Equipment for crop protection: standardization development in China

Caijin Huang[1]*, Xiansheng Zhang[1], Lingjuan Ma[2], Junbao Chen[1], Shusheng Lv[1]

(1 *Chinese Academy of Agricultural Mechanization Sciences, Beijing 100083;*

2 *China Agricultural Machinery Testing Center, Ministry of Agriculture, Beijing 100122;*

**Corresponding author, email: Caijin.huang@gmail.com*)

Abstract: In this paper the history of standardization for crop protection equipment was reviewed to analyze the trends of standards preparation. The standards currently in force were firstly reviewed by comparing their elements with the present general state of art. The trends of standard preparation, through which the overall development of crop protection equipment is reflected, were interpreted by descriptive items. Finally the future development was predicted as suggestions for decision-making in policy constitution.

Key words: equipment for crop protection, standardization, trends

1 Introduction

Equipment for crop protection refers to machinery and implements protecting crops in a scientific and effective way, aiming at eliminating pests, diseases and weeds, and ensuring stable and high yield of crops (Liu 2008). In a narrow sense, equipment items used for crop protection spray chemicals to protect crops against pests, diseases and weeds. It is an effective approach to maintain good harvest for grain, forest and orchard (Matthews 2008).

Equipment for crop protection, through the use of which both unit area yields and good quality of agricultural products are ensured (Oerke and Dehne 2006), is essential for modern agricultural production. The operation and safety performance of crop protection equipment have always been the concern of manufacturers, distributors and farmers (Alt 1996), since they are closely related to human health, safety and environmental pollution.

Standardization is one of the effective approaches to modernize production, to advance manufacturing technologies, to improve quality and enhance variety, and to lower the production cost of crop protection equipment (Li 2004). In this paper the standardization practices, particularly standard preparation and revision, were subjected to studies.

2 Standards system of China at a glance

The standards system of China comprises enterprise standards, provincial

Caijin Huang, Xiansheng Zhang, Lingjuan Ma, Junbao Chen, Shusheng Lv. Equipment for Crop Protection：Standardization Development in China. Agricultural Engineering International: CIGR Journal. Manuscript No.1262. Vol. 13, No.1, 2011. Provisional PDF Version.

standards, industry standards and national standards, among which the latter two have the power to regulate manufacturing across the whole country. The industry standards involved for crop protection equipment contain agricultural standards and machinery standards, denoted by NY and JB respectively in abbreviation of Chinese conversion into Roman letters. Distinguished from international standards, both national standards (GB for short) and industry standards can be subdivided into compulsory and recommended. The recommended standards are identified by adding a slash and a letter *T* after to the above-mentioned abbreviations, e.g. GB/T, NY/T and JB/T.

3 Standardization for crop protection equipment

Standardization had been given great importance since the reform and opening-up in 1978. The utilization of crop protection equipment in agricultural production can be traced back to a long history, however, the first standard officially was announced and publicly accepted only in 1980. In nearly three decades of development, the standards system for crop protection equipment has become fundamentally mature, but a more systematic and scientific system is still being expected. Only one standard, i.e. GB 10395.6-2006 that adopted ISO 4254-1995, is mandatory for the industry, although more than 30 national standards and industry standards have been published by corresponding administrative departments.

CCC, which stands for China Compulsory Certification, is the new compulsory safety and quality mark for many products sold on the Chinese market and a very important approach of safety standards. CCC became effective on May 1, 2002. And on August 2006, Certification and Accreditation Administration of People's Republic of China issued Provisions for the Implementation of Compulsory Certification of Agricultural Machinery - Crop Protection Machinery. China Agriculture Machinery Testing Center was assigned to undertake all relevant works regarding certifications for crop protection machinery.

The procedure of CCC certification consists of documents application, type testing, initial inspection of the factory, evaluation of certification results and approval of certification, and follow-up inspection. Safety standards were well utilized in the process, particularly in type testing. All appropriate provisions in GB 10395.1 and GB 10395.6 were employed as the requirements and test methods for CCC.

Through years' of effort, CCC for crop protection machinery has obtained great achievement. By the end October 2009, there are 226 enterprises having received 324 certificates for different units. Through the progress of CCC, the market order, manufacturing technologies, management ability and general level of the industry have been greatly improved.

3.1 Standards currently in force

The standards currently active for crop protection equipment are partly listed in Table 1. Apparently most of them were prepared or revised in recent years, suggesting that standards preparation was quite up-to-date and the existing standards can satisfy basic needs for normal verification.

Caijin Huang, Xiansheng Zhang, Lingjuan Ma, Junbao Chen, Shusheng Lv. Equipment for Crop Protection：Standardization Development in China. Agricultural Engineering International: CIGR Journal. Manuscript No.1262. Vol. 13, No.1, 2011. Provisional PDF Version.

Table 1 Incomplete list of active standards for crop protection equipment

No.	Titles	International standards from which the standards were adopted [1)]
GB 10395.6-2006	Tractors and machinery for agriculture and forestry Technical means for ensuring safety - Part 6: Equipment for crop protection	ISO 4254-6:1995, MOD
GB/T 17677-1999	Equipment for crop protection Antidrip devices Determination of performance	ISO 6686:1995, IDT
GB/T 18519-2001	Equipment for crop protection Sprayers Connecting dimensions for nozzles with bayonet fixing	ISO 10626:1991, IDT
GB/T 18520-2001	Equipment for crop protection Sprayers Connecting dimensions for nozzles and manometers	ISO 8169:1984, EQV
GB/T 18675-2002	Equipment for crop protection Agricultural sprayers Determination of the volume of total residual	ISO 13440:1996, IDT
GB/T 18676-2002	Equipment for crop protection Sprayer nozzles Colour coding for identification	ISO 10625:1996, IDT
GB/T 18677-2002	Equipment for crop protection Air-assisted sprayers Dimensions of nozzles swivel nuts	ISO 14710:1996, IDT
GB/T 18678-2002	Equipment for crop protection Agriculture spray Nominal capacity of spray tank and diameter of filling	ISO 9357:1990, EQV
GB/T 20084-2006	Equipment for crop protection Sprayers Connection threading	ISO 4102:1984, MOD
GB/T 20085-2006	Equipment for crop protection Vocabulary	ISO 5681:1992, MOD
GB/T 20183.1-2006	Equipment for crop protection Spraying equipment Part 1: Test methods for sprayer nozzles	ISO 5682-1:1996, IDT
GB/T 20183.2-2006	Equipment for crop protection Spraying equipment Part 2: Test methods for hydraulic sprayers	ISO 5682-2:1997, IDT
GB/T 20183.3-2006	Equipment for crop protection Spraying equipment Part 3: Test methods for volume/hectare adjustment systems of agricultural hydraulic pressure sprayers	ISO 5682-3:1996, IDT
NY/T 650-2002	Operating quality for sprayers	—
NY/T 992-2006	The operation quality for air-assisted orchard sprayer	—

Caijin Huang, Xiansheng Zhang, Lingjuan Ma, Junbao Chen, Shusheng Lv. Equipment for Crop Protection：Standardization Development in China. Agricultural Engineering International: CIGR Journal. Manuscript No.1262. Vol. 13, No.1, 2011. Provisional PDF Version.

NY/T 1348-2007	Single tube air-compressed sprayer	—
NY/T 1225-2006	Technical specification of safety application for operated sprayers	—
NY/T 1013-2006	Quality evaluation for sprayers	—
NY/T 1006-2006	Technical requirements for power sprayer	—
JB/T 5113-2005	Intermittent hand sprayer	—
JB/T 6661-2006	Sprayer	—
JB/T 7284-2005	Power sprayer	—
JB/T 7723.1-2005	Power-operated knapsack air-blast sprayer Duster Part 1: Technical requirements	—
JB/T 7723.2-2005	Power-operated knapsack air-blast sprayer Duster Part 2: Test methods	—
JB/T 8573-2005	Pedestal mounted sprayer	—
JB/T 9775-1999	Agricultural machinery Equipment for sowing, planting, distributing fertilizers and spraying Recommended working widths	ISO 6720:1989, IDT
JB/T 9781-1999	Engine-driven sprayer Spray parts	—
JB/T 9797-1999	Sprayer Spray parts	—
JB/T 9802-1999	Sprayer and washing machine Plunger pump and piston pump	—
JB/T 9805.1-1999	Technical requirements for boom sprayer	—
JB/T 9805.2-1999	Test methods for boom sprayer	—
JB/T 9806-1999	Sprayer diaphragm pump	—

1) IDT, Identical adoption; MOD, Modified adoption; EQV, Equivalent.

Caijin Huang, Xiansheng Zhang, Lingjuan Ma, Junbao Chen, Shusheng Lv. Equipment for Crop Protection：Standardization Development in China. Agricultural Engineering International: CIGR Journal. Manuscript No.1262. Vol. 13, No.1, 2011. Provisional PDF Version.

3.2 Draft standards for approval

With the advancement of technologies for crop protection, new types of equipment are innovated. Meanwhile economical benefits, as well as social and environmental benefits are increasingly combined in agricultural production, which demanding much more for crop protection equipment. New standards that meet these requirements are imminent and significant. Table 2 gives a list of draft standards for approval that are to be published in the near future in 2009, according to the Standardization Administration of People's Republic of China (2008).

Table 2 Draft standards for approval for crop protection equipment

Title	Standard to be withdrawn
Equipment for crop protection Knapsack sprayers Part 1: Requirements and test methods	—
Equipment for crop protection Knapsack sprayers Performance limits	—
Guideline on practice for aerial application of pesticide	—
Equipment for crop protection Testing methods for the evaluation of cleaning systems Part 1: Internal cleaning of complete sprayers	—
Equipment for crop protection Testing methods for the evaluation of cleaning systems Part 2: External cleaning of sprayers	—
Equipment for crop protection Testing methods for the evaluation of cleaning systems Part 3: Internal cleaning of tank	—
Equipment for crop protection Sprayer nozzles Colour coding identification	GB/T 18676-2002
Equipment for crop protection Method for field measurement of spray drift	—
Equipment for crop protection Drift classification of spraying equipment Part 1: Classes	—
Equipment for crop protection Test methods for air-assisted sprayers for bush and tree crops	—
Boom sprayer Specifications	JB/T 9805.1-1999
Boom sprayer Test method	JB/T 9805.2-1999
Agricultural sprayers Boom steadiness – Test methods	—
Crop protection equipment Sprayers Demonstration track for field crop sprayers	—

3.3 Interpretation of existing standards

Amid the active standards and draft standards for approval, only GB 10395.6, which deals with the safety aspects of crop protection equipment, is a compulsory one that manufacturers have to comply with. The remaining standards are, however, useful tools that regulate the development of the industry. For recommended

Caijin Huang, Xiansheng Zhang, Lingjuan Ma, Junbao Chen, Shusheng Lv. Equipment for Crop Protection：Standardization Development in China. Agricultural Engineering International: CIGR Journal. Manuscript No.1262. Vol. 13, No.1, 2011. Provisional PDF Version.

standards, once conformity to a standard is declared, manufacturers take the responsibility to ensure the compliance of their products with the standard declared.

Except for those determining the vocabulary and terminology, the standards can be divided into categories of *test method and/or specification*, *procedures* and *field operation guidelines*, to assess or improve performance of both whole machine and individual parts.

4 Trends analysis

After the detailed reading and examinations, the following conclusions were drawn by this investigation to indicate the development rule for past experiences of standardization.

a) Standards for vocabulary and terminology were frequently updated.

The contents of vocabulary and terminology in a standard which define common language are of essential contribution to the development of the industry, and laid a foundation for preparation of other relevant standards. The vocabulary and terminology are actually very straight reflections of technological development. Within past years, the standard in relation to vocabulary had been documented from the original GB/T 6959-1986, to JB/T 7875-1995 and later JB/T 7875-1999, and now GB/T 20084-2006. The interval years of revision turned shorter and shorter, and National Committee of Agricultural Machinery Standardization has already considered for a further revision near by.

b) Standards regarding to field operations were closely following the progress of new technology.

Standards such as NY/T 650-2002, NY/T 992-2006 and NY/T 1006-2006 were designed specially for field operation assessment. The first standard being developed was for field operation of manual sprayers since these are since long time and extensively utilized in agricultural practice. With the improvement in living standard and modern agriculture, powered sprayers and air-assisted orchard sprayers have been popularized to release intensive labor force and to protect people against harm of chemicals. NY/T 992-2006 and NY/T 1006-2006 issued by ministry of agriculture came into force. Nowadays as development of agricultural mechanization and automation booms, a standard for spraying pesticide by aircraft is ready for approval.

c) Emphasis was transferred from merely operational performance to both operational and safety performance.

Putting agricultural production in top priority in early stage, operational performance was paid more attention to increase yield for fighting hunger. It was until publishing the first version of standard GB 10395.6 in 1999, in which safety requirements of crop protection equipment were specified, that human safety issues were treated as principal aspects for equipment design and manufacturing. In the

Caijin Huang, Xiansheng Zhang, Lingjuan Ma, Junbao Chen, Shusheng Lv. Equipment for Crop Protection：Standardization Development in China. Agricultural Engineering International: CIGR Journal. Manuscript No.1262. Vol. 13, No.1, 2011. Provisional PDF Version.

revision of GB 10395.6 in 2006, many requirements items were reinforced and renewed. For instance, air pressure test and drop test of the sprayer tank were added into the text accounting for the actual situation met in China.

d) From evaluation of whole machine to individual evaluation of parts.

Standards issued before the year of 1999, were usually made to evaluate the whole machine, taking GB/T 8096-1987 and GB/T 15404-1994 for instance, were especially for knapsack sprayer and manual sprayer respectively. With strong and diversified functions that the present sprayers performed, the structure and manufacturing of sprayer turned more and more difficult. Containing complex parts, the sprayers rely on every part to secure their overall performance. It is certain that standards developed for individual parts will be of great importance for ensuring both operational and safety performance of the whole sprayers. A good example is JB/T 9781-1999 *Engine-driven sprayer -- Spray parts*.

e) Preparation and revisions of standards become faster.

To meet the demands of technological advancement, Standardization Administration of China has released corresponding policy to promote standards preparation. The National Committee of Agricultural Machinery Standardization also positively made plans to closely trace the emerging technologies of crop protection equipment for leading and accelerating development of the industry. Most of the early standards were revised from 2006 and standards for boom sprayers and cleaning systems were newly prepared for their widespread use.

5 Directions of future development

Based on analysis above and development trends of agricultural machinery, the directions of future development of crop protection equipment were summarized as following to give suggestions to manufacturers.

a) Attach more importance to environmental aspects.

Environmental considerations include the harm of unutilized pesticides to the atmosphere, to surface water and to the soil of crop land. Conclusions can be drawn from the draft standards for approval that environmental influence is the major issue which standards would regulate. All parts of *Equipment for crop protection- Testing methods for the evaluation of cleaning systems* embraced the objective to keep surface water from contamination. *Equipment for crop protection - Method for field measurement of spray drift* contributed to provide methodological support for further spray drift limits.

b) Systematic character and soundness of standards' system will be strengthened.

In the past two years preparation and revision of standards were greatly encouraged by the Standardization Administration of China, for satisfying the requirements of technology development and promoting equipment export. Large

Caijin Huang, Xiansheng Zhang, Lingjuan Ma, Junbao Chen, Shusheng Lv. Equipment for Crop Protection：Standardization Development in China. Agricultural Engineering International: CIGR Journal. Manuscript No.1262. Vol. 13, No.1, 2011. Provisional PDF Version.

amounts of standards were prepared, leading to a slight disorder that overlapping contents may appear in different standards. It suggested that in the next few years correction of the disorder is necessary and newly planned standards will be strictly censored.

c) The cycle of standard preparation will be shortened along with the boom of emerging technologies.

Competition for market share becomes more and more intense, which forces the manufacturers to develop new equipment popular with consumers. Therefore, participation of enterprises in preparation of standards is favorable for the enhancement of enterprises' competitive strength. The core technology and patents would soon be involved in the standards that enterprises prepared for the purpose of monopolizing the market. The cycle of standard preparation would become shorter answering the expectation of both manufacturers and distributors.

d) Precise pesticide application will be important in standards for improving quality of agricultural products.

Precise application of pesticides, a detailed branch of precision agriculture, is receiving increasing attention, and research has been intensively conducted by scientists and engineers at home and abroad. As a core technology to lessen pesticide residue on agricultural products, reduce the impact of unutilized pesticides on the atmosphere, surface water and soils, precise application of pesticides is surely in the scope of standardization when the technology has arrived at certain level. *Equipment for crop protection - Drift classification of spraying equipment - Part 1: Classes* has already started to deal with the problem in a way of defining the drift grade for future development of more specific standards.

6 Conclusions

The development of standardization of crop protection equipment in the past decades has been reviewed. It is concluded from the trend analysis and prediction of future directions that standards systems are still not at its sound state and further preparation and revisions are indispensable for improvement; that environmental aspects and precise application of pesticides is the technological direction of future.

References

Alt, N. 1996. Standardization of plant protection equipment in the EU: aspects of pollution control. EPPO Bulletin, 26 (1): 13-16.

ISO 10625:2005 Equipment for crop protection -- Sprayer nozzles -- Colour coding for identification

ISO 10626:1991 Equipment for crop protection -- Sprayers -- Connecting dimensions for nozzles with bayonet fixing

ISO 13440:1996 Equipment for crop protection -- Agricultural sprayers -- Determination of the volume of total residual

ISO 14710:1996 Equipment for crop protection -- Air-assisted sprayers -- Dimensions of nozzle swivel nuts

ISO 4102:1984 Equipment for crop protection -- Sprayers -- Connection threading

ISO 4254-6:1995 Tractors and machinery for agriculture and forestry -- Technical means for ensuring safety -- Part 6: Equipment for crop protection

ISO 4254-6:2009 Agricultural machinery -- Safety -- Part 6: Sprayers and liquid fertilizer distributors

ISO 5681:1992 Equipment for crop protection – Vocabulary

ISO 5682-1:1996 Equipment for crop protection -- Spraying equipment -- Part 1: Test methods for sprayer nozzles

ISO 5682-2:1997 Equipment for crop protection -- Spraying equipment -- Part 2: Test methods for hydraulic sprayers

ISO 5682-3:1996 Equipment for crop protection -- Spraying equipment -- Part 3: Test method for volume/hectare adjustment systems of agricultural hydraulic pressure sprayers

ISO 6686:1995 Equipment for crop protection -- Antidrip devices -- Determination of performance

ISO 6720:1989 Agricultural machinery -- Equipment for sowing, planting, distributing fertilizers and spraying -- Recommended working widths

ISO 8169:1984 Equipment for crop protection -- Sprayers -- Connecting dimensions for nozzles and manometers

ISO 9357:1990 Equipment for crop protection -- Agricultural sprayers -- Tank nominal volume and filling hole diameter

Li, C. 2004. Introduction to Standardization, 4th Ed. (In Chinese). Beijing: China Renmin University Press, P16-19.

Liu, S. 2008. Utilization and Maintenance of Crop Protection Equipments. Beijing: China Social Press, P5.

Matthews, G. 2008. Attitudes and behaviours regarding use of crop protection products—A survey of more than 8500 smallholders in 26 countries. Crop Protection, 27: 834-846.

Oerke, E. C., and H. W. Dehne. 1997. Global crop production and the efficacy of crop protection - current situation and future trends. European Journal of Plant Pathology, 3(103): 203-215.

Standardization Administration of People's Republic of China. 2008. http://www.sac.gov.cn/upload/071019/0710191012240150.xls. Accessed on June 22, 2008.