Research ~~progresses~~ progress in technological innovation and integration of agricultural engineering

ABSTRACT: Based on the technical characteristics of agricultural engineering, this research develops a theoretical system and methodology ~~on~~ for the integration of agricultural engineering technology by studying the classification of the constituent technologies, ~~technology~~ technological evaluation and integration, and optimization of agricultural engineering patterns ~~optimization~~. ~~32~~ Thirty-two integrated agricultural engineering patterns are proposed according to the methodology for different regions ~~with~~ having different local industry backgrounds, ~~different~~ operating scales and ~~different objects~~ objectives. ~~The~~ This research also provides a solid foundation for the study of ~~the~~ agricultural engineering technical schemes, patterns and construction standards~~, etc.,~~ which can help to provide a comprehensive solution to problems relevant to modern ~~agricultural relevant problems~~ agriculture.

Keywords: agricultural engineering, methodology, ~~technology~~ technological integration, ~~technology~~ classification, patterns

1. Introduction

1.1 Agricultural engineering and ~~Agricultural engineering~~ its technology

Agricultural engineering is ~~the~~ an integrated knowledge system consisting of many technical ~~factors~~ and non-technical factors, which can ~~be~~ include a production system or a social-service system, being constructed for large-scale specialized and sustainable agriculture. It is the key link that transforms ~~of~~ agricultural knowledge ~~transforming~~ into ~~the~~ real productivity. Agricultural engineering technology is a comprehensive subject that ~~comprehensively~~ methodically combines engineering, biology, information and management science, ~~It constitutes~~ thereby constituting the top three ~~top technology~~ technological backbones of modern ~~agriculture~~ agricultural science, along with agricultural biotechnology and agricultural management technology. As the most important key factor ~~of~~ in agricultural engineering, the developing level of agricultural engineering technology directly affects the construction level of agricultural engineering ~~directly~~. In recent years, the Chinese Communist Party Central Committee ~~pays~~ has devoted much attention and ~~invests much more on~~ investment toward the construction of agricultural infrastructure, which in turn promotes ~~the~~ innovational strength and achievements in agricultural engineering. But it is worth noticing that ~~there are still existing~~ big differences in innovation, R&D investment and construction effects of agricultural engineering among the different districts, sectors and specialty fields in China still exist. ~~There is still a gap to cover comparing to the~~ In comparison with developed countries, a gap ~~such as~~ characterized by an insufficient supply of agricultural engineering technologies, low levels of assembly equipment, weak infrastructure ~~which is~~ built ~~in~~ on a small scale, being fragmented, disordered and repeated, ~~and etc.~~ remains to be covered. Therefore, it is ~~very important and urgent~~ crucial to carry out ~~the~~ agricultural engineering technology research ~~of~~ into key technologies, construction patterns and ~~construction~~ standards, ~~as~~ because the results ~~could~~ can promote the construction and efficient operation of agricultural engineering systems ~~efficiently~~ and provide ~~generally~~ general engineering and ~~technology~~ technological support for the development and modernization of Chinese ~~agricultural modernization~~ agriculture.

1.2 Integration of ~~agricultural~~ engineering and technology

Integration is the ~~activity~~ process of blending or uniting two or more elements ~~integrating, which means two or more elements set~~ into an organic functioning whole, ~~process or results.~~ ~~It's~~ the core idea ~~is~~ being ~~the~~ a synergistic ~~integration~~

unification~~. It is~~ in a ~~way to~~ manner that solves complex system problems and ~~to~~ improves the function of the ~~whole~~ entire system. Any engineering project, regardless of size, ~~is~~ constitutes an ~~entirety~~ entire ~~of a~~ series of ~~technology~~ technologies that ~~related~~ relate to each other for a designed goal. The relationship between technology and engineering can be understood as ~~the~~ elements (the former) and ~~the~~ system (the latter). An agricultural engineering project must ~~be~~ consist of the application and integration of multi-subject ~~technology~~ technologies and ~~technology~~ technological groups. In addition, agricultural engineering involves constraints ~~of~~ within multiple-body organizations and ~~the~~ their external environment. ~~It needs to carefully plan~~ The resource mobilization and reasonable matching need to be carefully and systematically planned, ~~which should take~~ taking into account ~~of project~~ the economic ~~benefits~~, social ~~benefits~~ and environmental benefits ~~systematically~~. ~~So~~ Thus, the systemic essence of agricultural engineering relates it to integration inseparably. To ~~get~~ achieve ~~improved~~ improvement in agricultural engineering, ~~it must studyon~~ the integration process must be studied. A study ~~on~~ of agricultural engineering technology integration ~~is to~~ must focus comprehensively on the overall objectives of the engineering project, organically integrate ~~agricultural engineering~~ the technical elements ~~organically under the~~ that influence consideration of the organization, the environment and other factors ~~comprehensively~~, so as to fully realize the complementary advantage and greatly enhance the overall effect of ~~agricultural engineering~~ the system.

Although there has been a large ~~number~~ amount of ~~technology~~ technological integration practice in agricultural engineering, most of the literature is limited ~~on~~ to ~~the~~ research ~~of~~ on pure technology patterns, organizational modes or ~~depending~~ dependence on practical experience, with less consideration of social ~~factors~~ or environmental factors. ~~It~~ There is a lack of systematic and comprehensive research on ~~the~~ such integration~~. There is also~~ as well as a lack of scientific theory and methodology which has already been established for a systemic integration of agricultural engineering ~~systemic integration~~. Therefore, based on ~~the~~ this view of system theory, the existing research focuses on the formation of an integrated route incorporating agricultural engineering technology ~~integrated route~~ and a methodical system, by studying ~~from~~ the technical ~~factors~~, organizational ~~factors~~, ~~the~~ and social-environmental factors ~~and so on~~ encompassing ~~to~~ the study of agricultural engineering technology integration. ~~The~~ This methodology can enrich and develop ~~the~~ system engineering theory.

2. Technical ~~route~~ stages

Academician Yin Ruiyu pointed out that ~~the~~ engineering technology integration is divided into two stages. The first ~~stage~~ is ~~of~~ at an ~~technology elements~~ elemental level, ~~which is~~ called the ~~engineering technology~~ assessment and integration phase, where multiple disciplines and technologies are integrated by selection, organization and optimization ~~on~~ to a larger-scale quantity. The second stage ~~is~~ encompasses ~~the~~ an optimization of the engineering technology pattern phase, wherein the technical elements are comprehensively optimized within certain economic, social, management and other boundary conditions ~~of economic, social, managing and other factors~~ ~~comprehensively~~.

2.1 ~~Agricultural engineering technology~~ Assessment and integration

~~The~~ Integration ~~on~~ at the technical elements stage ~~is to~~ involves screening the appropriate technical sources ~~and~~ to provide feasible technical solutions. The

technological sources ~~of technology~~ can be divided into different types in order to cover as ~~much~~ many ~~as possible technology~~ resources as possible. The structure-function analysis method can be used to establish ~~the~~ classification clusters ~~of~~ within agricultural engineering technology according to the different status, roles and relationships ~~of each individual~~ among the respective technologies. ~~The~~ Such classification ~~is~~ constitutes the effective beginning of ~~the~~ technology integration.

In ~~the~~ this integrative process ~~of technology integration~~, a very important step is ~~to evaluate~~ an evaluation of the possible technologies, so as to make a reasonable choice. Technology evaluation includes ~~the evaluation~~ an assessment of advances, reliability, economical efficiency and assembility ~~etc~~. ~~The~~ An integrated scheme of engineering technology ~~is~~ can thus be formed after evaluation and optimization of the relevant technologies. [In the flowchart in Fig. 1, "patten" should be revised to "pattern."]

2.2 Optimization of ~~engineering technology~~ patterns

Organizations (such as investment or operational ~~organizations~~) and environments (such as ~~economy~~ economic, ~~society~~ societal or ~~industry~~ industrial) are both supportive and restrictive conditions ~~of~~ for agricultural engineering. Any technical integration scheme has limitations, and each ~~technical~~ scheme can ~~only~~ adapt to only certain conditions. ~~So~~ Hence, it is not only a variety of technologies but also various organizations (such as enterprises, cooperatives, and farmers~~, etc.~~) and environmental factors that are involved in the engineering technology integration process.

Therefore, on the basis of the first phase ~~of technology~~ in technological integration, ~~an~~ a system for evaluation and optimization ~~system~~ should be built by combining technical, economic, social and environmental evaluations with quantitative and qualitative ~~analysis~~ analytical methods. Then ~~engineering technology~~ the integration patterns can be derived by ~~integration~~ the merging of technology, organizations and environmental conditions~~, which are~~ suitable for specific conditions and ~~specific~~ scales ~~of organizations~~.

The technical root is shown in Fig. 1. [I had to delete the boxed caption for Fig. 1 because I found that it had moved and was covering some text on the next page.]

3. ~~Agricultural Engineering~~ Technology Classification

Technology classification research can reveal ~~the~~ a panorama of technology systems and ~~its~~ their typical characteristics, internal structure and mutual relationships, which in turn can provide ~~technology~~ resources for the integration of agricultural engineering technology.

3.1 ~~Classification~~ Methodology

The linear classification method classifies ~~the~~ objects into several levels of categories according to ~~the~~ selected attributes or features, and assorts them into a hierarchical system, expanding step by step (GB/T7027－2002). ~~Liner classification~~ This method is a traditional one ~~of the traditional classification methods~~, which has the advantages of a clear hierarchy, and can fully reflect the logical relationships of different categories. It both conforms to the tradition of manual information processing and ~~be~~ is ~~easy~~ easily ~~to processing information by~~ computer-processed. In order to reveal the structure and function of agricultural engineering technology systems concisely, ~~agricultural engineering technology classification used~~ the linear classification method is used for its longitudinal hierarchy, which ~~classified~~ classifies ~~the agricultural engineering technology~~ according to the selected number of attributes or features into the

corresponding number of levels of categories, then ~~assorted~~ assorts them into a hierarchical, gradually ~~expanded~~ expanding classification system.

3.2 ~~Classification~~ System

Because of the integrity and intersection of engineering technology, ~~it~~ there will be too much overlap~~ping~~ and ~~be very hard to~~ difficulty in reflecting on the purpose of the technology if ~~it~~ classification is ~~classified~~ implemented according to ~~the~~ its technical attributes and ~~technical~~ forms. Therefore, it is more reasonable to ~~take~~ consider the full functionality of agricultural engineering technology as the fundamental basis for classification, ~~and~~ thereby ~~use~~ using the basic idea of ~~integration~~ integrating ~~of~~ the technology ~~chain~~ and industrial chains ~~and~~ with technology ~~covering~~ encompassing the entire ~~producing~~ production process to guide the ~~agricultural engineering technology~~ classification. ~~According to~~ In accordance with the linear classification method~~s~~, the research ~~presents~~ reveals four classification- ~~catalogue~~ cataloging levels ~~of~~ within agricultural engineering technology, namely, major ~~classes~~, ~~middle classes~~ mid-level, and minor classes and subclasses, ~~which can reflect~~ encompassing the ~~agricultural~~ engineering technology chain, technical links, technical functions and technical measures, respectively. The hierarchical relationship is ~~shown~~ illustrated in Figure 2. [The text in the flowchart in Fig. 2 should be revised so that it agrees with the editorial revisions in the main text above.]

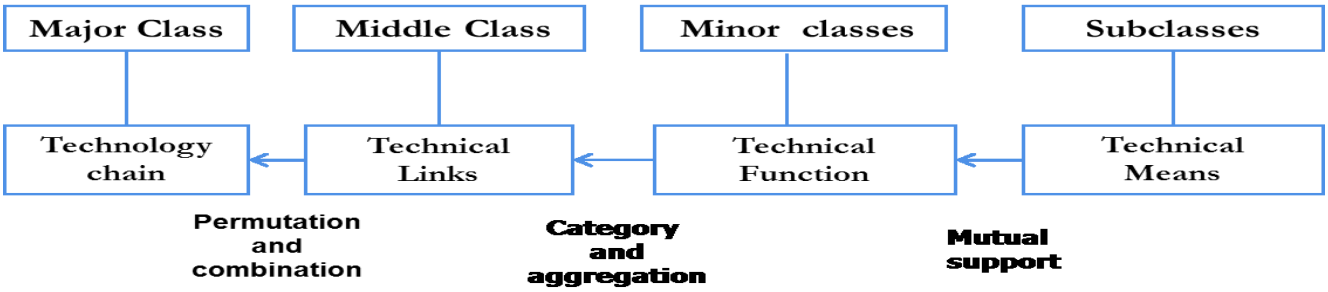

Fig. 2 ~~The~~ **Hierarchical relationships** ~~of~~ **in technology classification** [In this flowchart, revise "Middle" to "Mid-level" and use the word "technology" in only one field.]

3.3 Classification results

~~According to~~ In accordance with the main areas of ~~in~~ agricultural production before, during and after, this study divided the agricultural engineering technology system into seven major classes: ~~farmland~~ hectarage [See #2 in https://en.wiktionary.org/wiki/hectarage.] ~~engineering~~, ~~agricultural~~ mechanization engineering, ~~protected~~ general protection ~~agricultural engineering~~, ~~agricultural products~~ processing and storage of products, ~~agricultural~~ logistics ~~engineering~~, ~~agricultural~~ environmental protection ~~engineering~~ and ~~agriculture~~ information ~~engineering~~ (Figure 3), and gradually subdivided into 39 ~~middle~~ mid-level classes, 151 minor classes, and 369 subclasses (Figure 4). The results can reflect the ~~whole~~ entirety of agricultural engineering technology in detail, construct a relatively complete system and ~~make up~~ fill the ~~blank of~~ gap in agricultural engineering technology research

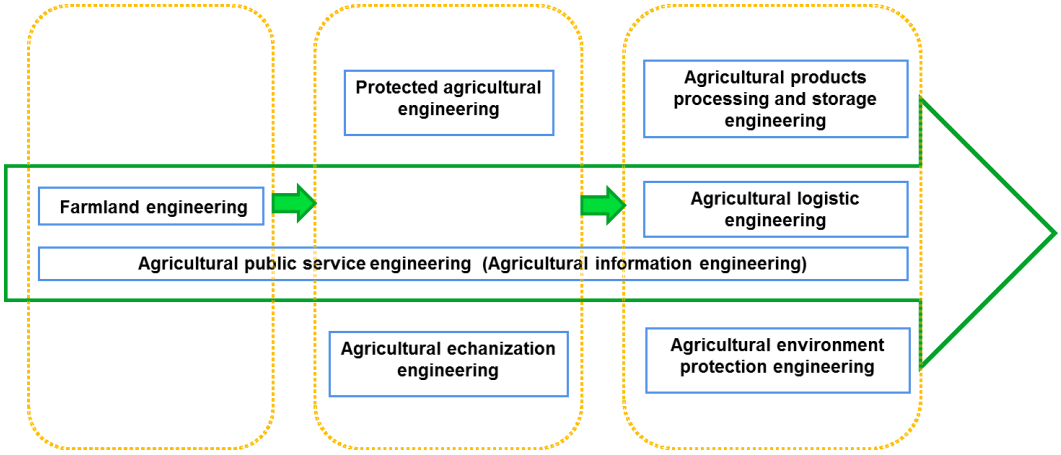

Fig. 3 Major classes ~~of~~ **within agricultural engineering technology** [Revise the text in this flowchart thusly (proceeding left-to-right from top to bottom): General protection, Processing and storage of products, Hectarage, Logistics, Public service / Information, Mechanization, and Environmental protection. Note: "Hectarage" in the metric system corresponds to "acerage" in the American and British system(s). In English it is quite common to refer to "farmland" as "acerage" because it is measured in "acres."]

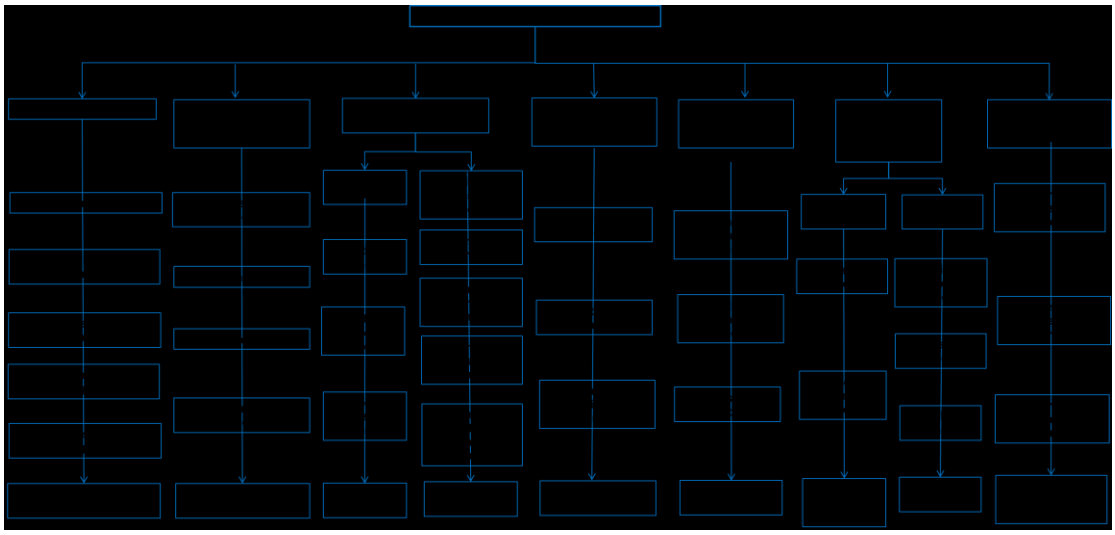

Fig.4 ~~Middle~~ Mid-level classes ~~of~~ in agricultural engineering technology [The word "technology" is redundant in this flowchart. Using this word once in the caption and once in the phrase "Agricultural Engineering Technology" is enough!]

4. Integration of research ~~of agricultural engineering technology~~

Integration is the ~~activity~~ process of ~~integrating~~ combining multiple ~~elements, which combine two or more~~ related elements into an organic functioning whole, ~~and~~ the core idea ~~is~~ being ~~integrate and synergy~~ synergistic unity. The fundamental ~~cause~~ goal ~~of~~ in the integration of engineering technology is ~~from integrated effect, especially~~ its economic effect. Because of the ~~attracting~~ attraction and ~~inducing~~ inducement ~~from~~ of an economic benefit, ~~of integrated, makes~~ the idea of integration ~~penetrated~~ can penetrate into ~~the~~ engineering practice. In the integration process ~~of~~ within agricultural engineering technology, ~~the~~ a proper ~~evaluate~~ evaluation can ~~make sure~~ ensure the best technical configuration, that is, a lower cost and ~~more efficient~~ greater efficiency, ~~and leading~~ resulting in ~~the~~ lower transaction costs and ~~the~~ better economic effects.

4.1 Methodology ~~of integration~~

Technology integration is a systematic process ~~including~~ encompassing input，transformation and output, in which the input ~~is~~ consists of the ~~single agricultural engineering~~ technology as a whole (containing subclass ~~technology~~, ~~middle~~ mid-level ~~class technology~~, and minor classes ~~technology, etc.~~); output is the preferred integration program ~~of agricultural engineering technology~~; and transformation (technology integration) is the process ~~that~~ by which the ~~single technology~~ whole forms ~~the integration~~ an integrative system (or module) by matching. Integration ~~of agriculture engineering technology~~ is a systems engineering methodology, its general approach ~~is~~ being setting goals, building schemes, ~~evaluation~~ evaluating and ~~optimization~~ optimizing. This study ~~formed~~ formulated three kinds of integration methods.

(1) Construction-Evaluation-Optimization ~~method~~

~~Based~~ On the basis of technological classification ~~of agricultural engineering technology~~, screen ~~single~~ the whole technology from the production process and its technical aspects ~~and~~ to constitute the preliminary, alternative integrated ~~technology~~ scheme ~~(alternative scheme)~~. Then, evaluate the ~~alternative scheme~~ result ~~and get~~ to obtain ~~the~~ a viable integration scheme ~~of agricultural engineering technology~~ based on the evaluation results, as illustrated in the flow

chart ~~is shown~~ in figure 5.

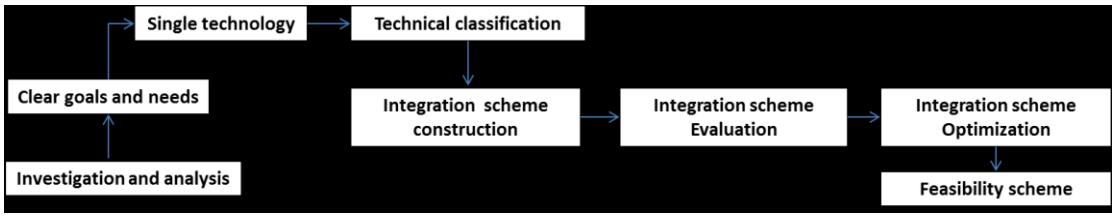

Fig. 5 ~~The flow chart of~~ Construction-Evaluation–Optimization method [Revise this flowchartThusly: ~~Integration scheme~~ Evaluation and ~~Integration scheme~~ Optimization]

(2)Evaluation-Construction-Optimization ~~method~~

~~Based~~ On the basis of technological classification ~~of agricultural engineering technology~~, evaluate the various technologies ~~in~~ with regard to their different aspects. According to the evaluation results, construct ~~the~~ an alternative scheme in three levels: high, ~~medium~~ middle and low ~~three levels~~. Then combine these with production practice and expert experience to recommend ~~the~~ a feasibility scheme in different constraints, as depicted in the flow chart ~~is shown~~ in figure 6.

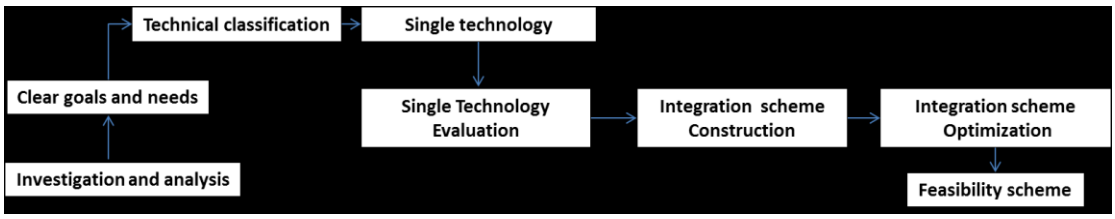

Fig.6 ~~The flow chart of~~ Evaluation–Construction-Optimization method [Delete redundancies from this flowchart thusly: ~~Single Technology~~ Evaluation and ~~Integration Scheme~~ Optimization]

(3)Goal-Evaluation-Optimization ~~method~~

~~Based~~ On the basis of technological classification ~~of agricultural engineering technology~~, construct the best integrated scheme of agriculture engineering technology from the production perspective and technical aspects. Construct ~~the~~ an evaluation index system ~~of agricultural engineering integration~~ for the integrated scheme, and use it to evaluate the practical ~~integrated scheme~~ version. ~~Compared~~ Compare the evaluation results ~~to~~ with the best integrated scheme; then, propose the optimized content for the practical integrated scheme, as illustrated in the flow chart ~~is shown~~ in figure 7.

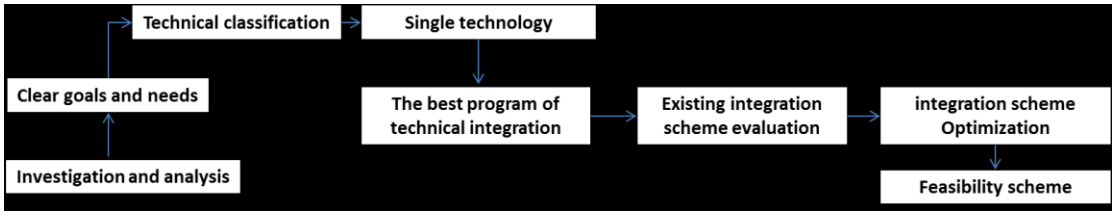

Fig.7 ~~The flow chart of~~ Goal-Evaluation–Optimization method [Revise this flowchart thusly: ~~The~~ Best program… (use headline grammar, which omits "the") and ~~Integration Scheme~~ Optimization (delete redundancy)]

4.2 Technologically integrated schemes

~~According~~ In accordance with the ~~idea~~ concept of technology integration, this study ~~formed~~ formulated 71 feasibility schemes ~~of~~ for agricultural engineering technology ~~for~~ in different regions, ~~which covering~~ including farmland infrastructure, ~~agricultural~~ mechanization, ~~agricultural~~ facilities, ~~agricultural products~~ processing and storage of products as well as their ~~agricultural products~~ circulation, ~~agricultural~~ environmental protection and ~~agriculture~~ information services. These schemes can be replicated as follows.

(1) ~~Technology Integrated scheme of~~ Farmland infrastructure ~~engineering~~

~~By using~~ Use the Goal-Evaluation–Optimization method to ~~structured~~ construct ~~the technology~~ an integrated scheme ~~of~~ for farmland infrastructure engineering of projects in plain, hilly and modern irrigation areas from five aspects: fields ~~project~~, irrigation and drainage ~~project~~, roads ~~project~~, forest protection ~~project~~ and electrification ~~project~~.

(2) ~~Technology Integrated scheme of agricultural~~ Mechanization ~~engineering~~

~~According~~ Use the Construction-Evaluation-Optimization method to resolve and ~~compared~~ compare the fully ~~mechanization~~ mechanized technologies, and reconstruct ~~those technologies~~ them in every link. Then, ~~formed~~ formulate ~~the Technology~~ integrated mechanical schemes ~~of Mechanical engineering~~ for the key link ~~of the field,~~ and ~~the entire~~ all of the field ~~and~~ as well as the ~~whole~~ entire production chain.

(3) ~~Technology Integrated scheme of agricultural facility engineering~~ Facilities

~~According to~~ Use the Construction-Evaluation-Optimization method to reconstruct ~~the~~ greenhouse horticultural technologies from three aspects, ~~includes~~ including ~~facilities~~ production facilities, original logistics and general management; ~~and~~ then, ~~got~~ formulate a ~~technology~~ technologically integrated scheme ~~of~~ for ~~agricultural facility~~ engineering ~~for~~ plastic ~~greenhouse,~~ ~~greenhouse~~ and multi-span greenhouses.

(4) ~~Technology Integrated scheme of agricultural products~~ Processing and storage ~~engineering~~ of products

~~Using~~ Use the Construction-Evaluation-Optimization method ~~and from the production flow chant and technical link of processing and storage, constructed~~ to formulate ~~the technology~~ an integrated scheme ~~of agricultural products~~ for the processing and storage ~~for~~ of four crops, including corn, potatoes, bananas and peanuts, from the corresponding technical links in the production flowchart.

(5) ~~Technology integrated scheme of agricultural products~~ Circulation of products ~~engineering~~

~~Using~~ Use the Evaluation-Construction-Optimization method ~~focused~~ to focus on harvesting, commercialized treatment, pre-cooling, loading and unloading, storage, transportation, trade, quality control and monitoring ~~and~~ as well as other aspects of circulation ~~formed~~ to formulate high- ~~level~~, mid- ~~level~~ and low-level ~~circulation~~ integrated circulation schemes for fruits and vegetables, fresh fish and eggs.

(6) ~~Technology Integrated scheme of agricultural~~ Environmental protection ~~engineering~~

~~Using~~ Use the Construction-Evaluation-Optimization method ~~constructed the~~ to formulate an integrated scheme ~~of agricultural~~ for waste recycling ~~technology,~~ from two aspects: waste-water treatment and solid-waste disposal. Then, ~~got the~~ further devise ~~Integrated~~ schemes ~~of agricultural wastewater treatment and the integrated scheme of solid waste disposal of fuel technology,~~ for the technologies addressing

fertilizers ~~technology~~, feed processing ~~technology~~, binders ~~technology~~ and materials ~~technology~~. [Note: Keep "feed," if it is for animals; but revise to "food," if for human consumption.]

(7) ~~Technology Integrated scheme of agricultural~~ Information ~~engineering~~

~~Using~~ Use the Evaluation-Construction-Optimization method ~~aimed at~~ to focus on different aspects and control points ~~of~~ for regulating the ~~Agricultural products quality~~ ~~regulation~~ quality of agricultural products and ~~agricultural~~ establishing an information service. Then, formulate ~~the~~ high-, ~~medium~~ mid- and low-level integrated schemes for monitoring the ~~aquatic product~~ quality and safety ~~monitoring~~ of aquatic products and vegetables. ~~quality and safety monitoring, and~~ Thus, agricultural information services ~~were~~ can be formed.

5. Optimization of Agricultural Engineering Technology Patterns

Patterning is ~~the~~ a methodology to solve ~~some~~ certain classification problems ~~which by emphasizes~~ emphasizing ~~the law in~~ formal laws; moreover, this methodology ~~is the~~ constitutes a summary of experience to solve the problems. Agricultural engineering technology patterning is ~~the~~ a new paradigm ~~of agricultural engineering technology~~ for developing modern ~~agriculture~~ agricultural construction, ~~which~~ being based on regional characteristics, ~~and has~~ possessing good economic ~~benefits,~~ and ecological environment benefits, ~~and~~ as well as being easily ~~to~~ extendable. Due to regional differences in ~~climate,~~ climatic conditions, economic levels and ~~the~~ subjects of construction and operation, ~~the agricultural engineering~~ such patterning ~~has the~~ is ~~characteristics of~~ characterized by regional, phased, systematic and hierarchical ~~and~~ diversity, ~~There is~~ as well as having no fixed pattern that can be copied. Therefore, ~~optimize~~ optimization of a regional ~~agricultural engineering technology~~ pattern should be in accord with the local conditions and seek truth from facts, in order to ~~improving~~ improve the matched-degrees and collaboration of ~~agricultural engineering~~ major agricultural engineering organizations, service ~~object~~ objectives, industry types, technology and equipment. Then, ~~establish~~ appropriate technology patterns can be established for developing local ~~economic,~~ economies and ~~promote~~ promoting ~~agricultural~~ the transformation and upgrading of agriculture.

5.1 Pattern Construction

An agricultural engineering technology pattern ~~is~~ comprises a whole with a specific target, function, and structure, ~~which is made up~~ consisting of subjective, objective, ~~technology~~ technological, organizational and environmental conditions ~~and~~ as well as other basic elements. Based on ~~the~~ system ~~theory~~, ~~industry~~ industrial- ~~chain~~ and value-chain ~~theory~~ theories, this study proposed a systematic and complete operational method ~~of~~ for an engineering technology system which ~~coupled~~ couples technology ~~pattern~~, organization ~~pattern~~ and industry patterns. ~~Whereby~~ In such a system, the technology pattern is the basis of the general ~~pattern~~ one; the feasible solution set is from technology ~~integrating~~ integration, and the organizational mode is the ~~organization way of the operation~~ manner in which the subject operates. At present, the cultivation of ~~the~~ family farms, specialized households and ~~peasant specialized~~ peasants' cooperative organizations, as well as ~~the agricultural~~ leading agricultural enterprises and other new ~~agricultural~~ management subjects ~~is~~ are major tasks for rural reform and development, ~~which has~~ also having great vitality and potential. This study focuses on the organizational pattern of new agricultural management

subjects in different development scales (family farms, specialized households, ~~farmers'~~ specialized farmers' cooperative organizations and ~~agricultural~~ leading agricultural enterprises), and different developmental stages (new construction, reconstruction, expansion). After considering the regional industrial layouts, development environments ~~and~~ supporting ~~capacity~~ capacities and other factors, the industry pattern was set. The purpose of coupling ~~of~~ patterns is to ~~make~~ render technology, organization and industry ~~three systems~~ system-specific and ~~ordering~~ ordered at a higher level, and ~~get that~~ obtain three kinds of patterns which can support each other and ~~show the~~ demonstrate a new systematic emergence ~~which couldn't~~ that cannot be obtained in ~~single~~ isolation. Then ~~formed the~~ an ~~integration~~ integrated pattern ~~of agricultural engineering technology~~ can be formulated for different scales and ~~developing~~ developmental stages.

5.2Methodology ~~of pattern~~ for optimization

Pattern optimization is a feasibility analysis process based on ~~the~~ pattern construction, and ~~a~~ decision-making ~~process~~. Based on technology integration, pattern optimization of agricultural engineering technology ~~carry out a~~ implements holistic research ~~about the~~ concerning ~~technology~~ integration schemes, operating-services subjects, socio-economic developments and environmental sustainability, which ~~content~~ consist of four stages: ~~pattern~~ construction, ~~pattern~~ evaluation, ~~pattern~~ demonstration and ~~pattern~~ optimization, as illustrated in Figure 8. This study ~~put forward~~ proposed ~~the agricultural engineering technology~~ patterns for different regions, subjects, ~~industry~~ industries and scales, all of which ~~make all~~ encourage the ~~elements~~ components of agricultural engineering to ~~play~~ achieve the best economic, social and ecological benefits in ~~engineering~~ design, project construction and ~~resources~~ allocation of resources.

Fig. 8 ~~The Flow chart of~~ Pattern optimization of agricultural engineering technology [Notes: The word "Pattern" is redundant in the illustration because "Pattern" is a key word in the figure caption; hence, you should use this word only once in all of Fig. 8. Although the remaining words are adequately explained in the main text, the figure is self-explanatory.]

5.3 Pattern evaluation

Evaluation of pattern optimization ~~evaluation~~ is a decision-making process. Because the complex giant systems characteristic of agricultural engineering technology patterns ~~that~~ encompass vast areas, complex operating subjects, ~~big~~ vast related content and strong comprehensives, it is ~~very necessary~~ imperative to establish ~~the pattern~~ an evaluation system in order to examine the effects ~~of patterns~~, as well as promote the improvement and development of the patterns. ~~There are~~ Many factors are involved in the problem of comprehensive evaluation

of complex systems: ~~technology~~ technological, ~~economy~~ economic, ~~society~~ social, environmental and other factors must be comprehensively considered, all of which can ~~make~~ render ~~the comprehensive evaluation become~~ uncertainty, randomness and fuzziness in the process. ~~So~~ Hence, it is difficult ~~for using~~ to use ~~the~~ a rigorous and accurate evaluation method ~~to evaluate~~. At present, ~~the comprehensive evaluation~~ such methods ~~mainly~~ rely mainly on qualitative and quantitative approaches, objective ~~statist~~ states and subjective ~~describe~~ descriptions, such as analytic ~~hierarchy~~ hierarchies ~~process~~, fuzzy comprehensive evaluations ~~method~~, as well as multi-attribute and multi-objective decision-making methods. The Analytic Hierarchy Process (AHP) is a decision-making method, which ~~firstly~~ first resolves the elements related to ~~the~~ a decision into objectives, standards and indices, ~~then~~ followed by qualitative and quantitative analysis. By using AHP, this study analyzed and integrated all ~~kind~~ types of ~~the~~ elements impacting the pattern. ~~So~~ Therefore, the evaluation system ~~of~~ for an integrated pattern was divided into ~~the~~ objective ~~layer~~, standards ~~layer~~ and index layers, in which the ~~whole~~ entire index ~~system~~ is a system ~~also~~ and each standards level is a complete subsystem. After ~~determined~~ determining the index system, the Delphi method was used to ~~determine~~ measure the weight of every standard-to-objective and every index-to-standards.

5.4 Typical Optimization Pattern

Based on ~~the~~ ~~technology~~ technological classification and integration, focusing on the needs of economic, social and natural conditions in different regions and ~~different~~ various operational subjects, this study undertook systematic and integrated research in seven agricultural infrastructure and equipment engineering fields, including farmland ~~engineering~~, ~~agricultural~~ mechanization ~~engineering~~, protected-area ~~agricultural engineering~~, ~~agricultural products~~ processing and storage of products, ~~agricultural~~ logistics ~~engineering~~, ~~agricultural~~ environmental protection engineering and ~~agriculture~~ information service ~~engineering~~, and optimized 32 typical agricultural engineering patterns for verification and demonstration (Table 1).

Table 1 Summary of agricultural engineering technical patterns

NO.	~~Pattern~~ Name
1	~~The~~ Construction pattern ~~of~~ for paddy mono-cropping system in Northeast China plain
2	~~The~~ Construction pattern ~~of~~ for paddy double-cropping system in North China plain
3	Farmland optimization pattern ~~in the~~ for arid areas of Northwest China
4	~~The~~ Integration pattern ~~of~~ for modern irrigation engineering technology
5	~~Produce entire~~ Complete mechanization ~~engineering~~ pattern ~~of~~ for corn production ~~for~~ in large cooperatives
6	~~Field entire~~ Complete field mechanization ~~engineering~~ pattern ~~of~~ for wheat/corn ~~for~~ in medium-size cooperatives
7	~~Produce entire~~ Complete mechanization ~~engineering~~ pattern ~~of~~ for wheat / corn ~~for~~ in medium-size cooperatives
8	~~Produce entire~~ Complete mechanization ~~engineering~~ pattern ~~of~~ for wheat / corn ~~for~~ in large enterprises
9	Field-key-link ~~mechanized~~ mechanization ~~engineering~~ pattern ~~of~~ for rice / wheat ~~for~~ in large cooperatives
10	Field-key-link ~~mechanized~~ mechanization ~~engineering~~ pattern ~~of~~ for rice / Cole [What's this? Corn?] ~~for~~ in medium cooperatives
11	Field-key-link ~~mechanized~~ mechanization ~~engineering~~ pattern ~~of~~ for rice / wheat ~~for~~ in small cooperatives

NO.	~~Pattern~~ Name	
12	Field-key-link ~~mechanized~~ mechanization ~~engineering~~ pattern ~~of~~ for rice ~~for~~ in small cooperatives	
13	Conserva-tion tillage patterns	Ridge culture ~~under~~ for mono-cropping of maize in Northeast China
		Mono-cropping of wheat in Loess Plateau
		Double-cropping of wheat and corn in North China
14	Vegetable production pattern ~~of~~ for greenhouse ~~for~~ at ~~cooperation~~ cooperative ~~organization~~ in Northwest China	
15	~~Automation~~ Greenhouse automation pattern ~~of~~ for flower production ~~for~~ at enterprise in North China	
16	Barn-healthy feeding pattern ~~of~~ for pig farm in Southwest China	
17	Point-of-origin processing and storage ~~engineering~~ pattern ~~of~~ for peanuts	
18	Point-of-origin storage pattern ~~of~~ for potatoes	
19	Origin processing pattern of corn	
20	Point-of-origin commercialized processing pattern ~~of~~ for bananas	
21	Farmland-market ~~engineering~~ pattern ~~of~~ for winter vegetables in Southern China	
22	Company +Farmers circulation ~~engineering~~ pattern ~~of~~ for eggs	
23	Circulation ~~engineering~~ pattern ~~of~~ for famous live freshwater fish in southeast coastal area	
24	Circulation ~~engineering~~ pattern ~~of~~ for freshwater fish in Yangtze Basin	
25	Circulation ~~engineering~~ pattern ~~of~~ for pomelos in Zhejiang, Fujian and Guangdong	
26	~~Nonprofit agricultural production~~ Environmental protection pattern for non-profit agricultural production	
27	~~Market agricultural production environmental protection engineering pattern by~~ Environmental protection pattern for inside-circle marketing ~~inside the circle~~	
28	~~Semi nonprofit agricultural production~~ Environmental protection pattern ~~by~~ for semi-non-profit ~~outside the circle~~ outside-circle production	
29	Agricultural information service pattern	
30	Quality and safety testing laboratory construction pattern ~~of~~ for agricultural products	
31	Information technology integration pattern ~~of~~ for quality and safety supervision ~~for~~ of aquatic products	
32	Information technology integration pattern ~~of~~ for quality and safety supervision ~~for~~ of vegetables	

6. Results, application and discussion

(1) This research ~~provides~~ provided ~~the~~ an advanced theoretical method for integrated innovation of agricultural science and technology. Original ~~innovation,~~ and integrated innovation, ~~and~~ as well as re-innovation after introduction and absorption are the three major areas of technological innovation. However, integrated innovation ~~has been~~ lacked ~~of~~ supportive scientific and systematic theory, especially for agricultural science and technology innovation, which ~~is~~ constitute a complex system involving biotechnology as well as engineering ~~technology,~~ and information ~~technology~~ technologies ~~and~~ plus other ~~subject areas~~ disciplines, ~~and being~~ all of which are used in ~~the whole~~ an entire ~~industry~~ industrial chain that ~~combined~~ links planting, breeding and processing, ~~and~~ as well as ~~combined~~ combining production, supply and sales. By using system knowledge, this study constructed ~~an integration~~ a methodically integrated system of agricultural engineering technology from technical classification and ~~technical~~ integration to pattern optimization, discussing how to build, ~~how to~~ evaluate and ~~how to~~ optimize an agricultural engineering technology pattern completely and systematically. It also ~~provides~~ provided ~~a~~

~~theory~~ theoretical guidance ~~of~~ for integrated innovation not only for agricultural engineering, but also for ~~the whole~~ all agricultural research, ~~which~~ thereby playing an important role ~~to promote~~ in promoting an integrated innovation level ~~of~~ for agricultural science and technology and its conversion rate.

(2) This research ~~provides~~ provided a holistic solution for constructing modern agriculture. The research content covered ~~7~~ seven agricultural engineering fields, ~~include~~ including farmland ~~engineering~~, ~~agricultural~~ mechanization ~~engineering~~, protected-area ~~agricultural engineering~~, ~~agricultural products~~ processing and storage of products, ~~agricultural~~ logistics ~~engineering~~, ~~agricultural~~ environmental protection ~~engineering~~ and ~~agriculture~~ agricultural information ~~engineering~~, which ~~covering~~ comprise the key ~~agricultural engineering~~ technologies in ~~whole~~ the entire ~~industry~~ industrial chain of ~~agricultural~~ production before, during and after. Our research results can provide ~~the technology~~ a roadmap of technical standards and construction programs ~~of~~ for agricultural engineering ~~for~~ in ~~different~~ various typical regions, ~~different~~ industries and ~~different~~ operators' subjects, which ~~is~~ constitutes a comprehensive and systematic solution ~~of~~ for ~~agriculture~~ agricultural engineering technology ~~for~~ in the ~~mixture~~ blending of ~~the~~ agricultural machinery and agronomy, the promotion of good farmlands, good seeds and ~~good ways~~ manners, ~~and~~ as well as the coordination of production, living and ecology during ~~the~~ an adjustment ~~of~~ in agricultural production.

(3)This research ~~puts forward~~ formulated 32 integrated optimization patterns ~~of~~ in seven agricultural engineering fields and has achieved good results in their practical application. ~~But~~ However, these integration patterns ~~is~~ are limited ~~in~~ to ~~the~~ their individual fields, respectively. The more comprehensive integrated ~~agricultural engineering~~ patterns, which cover the ~~whole~~ entire industrial chain for ~~a certain crop~~ the production of certain crops, need further exploration. ~~The~~ Management information systems which can provide agricultural engineering technology ~~query~~ queries, ~~engineering technology~~ optimization patterns, and project performance evaluations ~~shall~~ should be developed in the future to further support ~~for~~ the main food crops of ~~our country~~ China.

[CJR stopped editing at this point.]

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