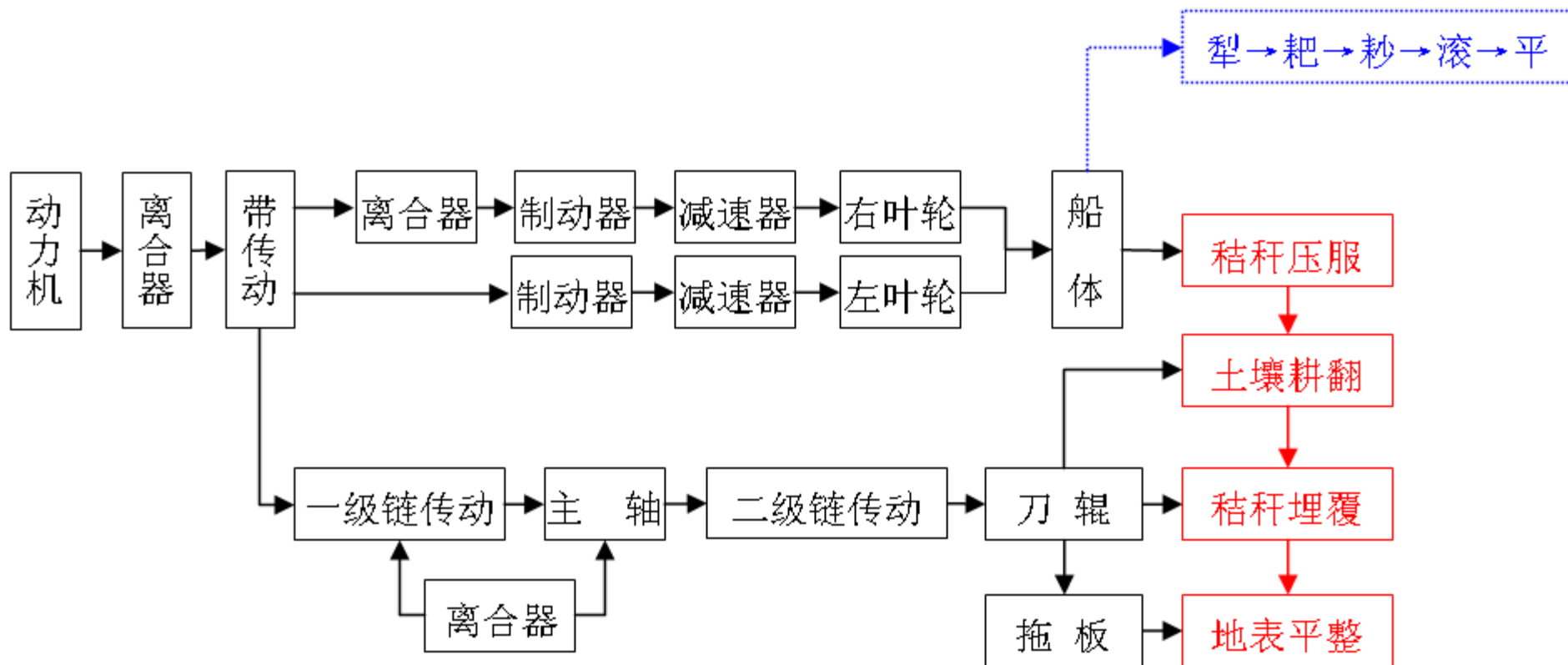
二、技术简介 (Technology introduce)

1. 总体结构 (General Structure)





2. 技术路线 (Technical line)



3. 核心技术(Core Technology)

船式拖拉机（机耕船）及其后置的卧式旋耕埋草机联合作业机组连续完成：船底板**有序推压**秸秆于地表→对置双向螺旋刀辊**翻耕**→**切碎**→**揉合**水田土壤→适当**切碎并翻埋**秸秆至耕作层→平整装置**平整**地表→达到下茬水稻播栽农艺要求。（Boat-tractor and its rotary tiller can do the following steps in sequence: push down the stubble orderly by boat bottom → plow with two-way symmetrical spiral knife-roller → shred → blend the soil → shred the stubble appropriately then mulch it → level off the surface → reach the agronomic requirements of rice sowing .)

4. 创新之处(Innovation)

- 一次性完成**压秆→耕翻→碎土→埋秆→平田**等工序，替代传统的**耕→耙→耖→滚→平**5道工序，实现精简化耕作。(Accomplishing the working procedure of **pressing stubble→rolling → shredding → stubble-mulch → leveling off the surface etc. at one time. which can instead of traditional working procedure of ploughing → harrowing → → rolling → leveling etc. realize streamlining cultivation.**)

- 由“三刀”构成的左右对称布置的两组螺旋刀辊，实现高秆乃至整秆翻埋和土壤的适度耕整，实现水田保护性耕作。(Two sets of symmetry blade roller made up of “three knives”, can mulch high stubble and moderately plough, can realize protective cultivation of paddy field .)

-
- 采用浮式原理，适用于我国一般水田，尤其适用于南方**深泥脚、烂泥脚田**，特别适用南方**多熟制**水稻的不同耕作制度。(Using the float style theory ,which is fit for the paddy field of our country, especially for the deep mud field in the southern , and multiple rice cropping system in particular .)

5. 适用范围(Application Area)

- 适于**油—稻—稻、麦—稻—稻、肥—稻—稻**等种植制度下的田块； (fitting for multiple rice cropping system ,such as rape-rice-rice, wheat-rice-rice, green manure-rice-rice etc.)
- 适于**人工收获、机械收获**等各种收获方式的田块； (fitting for farmland with all kinds of reaping mode, such as manpower harvesting, mechinary harvesting etc.)
- 适于**前茬作物留茬不同高度**的田块； (fitting for different altitudinal stubble that former crop remained)

-
- 适于不同泥脚深度的稻田，乃至湖田、藕田等；
(fitting for different depth muddy paddyfield, even for lake field, lotus field etc.)
 - 适于水稻栽插、水稻直播前的水田耕整作业；
(fitting for plough in paddy field before planting rice;)

-
- 适于血吸虫疫区“以机代牛”的迫切需求；
(fitting for the pressing need of “using machine instead of cattle” in schistosome epidemic district;)
 - 适于不同农机经营形式和经营规模。(Fitting for different management types and management scale of farm machinery .)

6. 技术经济指标(Technology Economy Index)

作业幅宽 (The work breadth) 700 mm

平均耕深 (The average plough deep) ≥ 120 mm

耕深稳定性系数 (The plough deep stability coefficient) $\geq 85\%$

耕宽稳定性系数 (The plough breadth stability coefficient) $\geq 95\%$

地表平整度 (The level degree of the earth's surface) ≤ 50 mm

泥脚适应深度 (The muddy acclimated depth) ≤ 350 mm

适应前茬作物留茬高度 (The height of crop stubble) ≤ 650 mm

植被覆盖率 (The plant coverage rate) $\geq 90\%$

作业速度 (The working speed) 4-5 km/h

纯工作小时生产率 (The productivity of net working) 2.5-3亩/h

主燃油消耗量 (The main fuel consumption) 1.2-1.3 kg/亩

保护性耕作的核心是减少环境破坏、保护环境；不同的区域，保护性耕作的内涵不同。 (The core of protective cultivation is protecting the environment from destruction or pollution. Different area have different connotation.)

1、配套技术采用浮式原理，适度浅耕，不破坏耕作层，保水、保肥。
(Suitable technology uses the float style theory, moderation shallow ploughing, not destroying cultivation layer, keeping water and richness.)

2、秸秆直接翻埋还田，增加有机质，改善土壤理化性能。 (Stubbles return fields directly, increasing organic matter of soil, improving physical chemical properties of soil.)

3、减少化肥使用量，减少环境污染，节本增效。 (Reducing the dosage of chemical fertilizer, decreasing environmental pollution, saving cost, increasing benefits.)

保护性耕作的核心是减少环境破坏、保护环境；不同的区域，保护性耕作的内涵不同。 (The core of protective cultivation is protecting the environment from destruction or pollution. Different area have different connotation.)

4、解决秸秆焚烧问题，保护生态环境。 (Solving the problem of burning straw,protecting environment .)

5、减少机器进地次数，减少对土壤的破坏，节约能源。(Reducing the work times of machine on earth, decreasing destructiveness for soil, saving energy.)

6、水旱轮作，减少病虫草害，提高地力。(Dry land and paddy fields rotate,decreasing the disaster of pest and ruderal weed, improving soil fertility .)

三. 研究过程(The Course of Study)

- 横向合作项目
- 湖北省科技厅攻关计划项目 (2004AA101D07)
 - 湖北省中小企业—大专院校产学研合作项目
 - 湖北省重点新产品计划 (2006BDS033)
 - 农业部农业科技跨域项目 (2007年)

科研选题

(Topic
Selected)

(2003)



研究设计
(Research
& Design)

(2003-2004)



第一轮样机
试制试验
(Firstly testing
preproduction model)
(2004-2005)



朱河镇 双十村

朱河镇 朱塔村

第一次试验
中稻秸秆

第二次试验
晚稻秸秆

(Mid-season Rice Stubble)

(Late Rice Stubble)



性能检测鉴定 (Performance Testing)



试制试验
(Trial-manufacture Testing)
(2004-2005)



晚稻秸秆
(Late Rice Stubble)



第三次试验(Third Trial)

第二轮样机 扩大试验

(Secondly extending
test of preproduction
model) (2006)



桥市镇三叉村
油菜秸秆
(Rape Stubble)



朱河镇傅良村
早稻秸秆
(Early Rice
Stubble)



小麦秸秆
(Wheat Stubble)
桥市镇三叉村



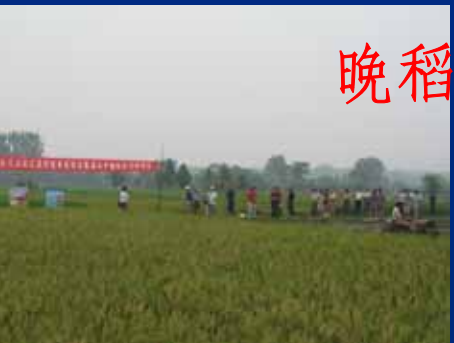
第三轮样机生产性试验示范 (2007年)

(Thirdly demonstrastion testing of the prototype machine)

湖北省团风
县现场会
(Scene Meeting
in Tuanfeng of
Hubei Province)

春
耕

(Spring
Ploughing)





晚稻秸秆
(Late Rice Stubble)



机耕机插
(Machine Ploughing
& Rice Transplantation)



湖北省浠水县
现场会 (Scene
Meeting in Xishui of
Hubei Province)





机收 (Machine Reaping)



湖北省鄂州市 现场会

(Scene Meeting in Ezhou
City of Hubei Province)



机耕
(Machine Ploughing)



湖北省监利县现场会(Scene Meeting in Janli of Hubei Province)



春耕（机耕机插）
(Spring Ploughing&Rice Transplantation)



第四轮熟化样机：三次改进设计与试制试验 (Fourthly Prototype Machine Ripened: three times improved design and trial-produced test)

湖北省
监利县

(Jianli

County of
Hubei
Province)



新产品性能检测(New Product Performance Test)



四、推广前景(Extension Prospect)

1. 经济效益(Economic Benefit)

就机手而言：本机械作业效率至少是人畜力的**16**倍；纯收入约是人畜力的**10**倍。若当年收回初始购置费，并扣除年使用成本，则当年还可获纯收入**14284**元。若按**6**年平均折旧，则每年可获纯收入**20534**元，折合机手每工作日纯收入**513**元。则全寿命周期内，机手可获纯收入**12.3**万元。

As for workers: This machine's efficiency is at least 16 times over the manpower and animal power and 10 times for net income, they will get about 14284 ¥ during the first year after withdrawing the cost of purchasing and other expenditure. The net income will be 20534 ¥ every year, If depreciation is averaged in six year, that is to say, they can earn 513 ¥ every workday. So during the life-cycle of machine, they can earn 12.3 thousand yuan.

四、推广前景(Extension prospect)

就农民而言：运用本项技术每亩可节约耕整地成本**10元**；至少亩节约化肥**10kg**，即节约肥料成本**16元**；若仅按**2%**的增产贡献率计，每亩可增收稻谷**9kg**，即增收**16元**。可见，实施本项技术可为农民每亩增收节支**42元**。

(As for farmers: Using this technology can save 10yuan of the tillage cost; decrease 10kg chemical fertilizer per 666m² (about 16yuan) ; If production only increase by 2%, they can increase rice 9kg per mu (666m²), be equal to 16yuan. So they can increase 42yuan per mu if using this technology.)

就企业而言：若年产**3000**台，其销售收入达**2250**万元，按**15%**的利税计，可获利税收入**337.5**万元；约为实施本项目的**新增制造设备投入的4.8倍**，效益十分可观。

(As for corporation: Sales revenue reach 22.5 million yuan, if the annual output is 3000 sets. the profit and tax totaled 3.375 million yuan, which is about 4.8 times as new manufacture equipment investment, return is considerable.)

2. 生态效益(Ecological Benefit)

如果每公顷耕地还田农作物秸秆**20000 ~ 30000kg**，即可增产粮食**1500kg**。连续三年秸秆还田，可增加土壤有机质**0.8 ~ 1.2**个百分点。因此，秸秆还田能有效增加土壤有机质含量，改善土壤结构，培肥地力，提高土壤蓄水保水能力，减少环境污染，促进农业生态系统的良性循环，有利于增产增收和农业的可持续发展。

(Grain output can increase 1500 kg, if 20000 ~ 30000kg straws returned to fields per hektare. if this consecutive for three years ,Soil organic matter can enhanced 0.8 ~ 1.2 %. Therefore, stubble-mulch can increase organic matter content of the soil effectively; improve the soil structure; enrich the soil, advance the capacablity of protecting soil moisture, decrease the environmental pollution, promote a healthy agricultural ecological system, increase production and incomes and be good to the sustainable development of agriculture .)

3. 社会效益(Social Benefit)

本项目的实施，能显著提高水稻生产机械化水平，减轻农民劳动强度，改善劳动环境，将多项工序高度集成，有利于提高生产效率，降低水稻生产成本，减少了机械下地次数和对土壤的压实及对土壤耕层的破坏，缩短了农田耕作时间，缓解了农时季节矛盾。如果本机组年生产能力能够达到**3000**台（套），新增就业岗位**100**个约，有效缓解社会就业压力。

(This project can greatly promote the level of mechanization for paddy working, alleviate labor intension, improve working conditions; and integrate lots of working procedures, which can increase working efficiency, reduce production costs, decrease the work times of machine on earth, avoid destroying on ploughing layer of soil, can also shorten the cultivation time on farmland, relieve the contradiction of farming seasons. About 100 job opportunities can be create if production capacity can reach 3000 sets per year, and alleviate the social pressure on employment effectively.)

恳请各位领导专家同志们

批评指正

(Please oblige me with your valuable comments)

谢谢

Thank you!