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Construction of Position Capacity Modular Curriculum System for Grassroots Agricultural Meteorological Observation

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Abstract Through the investigation and analysis of the operation status and training needs of the agrometeorological observation work of the grass-roots meteorological department, as well as the evaluation of training effects, the development of a modular curriculum system for agrometeorological observation posts was carried out. Research has shown that the structure and distribution of academic qualifications, age and professional title of the agrometeorological observation personnel currently on the job is basically reasonable, human resources are abundant and the observation work is comprehensive. However, there are problems such as lack of professional knowledge and skills, fewer training opportunities and large training needs. Therefore, the pilot training of agricultural meteorological observation still has room for improvement in terms of training frequency, curriculum arrangement, and quality of remote training.

Key words Agrometeorological observation, Training design, Questionnaire survey, Training summary

1 Introduction

The Party Group of the China Meteorological Administration issued the *Guiding Opinions on Promoting the Comprehensive Reform of County-Level Meteorological Institutions* (Zhong Qi Dang Fa [2012]66) in 2012. The document has proposed requirements for developing county-level integrated meteorological services, accelerating the construction of an intensive county-level integrated meteorological service platform, promoting the reform of county-level comprehensive meteorological services, and increasing the scientific and technological support and talent guarantee of county-level meteorological integrated services. According to the requirements of the comprehensive reform of county-level meteorological agencies for the comprehensive ability of grassroots operation personnel, it is imperative to construct a training course system with comprehensive content, reasonable structure, strong pertinence that can basically meet the needs of comprehensive operation posts of grass-roots meteorological agencies[1].

The county-level meteorological department is the basis for agrometeorological observations and services. It is also a frontier position. However, due to the lack of professional and technical talents and weak technical strength in agricultural meteorological services, the problems of low level of observation modernization, inability to integrate observation data platform, and insufficient service capacity have been exposed[2]. On-the-job training is a pioneering, basic, and strategic project for building a high-quality workforce. For carrying out the "four comprehensive" strategic layout and promoting the modernization of meteorology, talent is the key, and training needs to be done first. To implement the requirements of the *Regulations on the Work of Cadre Education and Training*, the meteorological education and training system must be improved, the content of education and training must be clarified, and methods of training must be innovated, so as to provide talent guarantee and intellectual support for the sustainable development of meteorological services.

According to the work deployment of the Meteorological Cadre Training Institute of China Meteorological Administration on the development of modular curriculum system for the ability and quality training of grassroots posts, the research team participated in the development of training modules for agricultural meteorological observations of grassroots meteorological agencies. To enhance the comprehensiveness, rationality and pertinence of the syllabus, through the preliminary questionnaire survey, the pilot training class and the post-training questionnaire evaluation, discussion and feedback, the research on the construction of modular curriculum system for the competence of agricultural meteorological observation posts was carried out.

2 Research methods

2.1 Questionnaire survey Questionnaire survey is an important method for training curriculum development research and effectiveness evaluation. This study included pre-training needs survey and post-training effectiveness survey. The two kinds of questionnaires designed were "Agricultural Meteorological Observation Modular Curriculum System Construction" and "Agricultural Meteorological Basic Knowledge and Technology Training (Pilot) Class Assessment".

The first kind of questionnaires included the basic situation of operation personnel, the work content of the agrometeorological observation, and professional skill training status and training needs. The survey targets were some staff of provincial, municipal (county) meteorological bureaus and observation personnel of the agricultural meteorological observatory. A total of 136 valid survey samples were collected, and the data sources were reliable and

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representative.

The second kind of questionnaires was for personnel who participated in the pilot course on agrometeorological basic knowledge and skill training. It was filled after the training session. The questionnaires included basic information of students, the status of agrometeorological services, agrometeorological training experience, teaching arrangements and quality, and difficulties encountered in the work and advices on training, a total of five parts. The effectiveness of the training was assessed through the results of the survey combined with feedback from panel.

2.2 Feedback from panel In the pilot training process of agricultural meteorological basic knowledge, four classes were arranged for the participants to discuss, and the feedback of the students was recorded to improve the quality of the training. In order to allow participants to speak freely about the shortcomings of the training, the form of collective discussion was taken to create a relaxed atmosphere. The issues such as how to improve the quality of the training, whether the curriculum met the needs of the grassroots, whether the difficulty of the course was appropriate were discussed. In addition, the participants were encouraged to put forward their recommendations and opinions on the training.

2.3 Data analysis After the questionnaires were collected, they were subjected to preliminary screening, computer input and invalidation elimination. Then, data processing and statistics was performed (analyzed by R software later). Before data analysis, the results of the questionnaires were parameterized. For the multiple-choice questions, the number of selections of the options was taken as statistical parameters. The answers to the short answer questions were categorized by category. In data analysis, for the duplicates in the two kinds of questionnaires, the pre-training survey results of the questionnaires with a larger number of valid samples were chosen. The results of the survey were also compared with the results of the panel in order to more accurately find out the inadequacies in the development of the modular curriculum system for the competence of agricultural meteorological observation posts, thus improving the credibility of the research results.

3 Survey of training needs of grass-roots agrometeorological staff

The valid pre-training questionnaires were mainly distributed in Hunan, Liaoning, Qinghai and Fujian, covering basically all the grassroots agrometeorological observatories in these four provinces. The survey results were representative, and a total of 136 valid questionnaires were recovered.

3.1 Basic situation of grassroots agrometeorological observers The first part of the questionnaires surveyed the age, profession, academic qualifications, title and years of working of the observers at the grassroots agricultural meteorological stations (Fig. 1). As shown in Fig. 1, the grassroots agrometeorological observers are mainly young people, and the employees under the age of 40 accounted for 54.7%; the profession was dominated by atmospheric science (30.7%), followed by agricultural meteorology (21.9%); in terms of education level, the participants with bachelor degree or above accounted for 68.6%; and in terms of title, the participants with intermediate titles accounted for 68.6%. Considering the years of working, there were 41 people with working duration less than 3 years, accounting for 30.1%; there were 22 people with working duration ranging from 3 to 5 years, accounting for 16.2%; there were 20 people with working duration ranging from 6 to 10 years, accounting for 14.7%; and there were 53 people with working duration longer than 10 years, accounting for 39.0%.

Based on the analysis above, it could be concluded that the academic structure, professional structure and age structure of the agricultural meteorological observers currently on the job were basically reasonable. However, the proportion of personnel with agrometeorological profession was relatively small, accounting for only 21.9%. The working years of most of the employees ranged from 3 to 10 years, accounting for 69.1% of the total. The survey also showed that most of the people with working duration longer than 10 years, especially those with age over 50 years were transferred from other positions to engage in agrometeorological observations, and problems such as lack of professional knowledge and skills exist.

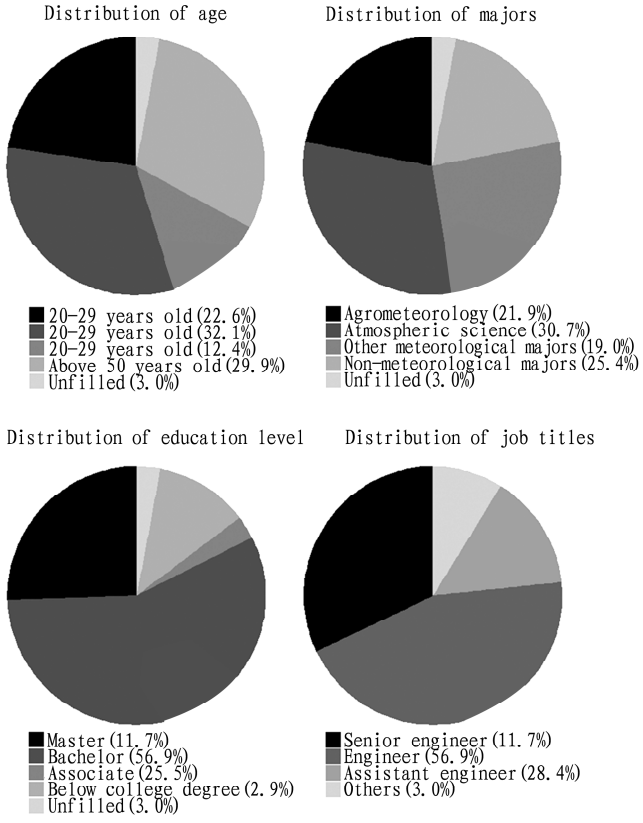

Fig. 1 Basic situation of grassroots agrometeorological observation personnel

3.2 Work situation of agricultural weather stations The second part of the questionnaires surveyed the station level and work content of the agrometeorological observatories and the types

of the crops observed. There were 78 people working at the agricultural meteorological observation stations of Class I, and there were 58 people working at the stations of Class II. Among the eight observations listed in the questionnaires, most of the participants chose crop observation and soil moisture observation. Nearly 50% of the participants chose natural phenology observation, special crop observation in the region and agricultural meteorological disaster survey, and there were relatively few participants choosing other options. As for the types of crops observed, there were great differences among different provinces. The survey results showed that the observation objects of the agricultural meteorological stations were dominated by rice and other special crops in various regions, accounting for 44.1% and 55.9%, respectively, while others such as wheat, maize, cotton, rape and soybean accounted for a small proportion.

In the agrometeorological observatories, the number of observers working in the observatories of Class I was greater than that working in the observatories of Class II. This suggests that the human resources engaged in observation are rich, which is beneficial to the practice of off-production learning. The work content covers a comprehensive range. The crops observed include wheat, rice, maize, cotton, soybean, rape, pasture, forest, *etc.*; and the items observed include soil moisture, natural phenology, agrometeorological disasters, farmland microclimate, characteristic observation, *etc.*, basically in line with the current status of the agricultural meteorological observation in China.

3.3 Training status of professional skills for grassroots agrometeorological observation The number of participation in agricultural meteorological knowledge training and the organization of agricultural meteorological training were shown in Fig. 2. As shown in Fig. 2, in the past three years, 89.1% of the participants had participated in less than three times of agrometeorological training. Among them, 43.8% of agrometeorological observers had never participated in agrometeorological training. In the agrometeorological trainings that the observers participated in, the provincial meteorological training units (including various branches of the Meteorological Cadre Training Institute of the China Meteorological Administration and the provincial meteorological training institutions) were the main contractors, which organized 58.5% of relative trainings. The number of trainings organized by the Meteorological Cadre Training Institute of China Meteorological Administration ranked the second, accounting for 28.5% of the total.

On-the-job training is important for the growth of job skills of grassroots agrometeorological personnel. Most people think this is the main way to acquire job skills. But according to statistics, there were only 72 agricultural meteorological training programs in China during 2012 – 2015, most of which were provincial training programs. In the four years, the average agricultural meteorological training in each province was less than three times, and there was almost no systematic training for agrometeorological observation. The results of the survey were also in line with this situation. The face-to-face training that grassroots agrometeorological observes can participate in does not meet the needs of job skills. Even nearly half of the operation people have never participated in agricultural meteorological training. In the existing related training, the provincial meteorological training institutions are the main undertakers, but relatively speaking, the Meteorological Cadre Training Institute of the China Meteorological Administration and the various branches have more professional resources and more targeted training. They should undertake more relative training tasks.

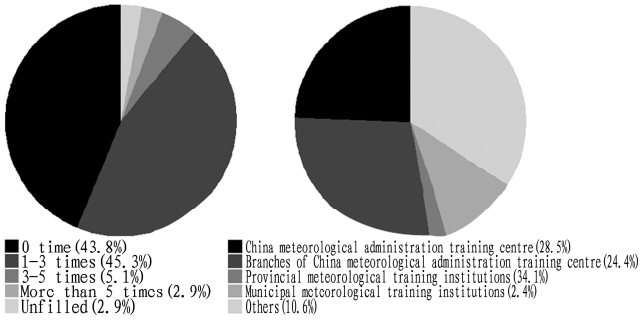

Fig. 2 Distribution of number of participations in agrometeorological training and training institutions

3.4 Needs analysis of agrometeorological training The individual needs of the observing staff of the agrometeorological stations for relevant training were investigated, including the training duration, the content of the training course, the knowledge or skills that need to be strengthened and the major difficulties faced by the agrometeorological observation.

(i) For the training duration, the needs of operation personnel were not uniform. Most of the participants chose the options of 7 d and longer than one month. The options of 10 d, 15 d and one month also had choosers.

(ii) For the course content, most of the 10 course options listed were positively responded (Table 1). Courses agrometeorological observation service system, agricultural meteorological disaster investigation, featured crop observation, farmland microclimate observation, agrometeorological observation basis and cutting-edge technology introduction, natural phenology observation and soil moisture observation had attracted more than 2/3 of the participants. More than 80% of the agrometeorological personnel believed that there is a great need for training related to the agrometeorological observation service system and the agrometeorological disaster investigation, while there is not much demand at the grassroots level for livestock observation and forest observation training. This was the only subjective question in the questionnaires to help understand the knowledge or skills that agrometeorological observers need to learn from the perspective of grassroots workers. According to statistics, most grassroots workers mentioned four aspects of knowledge, basic theory of agricultural meteorology, statistical analysis methods of observational data, agrometeorological service knowledge and application and planting and management techniques (ranked from most to least).

(iii) Considering the current difficulties faced by the agrometeorological observation service, multiple-choice questions were arranged: lack of agrometeorological professionals, lack of special training on agrometeorological observation, lack of a stable team of agrometeorological observers, and lack of cooperation with the ag-

ricultural sector. The choices of the participants showed that there are more difficulties. Among the participants, 65.3 chose more than three options, and 41.3% chose all. The option of lack of agrometeorological professionals was chosen the most.

The above analysis showed that there is still much room for improvement in the training of agricultural meteorological observers. For grassroots agrometeorological observers, the training with basic theoretical knowledge as the dominance, combined with actual application and agrometeorological service promotion knowledge should be developed. Considering that some employees have the need to publish papers, some courses such as data processing and analysis and paper writing methods should also be set up.

Table 1 Situation of need for training courses (Unit: %)

Course	Very need	Relatively need	No need
Introduction to Agricultural Meteorological Observations and Frontier Technology	73.88	24.63	5.60
Crop Observation	63.85	33.85	6.30
Soil Moisture Observation	69.53	26.56	12.60
Natural Phenology Observation	70.25	22.31	24.52
Livestock Observation	50.00	31.48	36.70
Forest Observation	41.82	40.91	29.49
Agricultural Meteorological Disaster Investigation	84.62	13.85	9.59
Agricultural Meteorological Observation Service System	87.40	11.02	11.85
Farmland Microclimate Observation	75.00	18.33	26.02
Characteristic Crop Observation	79.23	16.92	17.99

4 Training design and post-training effectiveness survey

4.1 Training design Based on the basic situation of the grassroots agricultural meteorological operation personnel, the basic knowledge of agricultural meteorology, and the type and nature of technical training, as well as the needs of the participants in the previous survey, the Meteorological Cadre Training Institute of China Meteorological Administration and the Hunan Branch targetedly developed a training mode that combines remote pre-training, exam selection, centralized face-to-face training, case teaching and experiential teaching. The training aims to enable students to master the basic knowledge of agricultural meteorology and the basic techniques and methods of agrometeorological services and to improve the ability of students to solve practical problems in agrometeorological services. The remote pre-training has total 60 class hours, and the training content mainly includes the basic concepts of agricultural meteorology, solar radiation and agricultural production, thermal conditions and agricultural production, water conditions and agricultural production, carbon dioxide, wind and agricultural production, agricultural meteorological model, *etc.* The face-to-face training is divided into four training modules, basic knowledge of agricultural meteorology, common techniques and methods for agrometeorological services, broadening the thinking of agrometeorological services, and the ability to solve practical problems. A variety of training methods including theoretical lectures, case teaching, special lectures, internship, exchanges and seminars were used. The training duration was 26 d, a total of 160 class hours (Table 2).

4.2 Effectiveness survey A total of two phases of training for agricultural meteorological basic knowledge and techniques were opened. After the training, all the participants were surveyed. Among them, the age was mostly under 30 years old, accounting for 78.3%; the education level was dominated by bachelor, accounting for 87.0%; the participants with majors of agrometeorology or agronomy accounted for only 23.1%. Most of the students were engaged in agrometeorological work, but 43.5% of them participated in the relevant training for the first time.

Table 2 Design of agricultural meteorological basic knowledge and technical training (pilot) class

No.	Training mode	Class hours	Proportion in total class hours//%
1	Theoretical lecture	80	50.0
2	Case teaching	12	7.5
3	Lecture	28	17.5
4	Experiential teaching	16	10.0
5	Exchange, seminars, class activities	24	15.0

The results of the questionnaires on training effect showed that the participants believed that the module of agro-meteorological basic knowledge training had the most learning gains. For the training module for solving practical problems, only 57.0% of the students considered that they had learned a lot, the least number among the four modules.

The students believed that the most rewarding courses were Agricultural Meteorological Sci-Tech Paper Writing and Shaanxi Fruit Industry Service Cases, and 87.0% of them thought they had learned a lot from the two courses. The Application of Geographic Information Systems in Agrometeorology was considered by the students to be the least rewarding course. In terms of course duration, 36.4% of the trainees believed that the duration of Agricultural Meteorological Observation Technology and Data Processing Technology and Agricultural Meteorological Disaster Prevention and Mitigation Technology was too short. These two courses are more practical for grassroots students and require more training class hours.

For all 18 face-to-face courses, 78.1% of the participants felt that there was a big grain after the training, 10 percentage points higher than remote training. Almost all trainees believed that the interface between face-to-face training and remote pre-training was successful. Among them, 82.6% believed that the previous re-

mote training was of great help to face-to-face training, and the face-to-face training also solved the problem left by remote pre-training.

The results of the training seminar and technique quality survey showed that 93.3% of the trainees believed that the training courses had a strong guiding significance for the actual work, and the proportion of students that believed that the teaching methods such as seminars, case teaching and experiential teaching were helpful was up to 96.7%. A 5-point scale was used in the teaching quality survey. The scores of various indicators of training design and arrangement were all above 4.70 points. Among them, the score of the accuracy of the training objectives was 4.89. The overall satisfaction of the training was 98.0%.

5 Suggestions

There are a large number of personnel engaged in agricultural meteorological observation and service in the county-level stations of the China Meteorological Administration, and many of them are non-related majors, so there is a great demand for professional related training. This aspect is also a gap in current meteorological training work. This study hopes to provide advice and suggestions for the training of agricultural meteorological basic knowledge through questionnaire survey and practical exploration. Based on the research results, the following suggestions were put forward.

(i) The Meteorological Cadre Training Institute needs to develop more training on agricultural meteorological observation knowledge and related skills at the grassroots level. The survey results showed that the on-the-job training of agrometeorological observation within the meteorological system faces a huge gap. According to the requirements of the *Integrated Meteorological Observing System Development Plan (2014 – 2020)*, automated meteorological observation based on infrared, microwave and image processing technologies will be achieved, agricultural meteorological service software system based on the fusion method of satellite observation data will be developed, and relevant regulations, standards and systems will be implemented by 2020. The requirements for agricultural meteorological observation personnel to acquire new knowledge and receive new technology training have been put forward. The traditional learning model of "experienced personnel teaching newcomers" cannot meet the requirements of continuous advancement of observation technology, and it is urgent to carry out comprehensive systematic agrometeorological basic knowledge and techniques training for grassroots.

(ii) The face-to-face training of agrometeorological related technology still needs to adhere to the basic knowledge course and combine the training of common techniques and methods, agricultural meteorological service thinking extending and practical problem-solving skills. The part of practical problem solving ability still needs to develop more teaching forms or case teaching. The training curriculum also needs to be diversified. Many participants in the seminar also proposed that the work of the grassroots observatories is mainly hands-on, and they hoped that there would be more practical teaching. Agricultural meteorological disaster services are also key points. Courses on crop disaster, pest and disease observation and investigation should be appropriately increased, especially the teaching of field investigation norms, which knowledge will be great help to the improvement of the quality of grassroots agrometeorological observation services. The grassroots meteorological observes have multiple positions and have sufficient knowledge of the ground observation system, so ground observation courses should be eliminated in targeted training of agrometeorological related technologies. Forest observation teaching should also be abolished because there are few forest weather stations and there are few relevant applications in operation services. There is a great need for grassroots workers to publish articles, and more data processing and article writing courses should be set up. Most of the trainees said that the data processing courses and practical teaching in the training were very rewarding, opening up the horizon and helping the application and completion of projects. The teaching of relevant courses can effectively improve the scientific research ability of grassroots employees and help the promotion of employees' titles.

(iii) Targeting at the prominent contradiction between working and learning of the staff of the agricultural meteorological observatories, the training method of short-term level-level training can be tried, step by step, multiple-time, gradually and more targeted. The levels of students participating in face-to-face training varied. Participants in the panel also generally reflected that the content-intensive long-term training affected the training effect. In the training of the basic class, difficult case teaching was involved, so the training effect for most students without the major of agrometeorology was poor.

(iv) The quality of remote pre-training is not high, and the level of courseware, training supervision technology and examination review technology need to be improved. The recorded teacher lecture video as a remote training courseware cannot meet the learning needs of the grassroots. The courseware production methods of video recording and post editing should be introduced to improve the quality of courseware and training effect of remote training. The form of remote examination should be innovated. New monitoring technology can be applied to increase the inspection and screening effect of examination, thus laying the foundation for face-to-face training.

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