农业应对气候变化蓝皮书

BLUE BOOK OF AGRICULTURE FOR ADDRESSING CLIMATE CHANGE

中国农业气象灾害及其灾损评估报告

（No.2）

主编／矫梅燕

副主编／周广胜　张祖强

ASSESSMENT REP [illegible] TEOROLOGICAL DISASTERS AND YIELD LOSSES IN CHINA (No.2)

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摘要

全球变暖已是不争的事实，针对气候变化采取稳健的适应措施已成为国际社会共识。随着全球气候变化，极端天气气候事件危害有加重趋势。由于特殊的地理环境与减灾能力相对薄弱，我国一直是农业气象灾害比较严重的国家，气候变化又给农业气象灾害带来了一些新特点。本报告重点评价了我国主要粮食作物（小麦、玉米、水稻）主要种植区的主要农业气象灾害演变趋势及其气象灾损，为制定农业气象防灾减灾措施提供决策依据。报告主要结论如下。

1. 极端天气气候事件演变趋势

1961 年以来，全国高温事件趋多，低温事件显著减少；年均与各季霜冻日数均呈下降趋势；全国平均年雨日呈显著减少趋势，强降水事件呈增加趋势。在全球气候变化背景下，我国气候变得暖时更暖、旱时更旱、涝时更涝。

2. 干旱演变趋势

1961 年以来，全国农业干旱灾害发展呈面积增大和频率加快趋势，21 世纪以来干旱成灾率平均达 56%，且以秦岭 – 淮河线为界的北方旱灾影响程度与增速均明显大于南方。全国旱灾呈从南向北增加趋势，黄淮海地区旱灾影响最为严重，其次为长江中下游地区和东北地区，三大耕作区总受灾面积约占全国受灾面积的 69%，为旱灾频发区。

3. 小麦涝渍演变趋势

冬小麦涝渍呈增加趋势且生育后期灾害强度增加更明显。1961 年以来，长江中下游地区冬小麦的涝渍多发于苗期、拔节期和抽穗灌浆期，而少发于孕穗期，但变化趋势不同。1981~2010 年冬小麦涝渍除拔节期外均呈增加趋

势，特别是在孕穗期和抽穗灌浆期，不仅发生灾害的趋势明显增加，而且灾害强度也显著增加。冬小麦各生育期的涝渍均呈南部多、北部少的分布格局。

4. 水稻高温热害演变趋势

水稻高温热害增加趋势明显且重度灾害显著增加。高温热害主要发生在抽穗开花期，1961 年以来高温热害均呈增多趋势，特别是 1981~2010 年重度高温热害增多趋势明显。长江中下游地区早稻高温热害呈西南部和东部多、中部和中西部少的分布格局；华南地区早稻高温热害少于长江中下游地区，呈北部多、南部少的分布格局；长江中下游地区一季稻高温热害呈西部多、东部少的分布格局。

5. 低温冷害演变趋势

1961 年以来，低温冷害总体呈减少态势，但 1981~2010 年低温阴雨呈增多趋势。长江中下游地区早稻低温阴雨和晚稻寒露风均呈减少态势；低温阴雨呈西部多、东部少的分布格局，寒露风呈西北部多、东南部少的分布格局。华南地区寒露风减少态势明显，呈东西部多、中部少的分布格局；低温阴雨增多态势明显，呈北部多、南部少的分布格局。东北地区水稻冷害减少态势明显，呈中北部多、南部少的分布格局；春玉米冷害减少态势明显，呈东南部和西南部少、中部和东北部多的分布格局。

6. 霜冻害演变趋势

1961 年以来，霜冻害总体呈减少趋势，但局部地区有加重趋势。黄淮海地区和长江中下游地区多发冬小麦苗期霜冻害，霜冻天数均呈减少态势；黄淮海地区呈西部多、东部少的分布格局，长江中下游地区呈北部多、南部少的分布格局；冬小麦发育提前使得霜冻害并未因霜冻天数的减少而减轻，部分地区甚至有加重趋势。东北地区春玉米乳熟期多发霜冻害，苗期少发霜冻害，但二者均呈减少态势；苗期霜冻害呈东部多、南部和北部少的分布格局，乳熟期霜冻害呈北部多、南部少的分布格局，但在黑龙江、吉林等部分地区，霜冻害有增多趋势。

7. 玉米气象灾损评估

1981~2012 年，春玉米主产区（黑、吉、辽）气象产量的波动幅度和灾

年平均减产量明显大于夏玉米主产区（冀、鲁、豫），春玉米主产区灾年平均气象减产率（10.7%）明显大于夏玉米（5.3%），春玉米比夏玉米面临更大的灾损风险。灾年玉米单位面积减产量较高的省份是辽宁和青海，吉林和辽宁的玉米减产总量最大，辽宁、天津和黑龙江的灾年玉米气象减产率较大。北方的黑龙江、吉林、辽宁、青海以及南方的江西、安徽、湖南、广东等地是玉米气象灾损风险的高发区。

8. 冬小麦气象灾损评估

1981~2012 年，全国年均冬小麦趋势产量为 3237 kg/ha，呈显著增加趋势；灾年年均气象减产率为 2.3%，最大达 6.5%。宁夏、安徽的气象产量波动幅度较大，安徽、宁夏和西藏的单位面积气象减产量较大，河南和山东的气象减产总量较大，宁夏和甘肃的气象减产率较大。冬小麦气象灾损主要发生在西北干旱区和黄淮海平原等北方冬麦区，宁夏、甘肃和贵州等地是冬小麦气象灾损风险的高发区。

9. 一季稻气象灾损评估

1981~2012 年，全国年均一季稻趋势产量为 6399 kg/ha，呈显著增加趋势；灾年年均气象减产率为 2.1%，最大达 6.5%。江苏和四川的一季稻减产总量较大，河南、陕西的一季稻气象减产率较大。一季稻气象灾损主要发生在吉林、黑龙江等北方水稻产区和江苏、安徽、四川等南方水稻产区。吉林等地是一季稻气象灾损风险的高发区。

10. 双季早稻气象灾损评估

1981~2012 年，全国年均双季早稻趋势产量为 5299 kg/ha，呈弱增加趋势；灾年年均气象减产率为 2.2%，最大达 5.9%。安徽、湖北的气象产量波动幅度较大，安徽、湖北和云南的单位面积气象减产量较大，江西的气象减产总量最大，安徽的气象减产率最大，最大气象减产率达 32.6%。双季早稻气象灾损主要发生在安徽、江西、海南和云南等地，其中安徽是双季早稻气象灾损的高发区。

11. 双季晚稻气象灾损评估

1981~2012 年，全国年均双季晚稻趋势产量为 4990 kg/ha，呈明显增加

趋势；灾年年均气象减产率为3.2%，最大达10.5%。云南的气象产量波动幅度最大，云南和广西的单位面积气象减产量较大，湖南的气象减产总量最大，云南和海南的气象减产率较大，其中云南最大气象减产率达8.9%。双季晚稻与早稻的种植区域基本相同，但由于种植时期不同，气象灾损的风险区也不相同。双季晚稻气象灾损主要发生在云南、广西和海南等地。

12. 农业气象防灾减灾对策措施

围绕气候变化背景下农业增产增收与粮食安全这一重大国家需求，基于农业气象灾害的演变趋势及其影响分析，针对中国小麦、玉米和水稻等主要粮食作物及不同粮食主产区，本书提出了中国农业生产气象防灾减灾的具体对策措施，主要包括：第一，充分利用气候资源调整作物播种期，合理避减灾害危害；第二，选育高产优质、抗逆性强的作物品种，科学应对灾害类型变化的影响；第三，推广农业节水栽培模式，提升防旱避险水平；第四，加强农业气象灾害风险管理，提升防灾减灾能力；第五，强化农业气象灾害减灾管理，有效减轻灾害损失。

Abstract

Global warming has become an indisputable fact, and taking some robust measures adaptive to climate change has become the consensus of the international community. With the change of global climate, the damages caused by extreme weather and climate events show an increasing trend. Due to the special geographical environment and the weaker capacity of disaster reduction, China has always been the country with more serious agricultural meteorological disasters, and climate change has brought some new characteristics of agro-meteorological disasters. This report will focus on the evaluation of the main agro-meteorological disaster evolution trend and meteorological disaster damage in the main producing areas of China's major grain crops (wheat, maize, and paddy rice), in order to provide the basis for decision making to develop a series of agro-meteorological disaster prevention and mitigation measures. The main conclusions of the report are listed as follows.

1. Evolution trends of extreme weather and climate events

Since 1961, the high temperature events in the whole nation tended to increase, low temperature events showed significant decrease; the mean frost days of annual and different seasons (spring, summer, autumn and winter) showed decreasing trend. The national mean annual rainy days showed a significant decreasing trend, and heavy precipitation events showed increasing trend. China's climate becomes warmer when more warm, more dry when the drought, and more floods when floods in the context of global climate change.

2. Evolution trend of drought

Since 1961, both the area and occurrence frequency of the national agricultural drought disaster tended to increase. Since the beginning of the 21st century, the drought disaster rate reached about 56% on average, and the extend and intersity of the drought disasters in the north divided by the Qinling-Huaihe line were significantly greater than the south. The drought showed an increasing trend from south to north. Among them, the drought impact was the most serious in Huanghuaihai region, followed by the middle and lower reaches of the Yangtze River region and the Northeast China. The total disaster area accounted for about 69% of the affected areas of the country, and they became the drought prone areas.

3. Evolution trend of wheat waterlogging

The occurrence frequency of waterlogging in winter wheat showed an increasing trend, and the intensity of the disaster increased more obviously in the late growth stage. Since 1961, winter wheat waterlogging in the middle and lower reaches of the Yangtze River often happened in seedling, jointing stage and heading to filling stage, but less at booting stage. Moreover, their changing trends were different. During 1981 to 2010, winter wheat waterlogging showed an increasing trend except the jointing stage, especially both the occurrence frequency and intensity of winter wheat waterlogging increased significantly at booting and heading as well as filling stages. The spatial distribution of winter wheat waterlogging in all growth stages presented the patten of more in the south and less in the north.

4. Evolution trend of high temperature heat damage in paddy rice

The high temperature heat damage of paddy rice showed a pronunced increasing tendency, and the severe disasters increased significantly. It occurred mainly in the heading and flowering stages. Since 1961, the damage from high temperature heat damage tended to increase, especially during 1981 to 2010. The spatial distribution of early paddy rice heat harm was more in the southwestern and eastern part and less in the central and western part in the middle and lower reaches of the Yangtze River. The early rice heat in the Southern China injuried less than in the middle and lower reaches of the Yangtze River, and its spatial distribution was more in the northern part and less in the southern part. The high temperature heat harm of single-cropping paddy rice was more in the western part and less in the eastern part.

5. Evolution trend of chilling injury

Since 1961, the chilling damage showed a decreasing trend, but during 1981–2010, low temperature and rainy injury showed an increasing trend. In the middle and lower reaches of the Yangtze River, both the low temperature and rainy injury in early paddy rice and the cold dew wind in late paddy rice showed a decreasing trend; the low temperature and rainy injury showed the more in the western part and less in the eastern part, and the cold dew wind was more in the northwestern part and less in the southeastern part. In South China, the cold dew wind showed a decreasing trend, and more in the western and eastern parts and less in the central part; the low temperature and rainy injury showed an increasing trend, and was more in the northern part and less in the southern part. In Northeast China, the chilling injury of paddy rice showed a decreasing trend, and was more in the central and northern parts and less in the southern part. The chilling injury in spring maize showed a decreasing trend, was more in the central and northeastern parts and less in the southeastern and southwestern parts.

6. Evolution trend of frost damage

Since 1961, the frost damage generally decreased, but the changing tendency was aggravated in local areas. The frost damage in winter wheat often happened in the seedling stage in both the middle and lower reaches of the Yangtze River and the Huanghuaihai, and it also showed a decreasing trend. The spatial distribution was more in the western part and less in the eastern part in Huanghuaihai region, and more in the northern part and less in the southern part of the middle and lower reaches of the Yangtze River area. The frost damage of winter wheat did not decrease with decreasing frost days, even become worse in local areas due to the ahead of the development stage.

The frost damage in spring maize in Northeast China more often happened at the milk ripe stage, but less at the seedling stage. The frost damage at the milk ripe stage and the seedling stage both showed a decreasing trend. The frost damage was more in the eastern part and less in the southern while northern part at the seedling stage, while more in the northern part and less in the southern part at the milk ripe stage, however, the frost damage showed a increasing trend in Heilongjiang and Jilin provinces.

7. Assessment of maize meteorological disaster damage

During 1981 to 2012, the fluctuation range of the meteorological yield and the average yield reduction in the disaster year in the spring maize producing areas (Heilongjiang, Jilin and Liaoning provinces) were obviously more than those in the summer maize producing areas (Hebei, Shandong and Henan provinces). The mean meteorological yield reduction ratio in the spring maize producing areas (10.7%) was much more than that in the summer maize producing areas (5.3%). The spring maize faced greater damage risk than the summer maize. The yield reduction per unit area in the disaster year in the spring maize was higher in the provinces of Liaoning and Qinghai. The yield reduction in the disaster year was more in the provinces of Jilin and Liaoning, and the meteorological yield reduction ratio was greater in the provinces of Liaoning, Tianjin and Heilongjiang. The meteorological disaster risk was higher in the northern provinces of Heilongjiang, Jilin, Liaoning, Qinghai and the southern provinces of Jiangxi, Anhui, Hunan, Guangdong.

8. Assessment of winter wheat meteorological disaster damage

During 1981 to 2012, the annual mean winter wheat trend yield in the national level was about 3237kg / ha, and showed an increasing trend. The annual mean meteorological yield reduction ratio in the disaster year was 2.3%, and the maximum value reached about 6.5%. The fluctuation range of the meteorological yield was greater in the provinces of Ningxia and Anhui. The meteorological yield reduction per unit area in the disaster year was greater in the provinces of Anhui, Ningxia and Tibetan. The meteorological yield reduction was greater in the provinces of Henan and Shandong.

The meteorological yield reduction ratio in the disaster year was more in the provinces of Ningxia and Gansu. The winter wheat meteorological disaster damage mainly happened in the Northwest arid region and Hunaghuaihai plain. The meteorological disaster risk was higher in the provinces of Ningxia, Gansu and Guizhou.

9. Assessment of single cropping paddy rice meteorological disaster damage

During 1981 to 2012, the annual mean single cropping paddy rice trend yield in the national level was about 6399kg/ha, and showed an obvious increasing trend. The annual mean meteorological yield reduction ratio in the disaster year was 2.1%, and the maximum value reached about 6.5%. The meteorological yield reduction in the disaster year was greater in the provinces of Jiangsu and Sichuan. The meteorological yield reduction ratio in the disaster year was more in the provinces of Henan and Shaanxi. The meteorological disaster damage of single cropping paddy rice mainly happened in the northern rice producing area of Jilin and Heilongjiang provinces and the southern rice producing area of Jiangsu, Anhui and Sichuan provinces. The meteorological disaster risk was higher in the province of Jilin.

10. Assessment of early paddy rice meteorological disaster damage

During 1981 to 2012, the annual mean early paddy rice trend yield in the national level was about 5299kg/ha, and showed a slight increasing trend. The annual mean meteorological yield reduction ratio in the disaster year was 2.2%, and the maximum value reached about 5.9%. The fluctuation range of the meteorological yield was greater in the provinces of Anhui and Hubei. The meteorological yield reduction per unit area was greater in the provinces of Anhui and Hubei. The meteorological yield reduction was the greatest in the province of Jiangxi. The meteorological yield reduction ratio was the greatest in the province of Anhui (32.6%). The meteorological disaster damage of early paddy rice mainly happened in the provinces of Anhui, Jiangxi, Hainan and Yunnan. The meteorological disaster risk was higher in the province of Anhui.