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北海道農業研究センター研究資料

第 67 号

Meteorological Observation System at the National Agricultural Research Center for Hokkaido Region since 1966

北海道農業研究センターにおける1966年からの気象観測について

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Hitsujigaoka, Sapporo, Japan

農研機構 北海道農業研究センター
NATIONAL AGRICULTURAL RESEARCH CENTER FOR HOKKAIDO REGION (NARCH)

Meteorological Observation System at the National Agricultural Research Center for Hokkaido Region since 1966

Ryoji Sameshima, Tomoyoshi Hirota, Takahiro Hamasaki, Kunihiko Kato and Yukiyoshi Iwata

National Agricultural Research Center for Hokkaido Region

Introduction

The National Agricultural Research Center for Hokkaido Region (NARCH) has been recording meteorological data since 1966 (Miyata, 1992). The meteorological data are available on NARCH's web site*. In this report, the methods used to obtain the data are explained.

*(English)http://www.cryo.affrc.go.jp/seisan/meteo/data1e.html;(Japanese)http://cryo.naro.affrc.go.jp/kisyo.html; use of the data is restricted to research and educational purposes.

The meteorological data recorded at NARCH are different from data recorded at more urban observatories because the NARCH data are almost free of urbanization effects (Sameshima *et al.,* 2007). Temperature data recorded at NARCH are therefore typical data for agricultural areas without urbanization effects. Although the NARCH observatory is surrounded by buildings (Fig. 1), NARCH's huge grounds (823 ha) are mostly covered by vegetation (experimental fields and forest), which insulates the observatory from urbanization effects.

Changes in the surrounding environment and observation fields

In 1966, the area surrounding NARCH was mostly farmland. There was a rapid increase in the population around NARCH until about 1980, a rough estimation of which is shown in Fig. 2. A subway terminal was opened 1.6 km northwest of NARCH in 1993. The Sapporo Dome Stadium (245 × 227 m in area and 68 m in height), which is located 0.7 km northwest of NARCH, was opened in 2001.

Observation fields and instruments

Two observation fields, Field-a and Field-b, have been used (Table 1, Fig. 1). Field-b, constructed in October 2000, replaced Field-a as the main field at NARCH on January 1, 2001. For comparison after the change, simultaneous observations were made in both fields

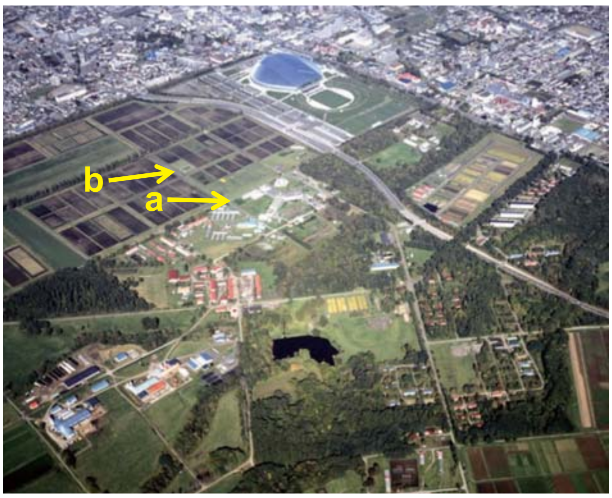


Fig. 1. Aerial view of the National Agriculture Research Center for Hokkaido Region.
Details for Field-a and Field-b are given in Table 1.

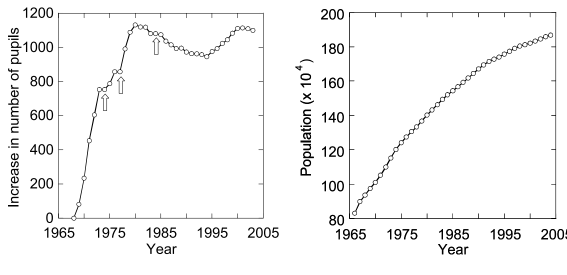


Fig. 2. Left: Increase in the number of pupils at a nearby school from 1968, at which time there were 427 pupils. No increase was assumed when the school district was changed (shown by arrows; data from the web site of Sapporo City Board of Education, http://school.sapporo-c.ed.jp/). Right: Changes in the population of Sapporo City from 1966 to 2005
(data from the web site of Sapporo City, http://www.city.sapporo.jp/city/).

Table 1. Observation fields

Name	Period of operation	Latitude*	Longitude	Altitude	Size	Slope
Field-a	Jan. 1966 - Oct. 2001	43°00.4'N	141°24.8'E	70 m	0 m x 20 m	2%**
Field-b	Nov. 2000 - present	43°00.4'N	141°24.7'E	73 m	0 m x 30 m	2%***

Field-b was located 230 m northwest of Field-a.

*Tokyo Datum.

**Facing northeast. Observation field is horizontal.

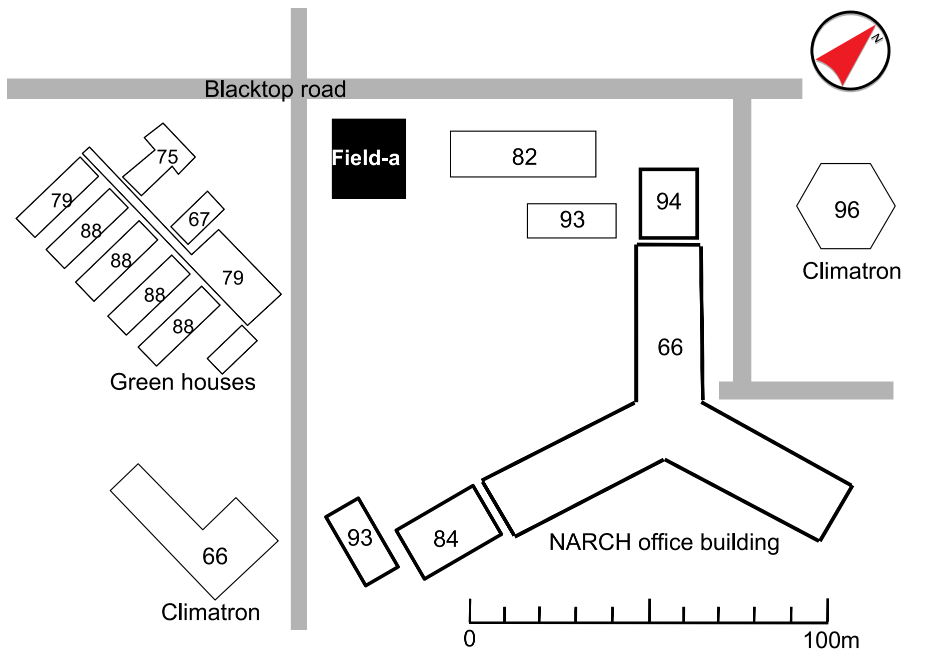
***Facing northeast. Center of the observation field (8 m x 8 m) is horizontal.

Table 2. Comparisons of measured values in Field-a and Field-b in the period from November 2000 to October 2001

Month	Tmax (b) (°C)	Tmax (a) (°C)	Tmin (b) (°C)	Tmin (a) (°C)	RH (b) (%)	RH (a) (%)	Prcp (B) (mm)	Prcp (a) (mm)	Sun (b) (h)	Sun (a) (h)	Rad (b) (MJ/m^2)	Rad (a) (MJ/m^2)	Wnd (b) (m/s)	Wnd (a) (m/s)	Snow (b) (m)	Snow (a) (m)
Nov.	6.1	6.3	-2.1	-1.8	48.6	50	84.5	83.5	103.5	98.4	185.5	181.5	6.8	7.4	0.41	0.36
Dec.	0.0	0.1	-10.2	-9.8	50.4	52	80.0	87.0	103.0	98.6	167.4	168.5	7.1	7.5	0.60	0.45
Jan.	-3.0	-2.5	-15.3	-15.0	51.0	52	51.0	20.5	124.0	117.0	212.0	206.0	6.5	6.9	0.97	0.86
Feb.	-3.5	-3.5	-14.3	-13.7	46.0	48	34.5	55.5	107.0	109.0	254.0	251.0	6.7	7.3	0.99	0.82
Mar.	2.0	2.3	-7.2	-6.6	48.0	50	89.5	69.5	164.0	165.0	412.0	414.0	7.3	7.8	1.01	0.85
Apr.	11.9	12.3	0.6	1.0	41.0	44	29.5	14.0	203.0	203.0	512.0	518.0	7.8	8.2	0.31	0.08
May	17.5	17.6	6.5	6.7	49.0	50	26.0	30.0	199.0	199.0	584.0	589.0	6.9	6.9	-	-
Jun.	20.9	21.2	10.3	10.6	54.0	58	31.0	34.5	189.0	185.0	587.0	592.0	6.1	6.6	-	-
Jul.	23.5	23.9	16.0	16.2	68.0	70	103.0	110.0	119.0	118.0	473.0	476.0	6.2	6.5	-	-
Aug.	23.9	24.2	15.1	15.4	63.0	68	119.0	150.0	209.0	209.0	565.0	564.0	6.3	6.6	-	-
Sep.	20.2	20.5	11.3	11.4	56.0	61	242.0	245.0	149.0	152.0	387.0	387.0	5.9	6.4	-	-
Oct.	14.8	15.1	5.8	6.1	55.4	59	69.0	97.0	131.0	128.0	264.0	260.0	6.1	6.8	-	-
Average	11.2	11.5	1.4	1.7	52.5	55.2	959.0	996.5	150.0	148.5	383.6	383.9	6.6	7.1		

Tmax and Tmin: Monthly mean daily maximum and minimum air temperatures.
RH: Monthly mean daily minimum relative humidity.
Prcp: Monthly precipitation.
Sun: Monthly sunshine duration.
Rad: Monthly global radiation.
Wnd: Monthly mean daily maximum 10-min mean wind speed.
Snow: Monthly maximum snow depth.

Fig. 3. Map of the area around Observation Field-a



·Vacant lots are covered by grass.

·Numbers in the structure show the year of construction by the last two digits of A.D.

·Three-story buildings are shown by thick lines and one-story buildings are shown by thin lines.

from November 1, 2000 to October 1, 2001. After these comparisons had been completed, operation of Field-a was terminated and a laboratory building was constructed on the site. Simultaneous observations in the two fields showed that the temperatures in Field-b were 0.3 ℃ lower than those in Field-a (Table 2), this difference being attributed to overestimation of temperature in Field-a from 1990 (Sameshima *et al.*, 2007). Some buildings were constructed around Field-a during the period of its use (Fig. 3), whereas a broad expanse of experimental fields surrounds Field-b.

Sensors, sensor positions, sensor housing, and recorders used for meteorological observations are shown in Fig. 4 and Table 3 (recorders), Table 4 (air temperature), Table 5 (wind direction and speed), Table 6 (precipitation), Table 7 (sunshine duration), Table 8 (snow depth), Table 9 (global radiation), Table 10 (humidity) and Table 11 (soil temperature and moisture). Table 12 shows new types of data recorded from 2001. Table 13 shows major problems and failed observations from 1991.

Fig. 4. Analog recorder (left) and instrument shelter (right) in 1966. Daily maximum and minimum values were read from the chart.

Table 3. Data recorders

Date	Recorder
Jan. 1966	Analog pen recorder (draw chart on a rolled paper)
Jan. 1980	Digital recorder (Nakaasa Instruments, M-710)
Nov. 1990	Digital recorder (Nakaasa Instruments, M-801)
Jan. 2001	Digital recorder (Yokogawa Denshikiki, M-8021)

Digital recorders scan sensor output every minute, and daily maximum and minimum values are recorded.

Table 4. Methods used to measure air temperature

Date	Sensor	Housing	Position of sensor in field
Jan. 1966	Pt100*	Instrument shelter**	middle of field
Jun. 1974	↓	↓	↓
Mar. 1976	↓	↓	↓
Oct. 1979	↓	↓	↓
Nov. 1990	↓ (Nakaasa Instruments, E-733)	Ventilated tube (Nakaasa Instruments, E-831)	north end of field
Jan. 2001	↓ (Yokogawa Denshikiki, E7061)	↓ (Yokogawa Denshikiki, E7063)	middle of field

Height of observation is fixed at 1.5 m above the soil surface.
↓ : Same as above
*Platinum resistance thermometer (100 Ω).
**Photo is shown in Fig. 4.

Table 5. Sensors used to measure wind direction and speed

Date	Sensor
Jun. 1974	Windmill anemometer with wind vane (Koshin Denki Kogyo, KD-110)
Jan. 1980	Windmill anemometer with wind vane (Koshin Denki Kogyo, A-711)
Nov. 1990	Windmill anemometer with wind vane (Nakaasa Instruments, A-722)
Jan. 2001	Windmill anemometer with wind vane (Yokogawa Denshikiki, A7401)

Height of observation is 10 m above the ground.
Instantaneous and 10-min mean values were recorded.

Table 6. Methods used to measure precipitation

Date	Sensor	Height*	Wind shield	Heating in winter
Jan. 1966	Tipping bucket rain gauge	0.5 m	None	None (not observed in winter)
Jun. 1974	↓	↓	↓	↓
Mar. 1976	↓	2.0 m	↓	With heater inside the gauge
Nov. 1990	↓ (Nakaasa Instruments, B-071)	↓	*Jotan***	Heated water reservoir***
Jan. 2001	↓ (Yokogawa Denshikiki, B-071)	2.5 m	↓	↓

*At top of gauge

**Diameter and height 0.5 x 0.2 m around gauge

***Maintained at 10 ºC around gauge (only in winter).

Table 7. Sensors used to measure sunshine duration

Date	Sensor
May. 1976	Bimetallic*
Nov. 1979	Solarcell (old type)**
Nov. 1990	Solarcell (new type: Nakaasa Instruments, H-061)***
Jan. 2001	↓ (new type: Yokogawa Denshikiki, H0621)

*Corresponding threshold global radiation: 0.279 kW

**Threshold global radiation is 0.21 kW.

***Threshold global radiation is 0.12 kW.

Table 8. Methods used to measure snow depth

Date	Sensor	Measured position
Nov. 1966	Snow depth gauge	Outside field*
Nov. 1990	Ultrasonic snow depth meter (Nakaasa Instruments, B-776)	↓
Jan. 2001	Laser snow depth meter (Yokogawa Denshikiki, B7605)	Middle of field

*Sensor was placed 20 m east of the field.

Table 9. Sensors used to measure global radiation

Date	Sensor
Aug. 1972	Pyranometer*
Nov. 1990	↓ (Nakaasa Instruments, H-201)*
Jan. 2001	↓ (Yokogawa Denshikiki, H2122)*

*Thermocouple type

Table 10. Methods used to measure humidity

Date	Sensor	Housing	Resolution
May. 1975	Hair hygrometer		1%
Jul. 1988	None (data not available)		
Nov. 1990	Lithium chloride dewpoint hygrometer* (Nakaasa Instruments, H-201)	Shelter (Nakaasa Instruments, E-851)	0.1%
Jan. 2001	Capacitive hygrometer (Yokogawa Denshikiki, E771)	Ventilated tube (Yokogawa Denshikiki, E7063)	↓

*Cleaned and repainted with LiCl twice a year (in May and November).

Table 11. Methods used to measure soil temperature and moisture

Date	Temp. sensor	Moist. sensor	Measurement depth (m)
May. 1975	Pt100	None	0.05, 0.1, 0.3
Nov. 1990	↓	↓	0.05, 0.1, 0.3, 1.0, 1.5
Jan. 2001	↓	TDR sensor (TRIME, TRIME-EZ)	0.05, 0.1, 0.3, 0.5, 1.0

Table 12. New types of data recorded from 2001

Item	Sensor
Longwave radiation	Eiko, MS-202F
Net radiation	Eiko, MR-40
Precipitation intensity	Yokogawa Denshikiki, B-061

Table 13. Major problems and failed observations

Date	Failed item(s)
Apr. 1, 1991	All
Apr. 11-14, 1991	All
Feb. 1, 1992	All
Jan. 31, 1993	All
Jun. 20, 1994	Precipitation
Oct. 24-25, 1994	Humidity
May. 8, 1995	Humidity
Nov. 7, 1995	Humidity
Feb. 6-7, 1996	Radiation (reduction of sensor output by snow cover)
Oct. 10-16, 1997	Soil temp. at depth of 10 cm (abnormal output)
Dec. 20-22, 1997	All (1500 h on 20 Dec. to 0800 h on 22 Dec.)
10 Dec. 1997 - 20 Jan. 1998	Soil temp. at depth of 10 cm (abnormal output)
Nov. 17-18, 1998	Precipitation*
Sep. 14-18, 2000	All*
May 24-27, 2002	Global radiation**
May 24, 2002 - Oct. 27, 2003	Long wave radiation**
Jun. 25-28, 2002	All*
Dec. 20, 2003 - Mar. 14, 2004	Short-wave radiation from ground in the net radiation output

*Backup data, measured nearby, are listed on NARCH's Web site

**The same item is available from the net radiation data composed of four outputs.

Soil properties in Field-b

Field-b has volcanic ash soil (Andosols) from the surface to 0.3 m in depth with buried alluvial soil underneath. The physical properties shown in Fig. 5 and listed in Table 14 were examined by using the methods of the Japanese Society of Irrigation, Drainage and Reclamation Engineering (1978). Other features of the soil were surveyed by the methods of the Japanese Society of Pedology (1978) and are listed in Table 15.

Fig. 5. Relationship between water potential (pF) and volumetric water content

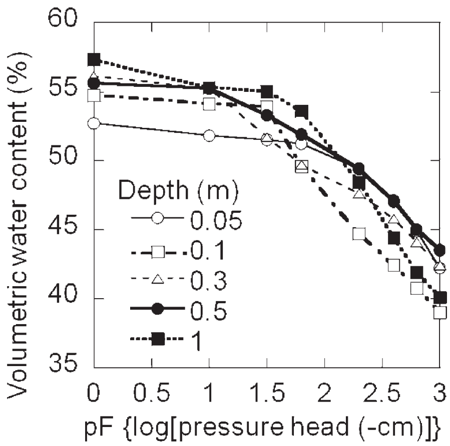


Table 14. Soil physical properties

Depth (m)	Dry bulk density (Mg/m^3)	Porosity (m^3/m^3)	Particle density (Mg/m^3)	aturated hydraulic conductivity (cm/s)
0.05	1.13	0.546	2.50	8×10^{-7}
0.1	1.09	0.577	2.58	2×10^{-4}
0.3	1.09	0.583	2.63	1×10^{-4}
0.5	1.12	0.610	2.86	2×10^{-5}
1	1.14	0.596	2.84	1×10^{-4}

Table 15. Soil profile description

Soil groups/Soil subgroups: Wet Andosols/Thapto-upland Wet Andosols
(Classification of cultivated soils in Japan, Third Approximation 1995)

Melanaquands: by USDA Soil Taxonomy

Date:19, 10, 2000 (weather: fine)

Vegetation or land use: pasture (upland crop preceding year)

Horizon	Depth	Color	Organic matter	Texture	Porosity	Rock fragment	Manganeze oxide	Active aluminium
	cm						Mn	Al
	0							
Ap (Ta-a)	30	10YR 1.7/1	High	CL	Common			+
B (En-a) (Y0?) (Scoria) ↘	50	10YR5/6	Medium	LiC	Few	Fine gravel 2-5mm around 50cm (scoria)		+-
2Bgl	60	mottling 10YR5/6 matrix 2.5Y5.5/2 mottling:matrix=2:5	Low	LiC	Common			-
2Bg2	77	10YR4/3 7.5YR4/4 1:1	Low	SCL	Common			-
2Bg3	92	2.5Y5/3 10YR5/6 3:1	Low	LiC	Common			+-
2Bg FeMn		2.5Y5/3 N2/0	Low	SCL			++	+-
▽ -----	100							

Time domain reflectometry (TDR) sensors (Table 11; see also reviews by Topp *et al*., 1980; Hirota, 2000) are used to monitor soil moisture, but the data require transformation when used for volcanic ash soil (*e.g*., Hatano *et al*., 1995; Fukumoto, 1999). Table 16 shows the formulas used to calculate actual soil moisture from the sensor output listed at NARCH's web site. These formulas represent the relationship between sensor outputs and soil moisture measured by the oven-dried method.

Table 16. Formulas used to calibrate the output of the TDR sensor

Depth (m)	Calibration formula
0.05	$y = 1.0576x + 13.461$
0.1	$y = 1.0998x + 7.3925$
0.3	$y = 1.8431x - 36.122$
0.5	$y = 1.1638x$
1	$y = 0.8575x$

x : Sensor output
y : Actual volumetric water content (%)

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References

Fukumoto, M.1999. Study of evaporation from bare soil surfaces and surface soil moisture. *Res. Bull. Hokkaido Natl. Agric. Exp. Stn.,* **169**, 15-86.

Hatano, K., Hasegawa, S. and Sakuma, T. 1995. Calibration for the measurement of soil water content using time domain reflectometry (TDR). *Jpn. J. Soil Sci. Plant Nutr.,* **66**, 678-680.

Hirota,T., 2000. Soil temperature and moisture. In Ushiyama, M., ed. How to investigate local climate [*Mijikana kishou kikou chousa no kiso*], Kokon Shoin, Tokyo, pp. 28-44.

Japanese Society of Irrigation, Drainage and Reclamation Engineering. 1978. A guide for experiments of soil physics [*Tsuchi no rikougakusei jikken guide*], JSIDRE, Tokyo, pp. 217 [in Japanese].

Japanese Society of Pedology. 1978. Handbook for soil survey [*Dojou chousa handbook*], Hakuyusha, Tokyo, pp. 165.

Miyata, A. 1992. Meteorological table of Hokkaido National Agricultural Experiment Station (Hitsujigaoka) for the period 1966-1990. Miscellaneous Publication No. 44, Hokkaido National Agricultural Experiment Station, Sapporo, pp. 219 [in Japanese with English explanatory notes].

Sameshima, R., Hirota, T., Hamasaki, T. and Suzuki, S. 2007. Temperature trends at the National Agricultural Research Center for Hokkaido Region in the 40 years from 1966 to 2005. *J.Agric. Meteorol.*, **63**, 95-102.

Topp, G. C., Davis, J. L. and Annan, A. P. 1980. Electromagnetic determination of soil water content: measurement in coaxial transmission lines. *Water Resour. Res.*, **16**, 574-582.

北海道農業研究センター研究資料　第67号

北海道農業研究センターにおける 1966年からの気象観測について

鮫島良次、廣田知良、濱嵜孝弘、加藤邦彦、岩田幸良
（北海道農業研究センター）

北海道農業研究センターは、1966年から継続して気象観測を実施している。一般の観測項目に加え、地温、土壌水分、長波放射等、農業上重要な項目の観測が行われている。気象観測データはWebで公開しており、研究・教育目的の利用が可能である。この資料は、気象観測データの利用者のために、北海道農業研究センターの気象観測露場、観測方法、測定センサー類、露場の土壌特性について説明する。

北海道農業研究センターの組織

【札幌（本　　　所）】	〒062-8555	札幌市豊平区羊ヶ丘1番地	Hitsujigaoka, Toyohira, Sapporo, 062-8555, Japan
【芽室（芽室研究拠点）】	〒082-0081	河西郡芽室町新生南9-4	Memuro, Kasai, 082-0081, Japan
【美唄（美 唄 試 験 地）】	〒072-0045	美唄市開発南	Kaihatsu, Bibai, 072-0045, Japan
【紋別（紋 別 試 験 地）】	〒099-6132	紋別市小向	Komukai, Mombetsu, 099-6132, Japan

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研究管理監	（札幌・芽室）
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Organization of
The National Agricultural Research Center for Hokkaido Region

Organization	Location
Department of Planning and General Administration	(Sapporo/Memuro)
Research Manager	(Sapporo/Memuro)
Farm Management Research Team(Hokkaido Region)	(Sapporo)
Potato Production and Protection Research Team	(Memuro/Sapporo)
Lowland Crop Rotation Research Team(Hokkaido Region)	(Sapporo)
Upland Farming Research Team(Hokkaido Region)	(Memuro/Sapporo)
Forage Crop Breeding Research Team(Hokkaido Region)	(Sapporo)
Intensive Grazing Research Team	(Memuro/Sapporo)
Research Team for Dairy Production Using Regional Feed Resources	(Sapporo)
Rhizosphere Environment Research Team	(Sapporo/Memuro)
Climate and Land-use Change Research Team	(Sapporo/Memuro/Bibai)
Crop Cold Tolerance Research Team	(Sapporo)
Bred Wheat Research Team	(Memuro)
Local Crop Breeding Research Team(Hokkaido Region)	(Sapporo/Memuro/Mombetsu)
Biomass Research Team(Hokkaido Region)	(Memuro)
Decision Support System Research Subteam(Hokkaido Region)	(Sapporo)
Rice Breeding Research Subteam(Hokkaido Region)	(Sapporo)
Waste Recycling Research Subteam(Hokkaido Region)	(Sapporo)
Crop Functionality and Utilization Research Subteam(Hokkaido Region)	(Memuro)
Rice Quality Research Team (Hokkaido Region)	(Sapporo)
Rice Disease Resistance Research Team (Hokkaido Region)	(Sapporo)
Research Support Center	(Sapporo/Memuro/Bibai/Mombetsu)

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062-8555　札幌市豊平区羊ヶ丘１番地　電話（011）851-9141
http://cryo.naro.affrc.go.jp/

印　刷　**大同出版紙業株式会社**

080-0017　帯広市西７条南６丁目２番地　電話（0155）23-5107

NARO