

Cultivation of Innovation Ability for Graduate Students in the Field of Agricultural Engineering and Information Technology Based on Interdisciplinary Projects

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Abstract: The paper takes graduate students in the field of agricultural engineering and information technology at the College of Engineering and Technology of Tianjin Agricultural University as an example, and combines with graduate students in Food Science and Environmental Science majors. Based on interdisciplinary research projects, the photoelectric detection laboratory and agricultural environment laboratory were as platforms, and a large team of supervisors and graduate students from different colleges and majors were formed. The interdisciplinary project enables students to broaden their knowledge areas while complementing each other's strengths, cultivating professional qualities and skills in related majors, and multiple majors, laying a solid foundation for future career development.

Keywords: Graduate Students; Interdisciplinary Projects; Innovation Ability.

1. Introduction

With the development of society, science and technology, the boundaries between existing disciplines are constantly blurring, and a large number of interdisciplinary and marginal disciplines have emerged. The intersection, penetration, and integration between disciplines are becoming more extensive and in-depth, which have been integrated into various industries. At present, the major cutting-edge scientific issues, social problems, and global challenges facing humanity are becoming diverse and complex, involving knowledge far beyond the scope of a single discipline [1]. Therefore, cultivating interdisciplinary graduate students and improving their innovation ability and comprehensive quality is of great significance.

In January 2021, the category of "interdisciplinary" was officially formulated jointly by the Academic Degrees Committee of the State Council and the Ministry of Education. The emergence of interdisciplinary fields has greatly changed the traditional disciplinary structure and had a profound impact on talent cultivation models, especially in agricultural and forestry colleges. Multidisciplinary integration will promote disciplinary development, achieve sustainable resource utilization, and have important implications for cultivating innovative talents. Relying on the cohesion of the scientific research team's party branch, Xie and Ye established a new model for cultivating team graduate students through various methods such as building activities, "interdisciplinary, teacher-student activities," collaborative development of industry, academia, and research, "large group + small group" academic activities, and "guided learning and mutual benefit" subject competitions [2]. Bai and Lu have created a four in one collaborative training mechanism for interdisciplinary research resource sharing, which cultivates the comprehensive quality of graduate students through interdisciplinary cross fusion education [3]. Ma has adopted measures such as broadening the scope of graduate education, setting up interdisciplinary courses, strengthening guidance

from interdisciplinary mentor teams, and establishing interdisciplinary academic exchange platforms to construct a graduate education model with interdisciplinary mentor teams [4]. Dan and others have constructed an innovative graduate training model led by innovation and entrepreneurship, integrating industry and education, and crossing disciplines [5]. Liang et al. conducted empirical analysis and evaluated its interdisciplinary training model, pointing out the need to strengthen the construction of the following aspects: interdisciplinary training paradigm, interdisciplinary academic exchange platform, guarantee mechanism for the quality of interdisciplinary talent training, and active innovation management system [6]. Qi and others have improved the selection model for interdisciplinary doctoral students, established a reasonable joint training system for interdisciplinary doctoral students, formed a multidisciplinary mentor team, implemented a joint guidance system for interdisciplinary mentors, built an interdisciplinary research and innovation platform, and enhanced the innovative thinking awareness and innovation ability of graduate students [7]. Practice has shown that implementing the interdisciplinary graduate training model has obvious advantages and characteristics. It can not only stimulate students' interest in learning and research, broaden their knowledge fields, cultivate their ability to solve problems from multiple methods and perspectives, but also promote the coordinated development of students' knowledge, abilities, and qualities.

The field of agricultural engineering and information technology is a newly established professional degree field in the College of Engineering and Technology in 2023. This interdisciplinary field involves the integration of different disciplines, which puts higher demands on the cultivation of graduate students. The knowledge of the major alone cannot meet the needs of graduate students in the scientific research process. For example, the detection of microplastics (MPs) in meat that we are currently doing involves multiple disciplines such as spectroscopy, analytical chemistry, food science, and

chemometrics. Graduate students lack a systematic understanding of the preparation and preservation of meat samples during the process of MPs experiments.

In response to the shortcomings in the process of cultivating innovative abilities among graduate students in new fields, the paper proposes to cultivate the innovative abilities of graduate students in the fields of agricultural engineering and information technology based on interdisciplinary projects.

2. Agricultural Engineering and Information Technology Major

The agricultural engineering and information technology major is an interdisciplinary field that studies agricultural engineering equipment, agricultural information collection, agricultural information system research and development, agricultural big data analysis, agricultural bioenvironment and energy engineering. It includes modern intelligent agricultural engineering equipment, agricultural data analysis technology, agricultural information system development, agricultural bioenvironment protection and energy conversion, and other parts. With the characteristics of "agricultural information", "intelligent agricultural equipment", and "bioenvironment and energy". it aims to cultivate applied and composite high-level talents with comprehensive vocational skills for the application and promotion of agricultural mechanization, agricultural application development and promotion, rural development, agricultural education and other enterprises, institutions and management departments.

Research direction 1: Based on the disciplines such as optics, electronics, biology, and chemometrics, multi-channel, multi angle, and multi spatial detection instruments and technologies have been developed for obtaining multidimensional data in the extraction of agricultural product quality parameters, photoelectric characteristic signals, and quality and safety testing of agricultural products and food. Relevant technologies and methods with the own intellectual property rights have been established and applied them to the quality and safety testing of agricultural products and food.

Research direction 2: Based on the disciplines such as optics, physics, chemistry, biology, molecular dynamics, statistics, and chemometrics, this direction focuses on the separation and detection methods of organic pollutants, heavy metals, and microplastic pollutants in agricultural environments. Advanced instruments and equipment are utilized to combine microscopy imaging technology, two-dimensional correlation analysis technology, and molecular dynamics simulation technology to reveal their interaction mechanisms from a molecular perspective, providing reference for environmental risk assessment, pollutant control, and remediation.

3. Interdisciplinary with Food Science

The degree in Food Science and Engineering is closely related to food production, processing, and overall quality and safety control. The degree field of the major focuses on agricultural planting and breeding products as raw materials, with engineering, agriculture, science, and medicine as the main scientific foundations. It studies practical issues related to the production and processing of food raw materials, as well as quality and safety. Mainly cultivate high-level,

application-oriented, and versatile specialized talents in research, development, promotion, application, and education of food production in enterprises, institutions, and management departments.

Plastic has been widely used in various fields, bringing convenience to people's lives but also causing serious pollution to the environment. Plastic waste in the environment can degrade into MPs, and organisms such as chickens, ducks, and fish can enter the food chain due to drinking contaminated water and consuming feed containing MPs. When consumed by humans, it can be toxic to the human body. The interdisciplinary project focuses on establishing a rapid detection method for qualitative and quantitative analysis of MP in chicken meat based on near-infrared spectroscopy (Fig. 1), providing technical guidance for MP risk detection and scientific law enforcement in meat products. This project involves multiple disciplines such as food science, spectroscopy, biology, and data science and information technology.

During the project research process, students majoring in food and agricultural information can leverage their respective professional strengths, learn from each other, and achieve cross disciplinary cooperation. Food majors are responsible for the collection and pretreatment of chicken samples, including steps such as cleaning, cutting, and grinding. They utilize their professional knowledge to extract MPs from chicken using physical methods such as sieving and filtration, density separation, and chemical and biological methods for subsequent spectral analysis. Agricultural information majors can utilize their expertise in data analysis to collect, process, and analyze spectra of samples. Based on this, they can use machine learning algorithms to pattern recognize spectral data and establish predictive models for qualitative and quantitative analysis of MPs in chicken meat.

Through cross disciplinary collaboration, food majors can characterize the physical and chemical properties of MPs, while agricultural information majors can establish analytical models through data processing and analysis methods to jointly improve the accuracy and efficiency of MPs detection.

4. Interdisciplinary with Environmental Science

Environmental Science is the study of the impact of human activities on the environment, as well as the science of environmental protection and management. In pollutants testing, environmental science provides in-depth understanding of the sources, distribution, migration, and transformation of pollutants. This helps researchers understand how pollutant enter the food chain, such as chicken, and assess their potential risks to the environment and human health. In addition, environmental science provides recommendations for the control and management of pollutant pollution, providing a scientific basis for reducing the accumulation of pollutants in the environment.

Polycyclic aromatic hydrocarbons (PAHs) are common organic pollutants in the environment and one of the earliest discovered and studied chemical carcinogens. Due to its toxicity, bioaccumulation, low volatility, and ability to persist in the environment, it has been classified as a typical persistent organic pollutant and has received widespread attention. More than 90% of PAHs in the environment eventually accumulate in the soil, making the pollution problem of PAHs on soil particularly prominent.

Fluorescence spectroscopy technology has been applied to detect PAHs in soil, but the fluorescence of organic matter can affect the fluorescence of PAHs, limiting the application of this technology. The interdisciplinary project mainly studies the interaction between PAHs and organic matter

through spectroscopic techniques, providing technical support for their impact correction. This project involves multiple disciplines such as environmental science, analytical chemistry, spectroscopy, and data science and information technology.

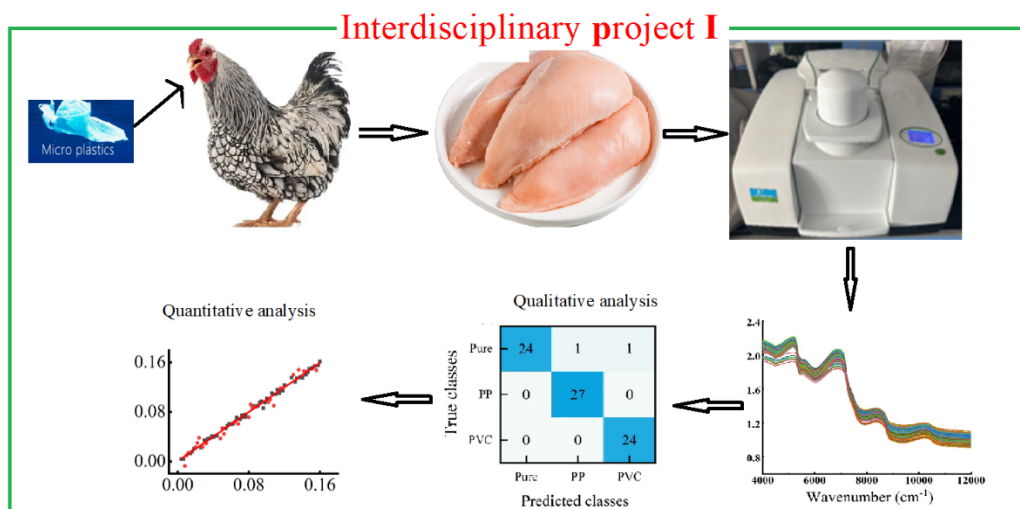


Fig 1. Interdisciplinary project I

During the project research process, students majoring in environmental science are responsible for collecting and processing soil samples, including removing impurities, grinding and sieving, drying, etc. On this basis, utilizing its professional knowledge, PAHs are extracted and purified using techniques such as Soxhlet extraction, ultrasonic extraction, or microwave extraction for subsequent fluorescence spectroscopy detection. Agricultural information majors can utilize their expertise in spectral analysis to collect three-dimensional fluorescence spectra and ultraviolet visible spectra of samples. Based on this, they can

use parallel factor algorithm and two-dimensional correlation spectroscopy techniques to study the interaction between PAHs and humic acids (HA).

Through interdisciplinary collaboration, environmental students can characterize the physicochemical properties of PAHs and HA in soil, while agricultural information students can characterize the dynamic interaction process between PAHs and HA through data processing and visualization, complementing each other's strengths and revealing the interaction mechanism between the two more comprehensively and deeply.

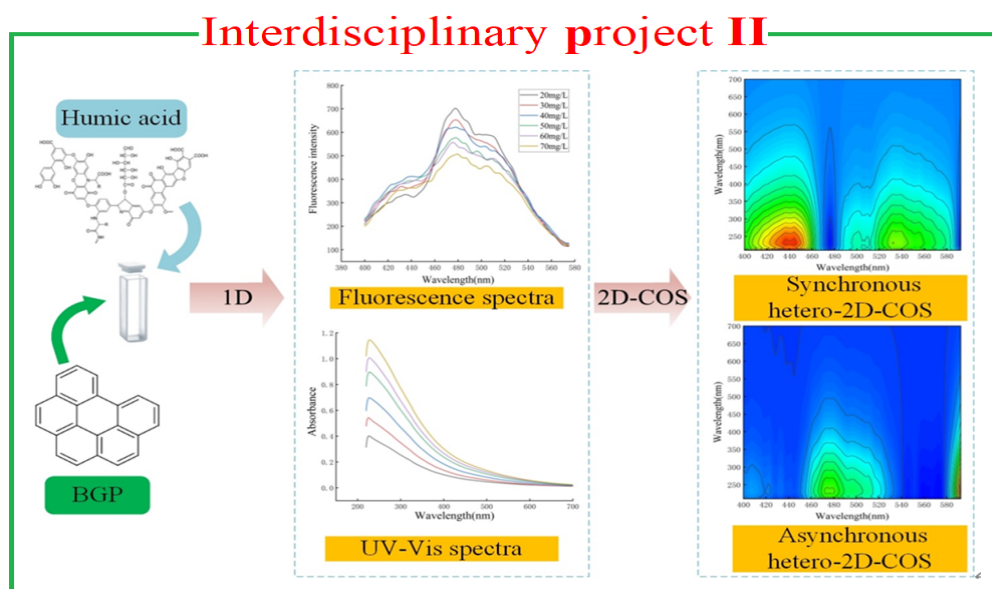


Fig 2. Interdisciplinary project II

5. Cultivate Ability

Based on interdisciplinary projects, complementary

advantages, mutual learning, and the cultivation of various abilities in agricultural engineering and information, food science, and environmental science majors (Fig.3)

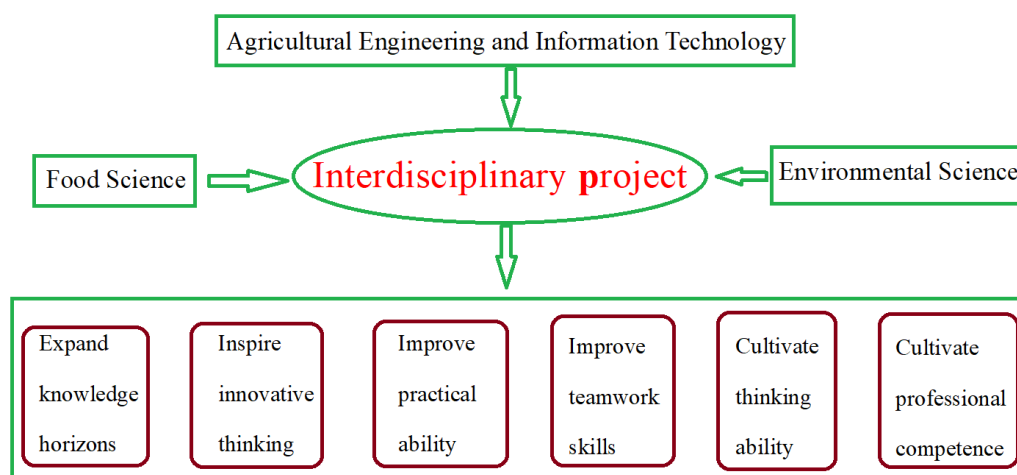


Fig 3. Cultivation of various abilities

(1) Inspire innovative thinking

Interdisciplinary integration is an important source of innovative thinking. The intersection of agricultural engineering and information science, food science, and environmental science can stimulate students' innovative thinking, enabling them to think about problems from different perspectives and propose new solutions. For example, in the field of food and environmental testing, students can try to apply spectral technology to rapid detection of food quality and agricultural environment, and develop detection methods with higher sensitivity and accuracy.

(2) Practical ability

By participating in interdisciplinary research projects or experiments, students can exercise their practical abilities and learn how to apply their knowledge to solve practical problems.

(3) Teamwork ability

In interdisciplinary project research, students need to collaborate with peers from different disciplinary backgrounds, which helps develop their teamwork and communication skills.

(4) Interdisciplinary thinking ability

Interdisciplinary projects require students to possess interdisciplinary thinking ability, that is, the ability to establish connections between different disciplines and form a comprehensive way of thinking.

(5) Cultivate professional competence

Interdisciplinary projects can enable students to gain a deeper understanding of the latest developments and cutting-edge trends in food science, environmental science, and spectroscopic technology, thereby enhancing their professional competence. At the same time, this interdisciplinary project also helps cultivate students' research abilities and innovative spirit, laying a solid foundation for their future career development.

6. Summary

This study focuses on graduate students majoring in agricultural engineering and information technology at the College of Engineering and Technology, Tianjin Agricultural University. With interdisciplinary projects as the foundation,

the project is conducted in collaboration with graduate students majoring in Food Science and Environmental Science. In the process of project research, graduate students from different majors learn from each other, achieve complementary knowledge systems and skills, broaden their knowledge horizons, stimulate innovative thinking, cultivate professional competence, and enhance comprehensive abilities.

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