“One Straw Revolution” revisited
No-till trials in Japan

Bioeconomics

25. Japanese-German Symposium

Japan Society for the Promotion of Science and
Deutsche Gesellschaft der JSPS-Stipendiaten e.V.

KANEKO Nobuhiro
Fukushima University

科研費 KAKENHI

Leadership Program in Sustainable Living with Environmental Risk

Strategic Funds for the Promotion of Science and Technology

Soil biodiversity

Fukushima accident and farming

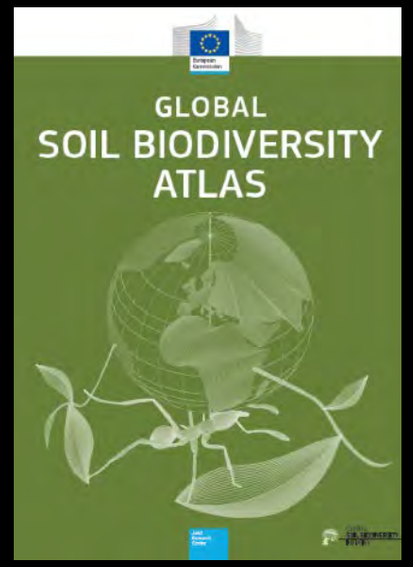
“One straw revolution” and soil ecology

Rehabilitation of contaminated farm




Soil Biodiversity

Global Soil Biodiversity Atlas (2016)



地球規模土壌生物多様性アトラス







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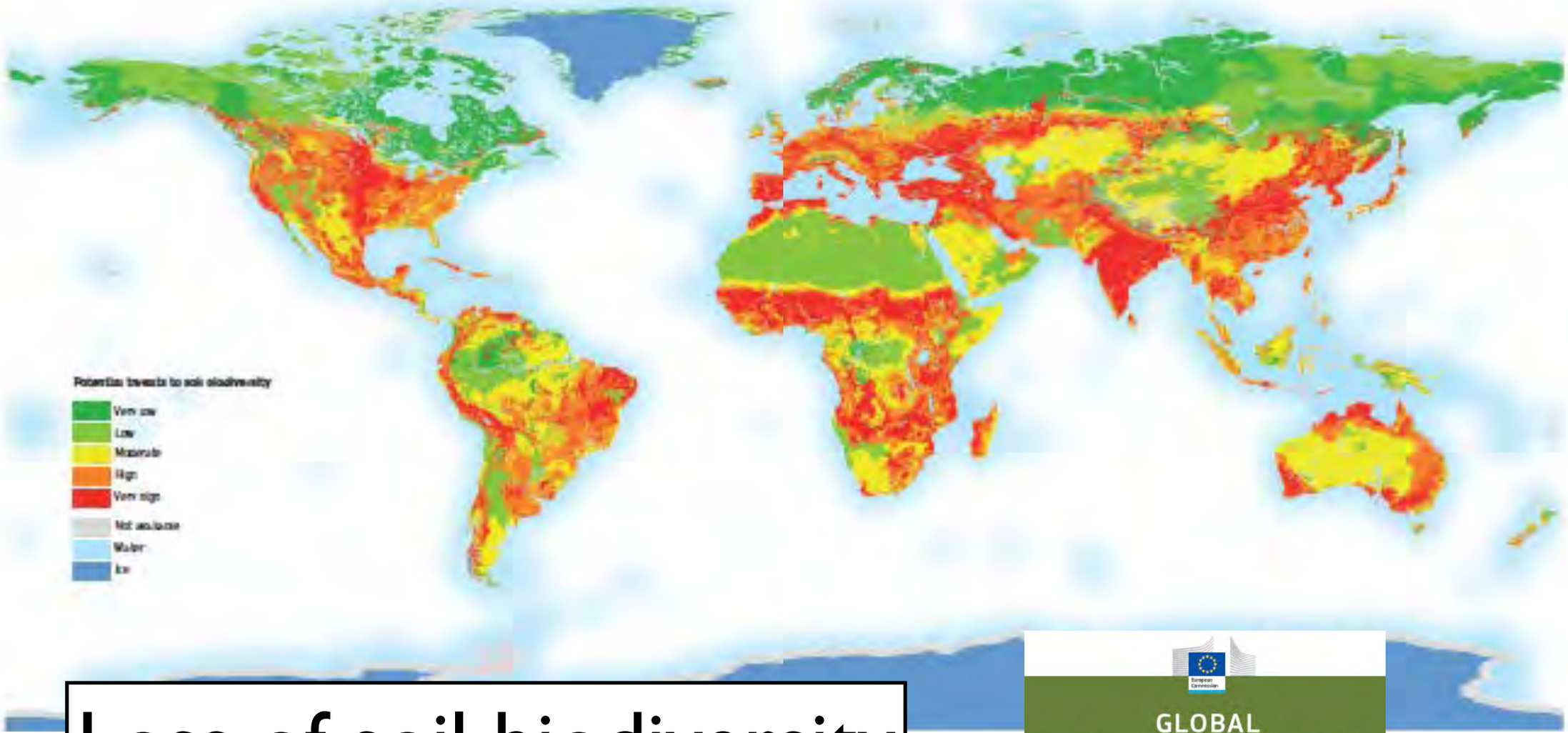
SEEKING TO PROMOTE EXPERT KNOWLEDGE ON

SOIL BIODIVERSITY INTO ENVIRONMENTAL

POLICY AND SUSTAINABLE LAND MANAGEMENT

TO PROTECT AND ENHANCE ECOSYSTEM SERVICES

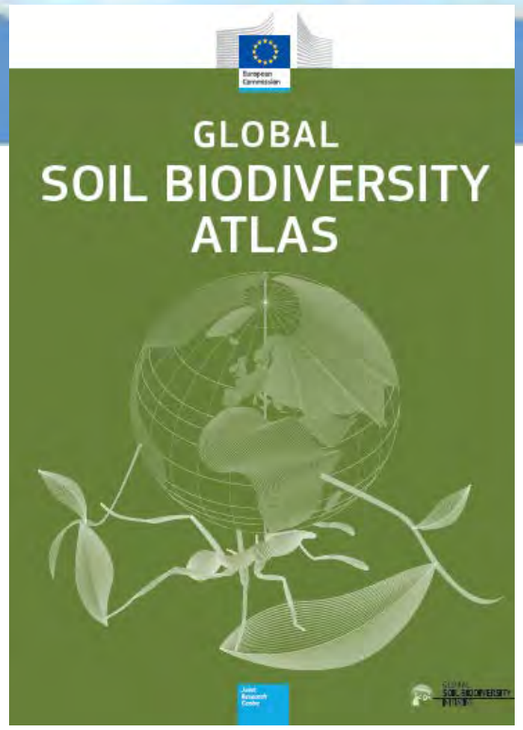
Potential threats to soil biodiversity



Loss of soil biodiversity

↓

Loss of ecosystem services



Orgiazzi et al, 2016

Fukushima nuclear accident and agriculture

Estimated environmental releases of radionuclides from the reactors

		Chornobyl	Fukushima	
Nuclear species	Half life (yr)	UNSCEAR (2005)	Nuclear and Industrial Safety Agency (2011)	UNSCEAR (2014)
^{134}Cs	2.06	47	18	9.0
^{137}Cs	30.2	85	15	8.8
^{90}Sr	28.8	10	0.14	n.a.
^{239}Pu	24,000	0.013	3.2×10^{-6}	n.a.

PBq (10^{15} Bq)

Reconstructed initial ^{137}Cs fallout map

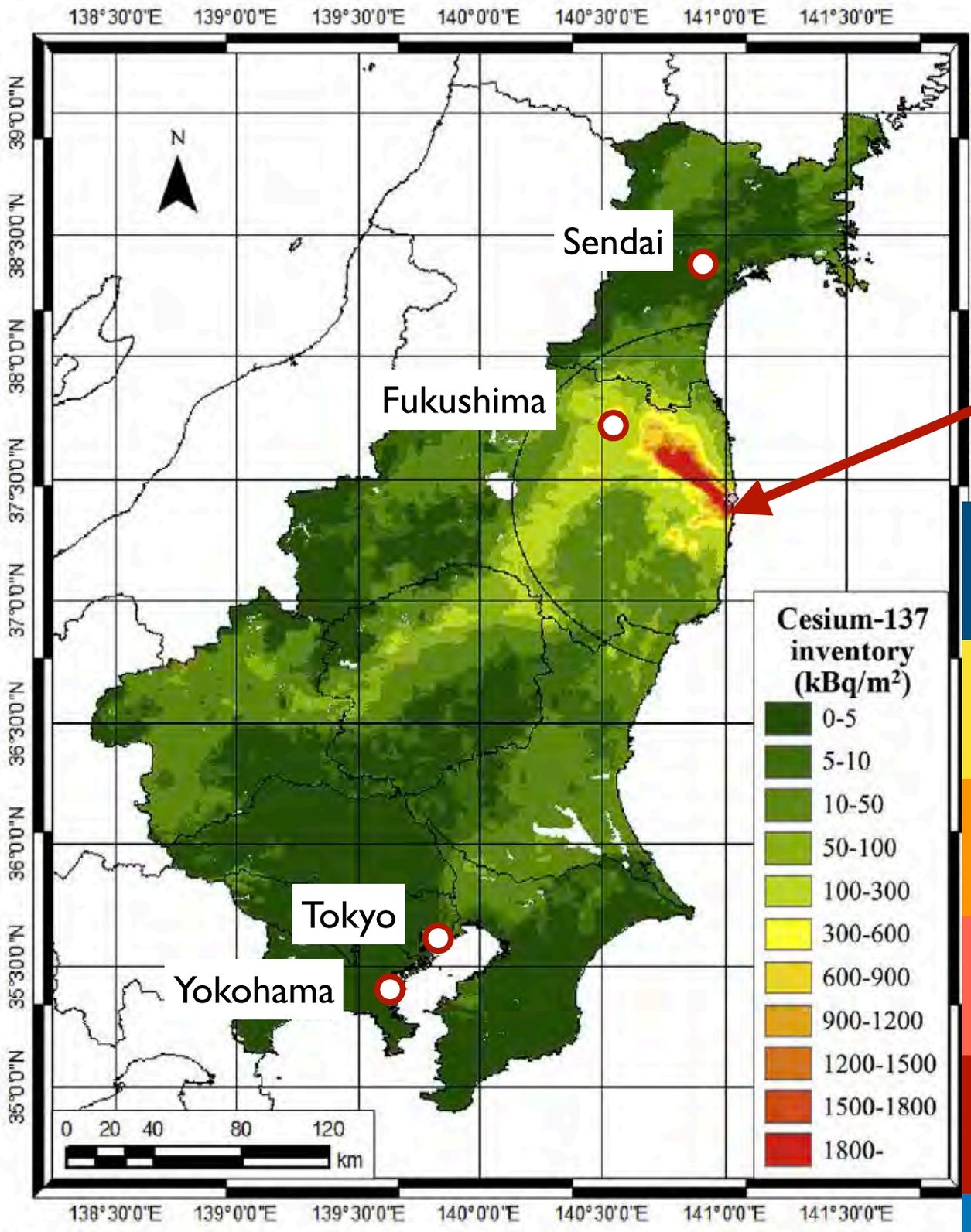


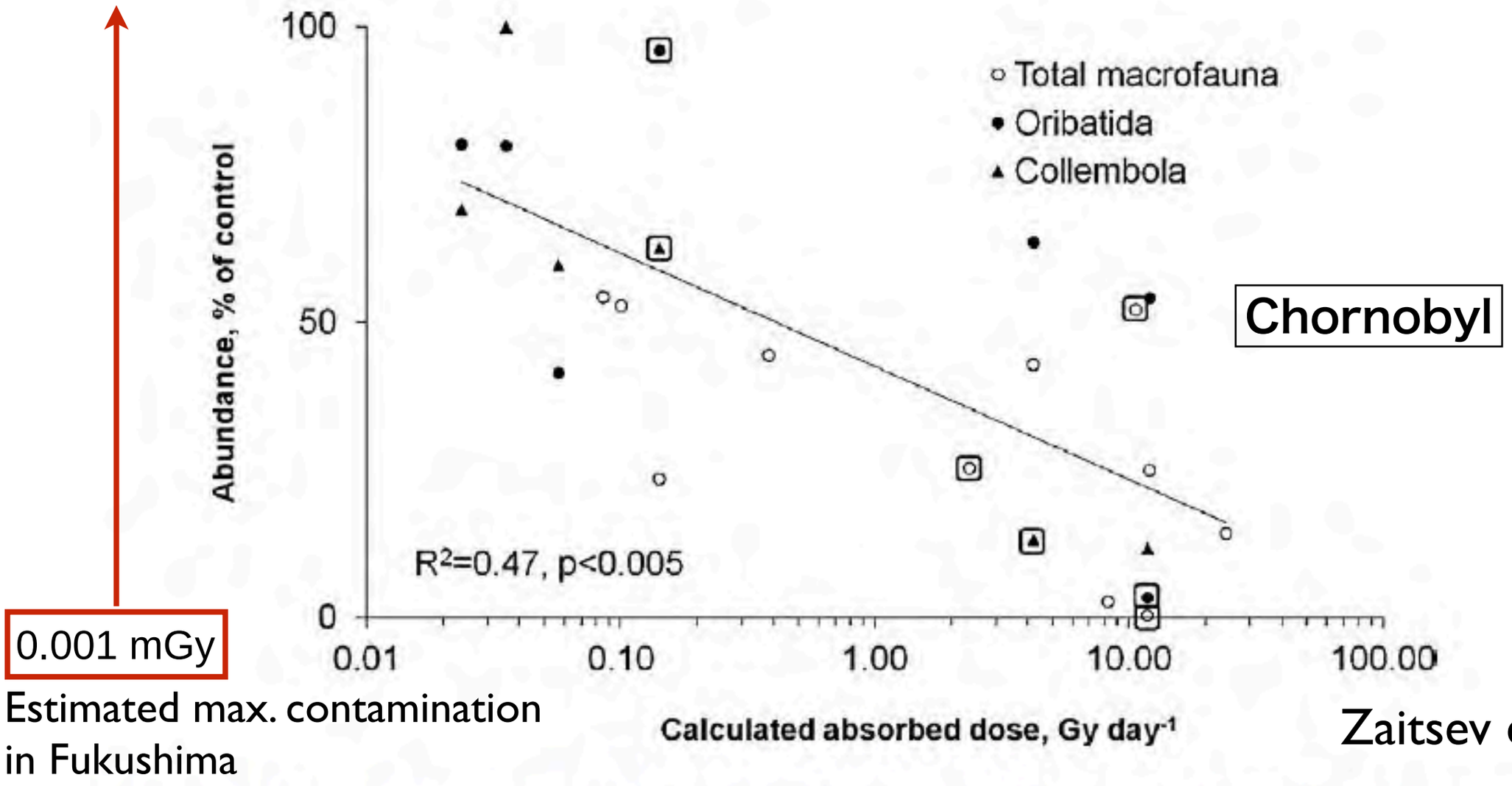
Fig. 6. Reconstructed initial ^{137}Cs fallout map following the Fukushima ichi Nuclear Power Plant accident in eastern Japan.

Fukushima Daiichi Nuclear Power Plant

Contamination (kBq/m²)	Chornobyl (km²)	Fukushima (km²)
37- 555	116,900	6,900
185 - 555	18,900	1,400
555 - 1,480	7,200	400
> 1,480	3,100	200
Total	146,100	8,900

Kato et al., 2019

Contamination and density change



Estimated max. contamination in Fukushima

Zaitsev et al. 2014

Fig. 1. Relative decrease in abundance of soil macro- and mesofauna in relation to the calculated absorbed daily dose in different locations contaminated with radionuclides (natural abundance in respective control plots was taken as 100% for each of presented data points). Data points derived from radioecological research near Chernobyl NPP are framed. The regression line is based on all data points.

Source: Data was collected from multiple sources (Krivolutsky, 1987a,b; Krivolutskii and Pokarzhevskii, 1992; Krivolutsky et al., 1992; Vershinin and Seredyuk, 2000; Gongalsky, 2003; Kolesnikova et al., 2005; Geras'kin et al., 2007; Asvarova and Gazaliev, 2009).

Decontamination policy of croplands

Contamination (Bq/kg)	Paddy (ha)	Upland (ha)
0 - 1,100	59,942	22,022
1,000 - 5,000	39,164	14,658
5,000 - 10,000	1,958	796
10,000 - 25,000	2,575	751
> 25,000	1,646	581

Deep tilling and potassium application

Selection of tilling/ soil replacement

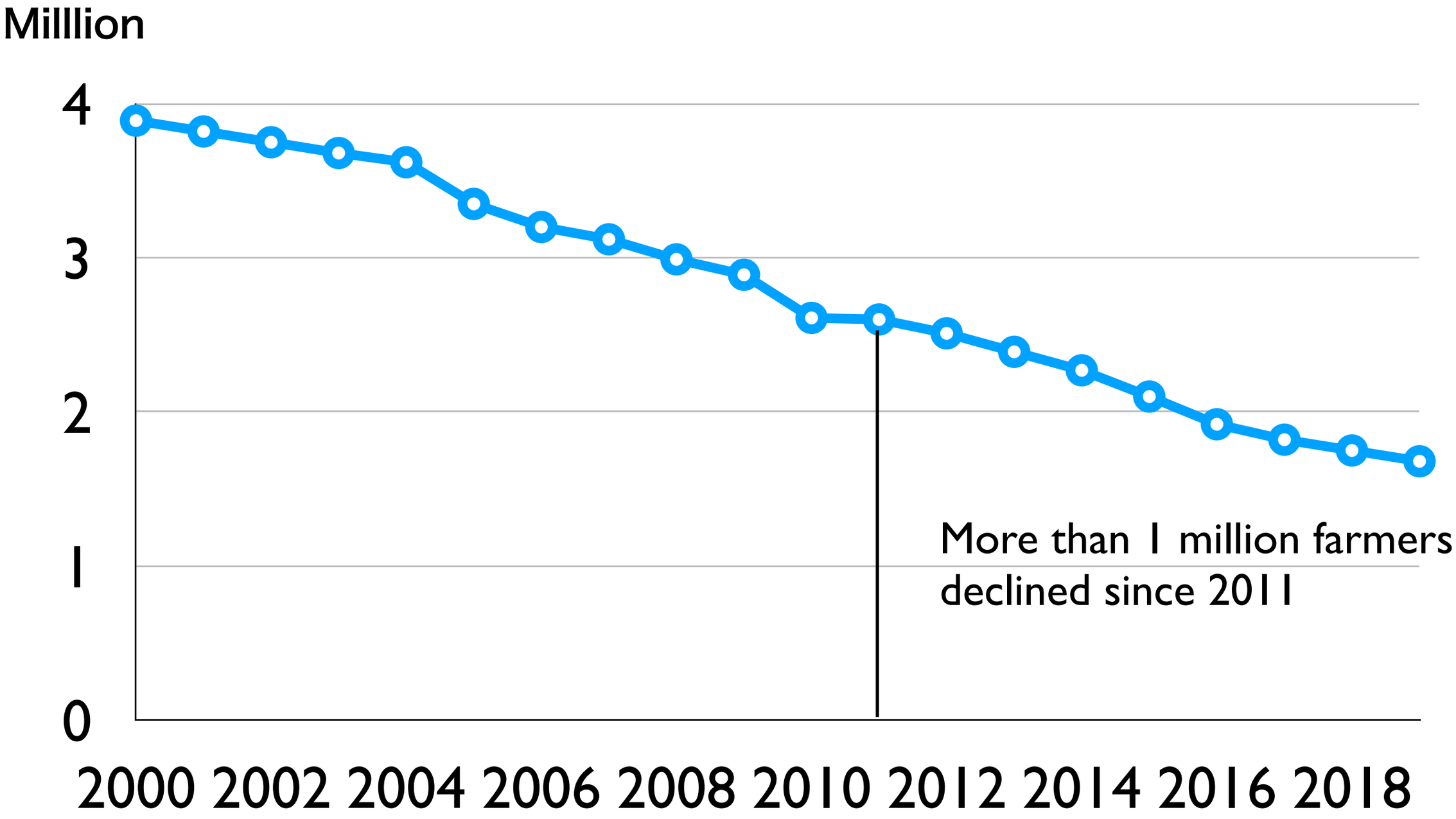
Soil replacement

Decontamination of croplands

Scraping surface soil

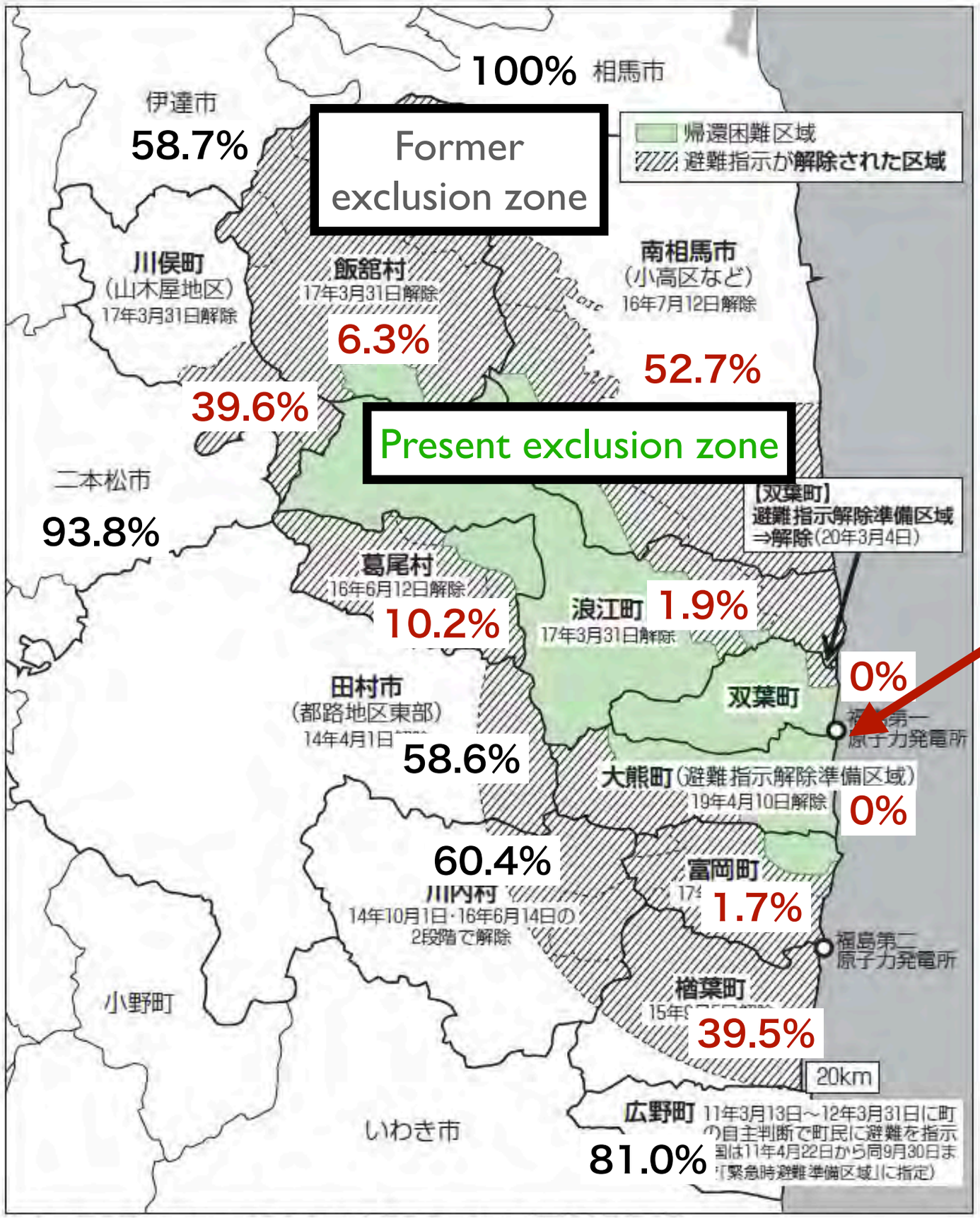
Covering by clean sand

Number of farmers in Japan



Percentage of resumed farmland area in 2019

第1図　避難指示区域の概念図



出典　福島県ホームページ「ふくしま復興ステーション」資料に筆者加筆
（注）　南相馬市を除く6町村の帰還困難区域内にはそれぞれ特定復興再生拠点区域が設定され、23年春までの避難指示解除を予定。双葉町・大熊町・富岡町ではその一部が20年3月に先行解除された。

Fukushima Daiichi Nuclear Power Plant

- Local population has been declining in these area.
- All croplands were decontaminated irrespective of farmers willingness for agriculture.

To till or not to till

No-till problems and solutions

Till → Soil erosion

No-till → Weeds

+ Herbicides → Herbicide tolerant weeds

Soil erosion

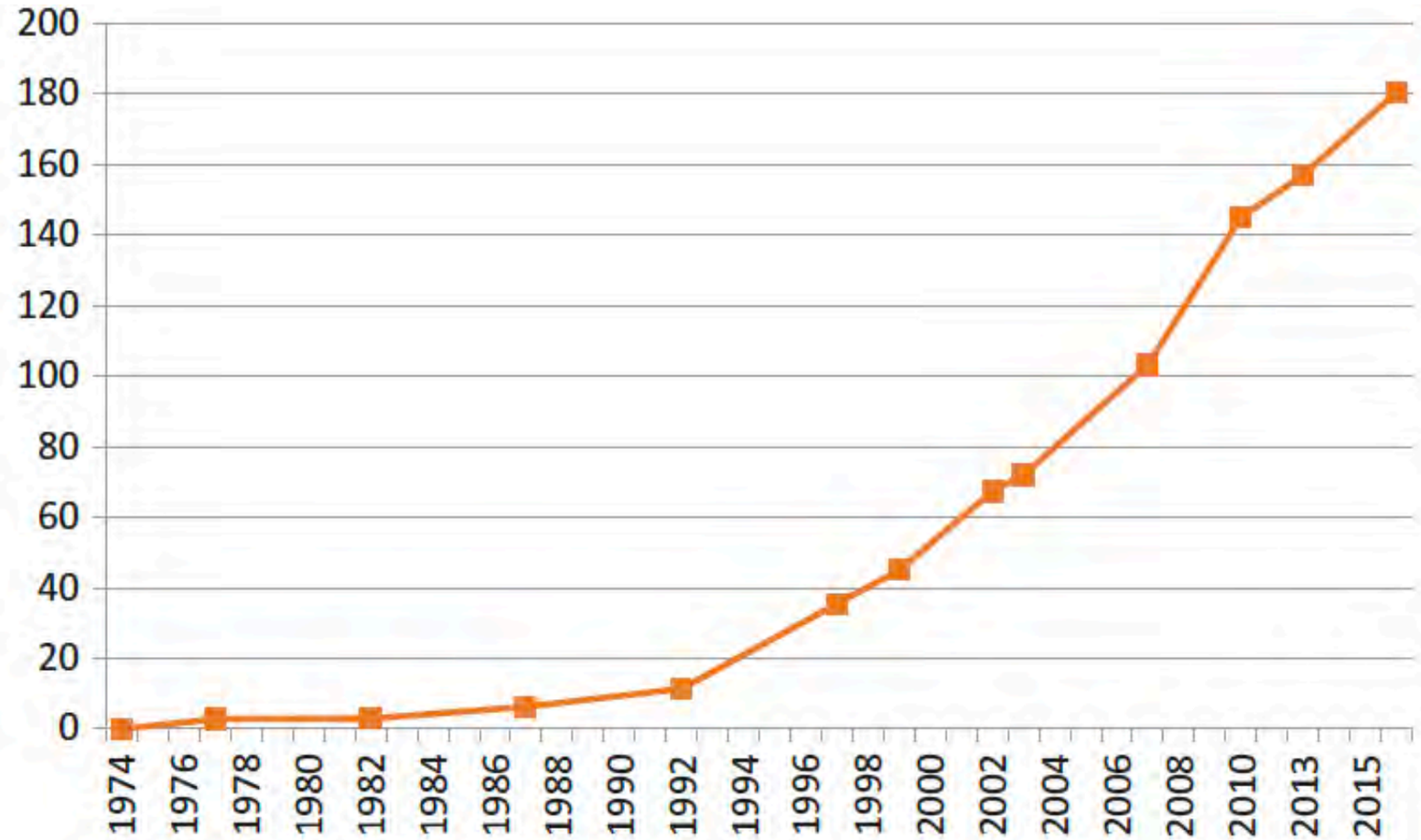
Conservation agriculture
no-till with cover crops

"Natural farming"
no-till with cover weeds

Soil conservation

Conservation agriculture

Annual expansion of conservation agriculture



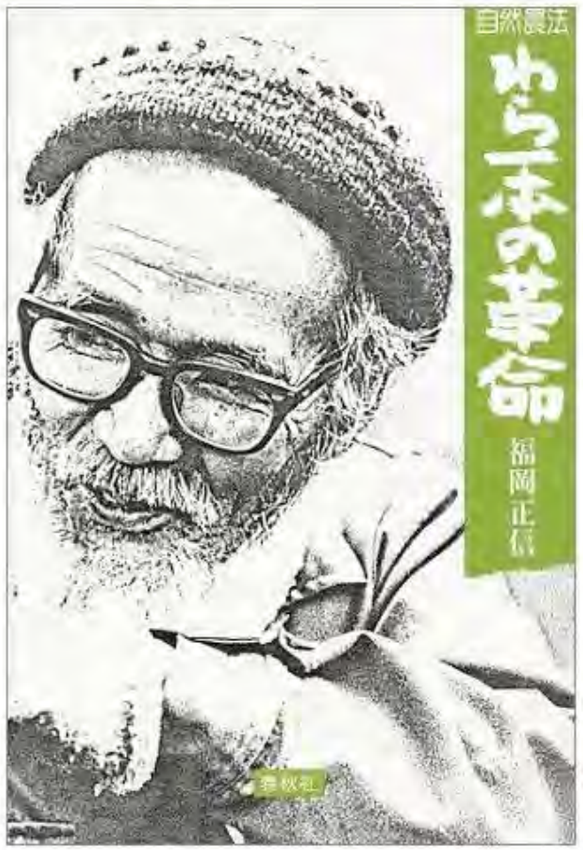
2015/2016

- 180 million ha
- 12.5% of global croplands
- Annual increase 10 million ha
- Adopted in 78 countries
- China: 9 million ha
- Korea: 23 thousand ha

Kassam, Friedrich, Derpsch 2018

FUKUOKA Masanobu (1975)

"One Straw Revolution"



- No-tillage
- No-fertilization
- No-pesticide
- No-weeding

No-till continuous rice-wheat rotation

No-tillage with extensive weed management
“Natural farming”

福岡正信

FUKUOKA Masanobu (1913-2008)

One straw revolution

岡田茂吉

OKADA Mokichi (1882-1955)

川口由一

KAWAGUCHI Yoshikazu (1939-)

Tillage

No-till + weeds

a)

Tillage

No-till

Time 0

b)

Tillage

No-till

5 min.

c)

Tillage

No-till

10 min.

d)

Tillage

No-till

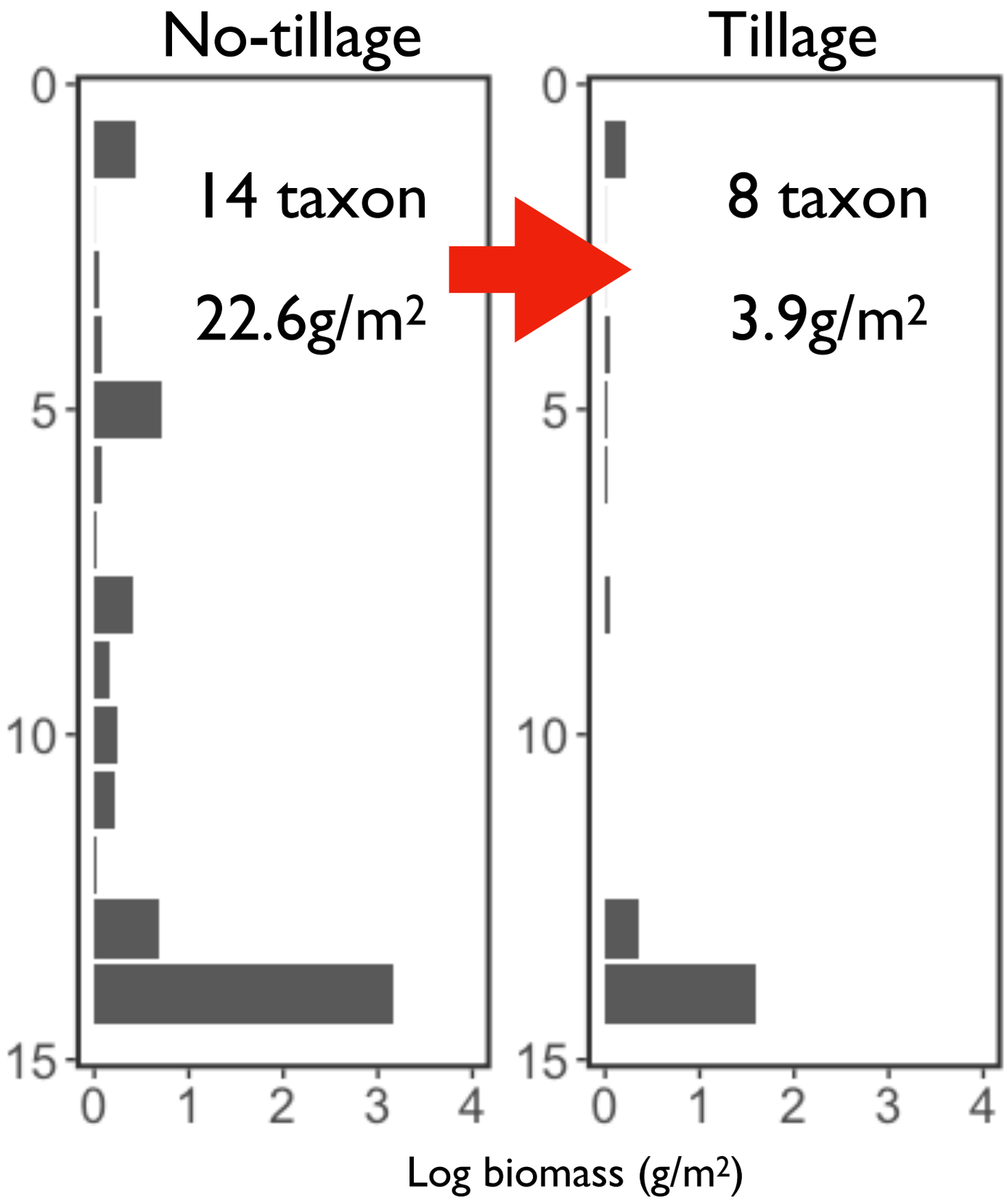
24 hr

Tillage destroys soil ecosystem

Decline of soil biodiversity by tillage

Soil macrofauna

- Aranea
- Chilopod
- Ants
- Hymenoptera
- Adult Coleoptera
- Dermaptera
- Hemiptera
- Juvenile Coleoptera
- Gastropoda
- Isopoda
- Juvenile Diptera
- Amphipoda
- Diplopoda
- Annelida



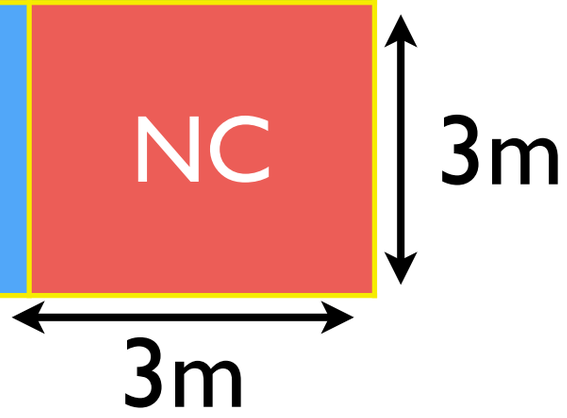
Komatsuzaki & Kaneko、2019

Do weeds help farmers?

Experimental study on “Natural Farming”

Treatments 処理	Tillage 耕起	No tillage 不耕起・草生
Fertilization 施肥	TF	NF
No fertilization 無施肥	TC	NC

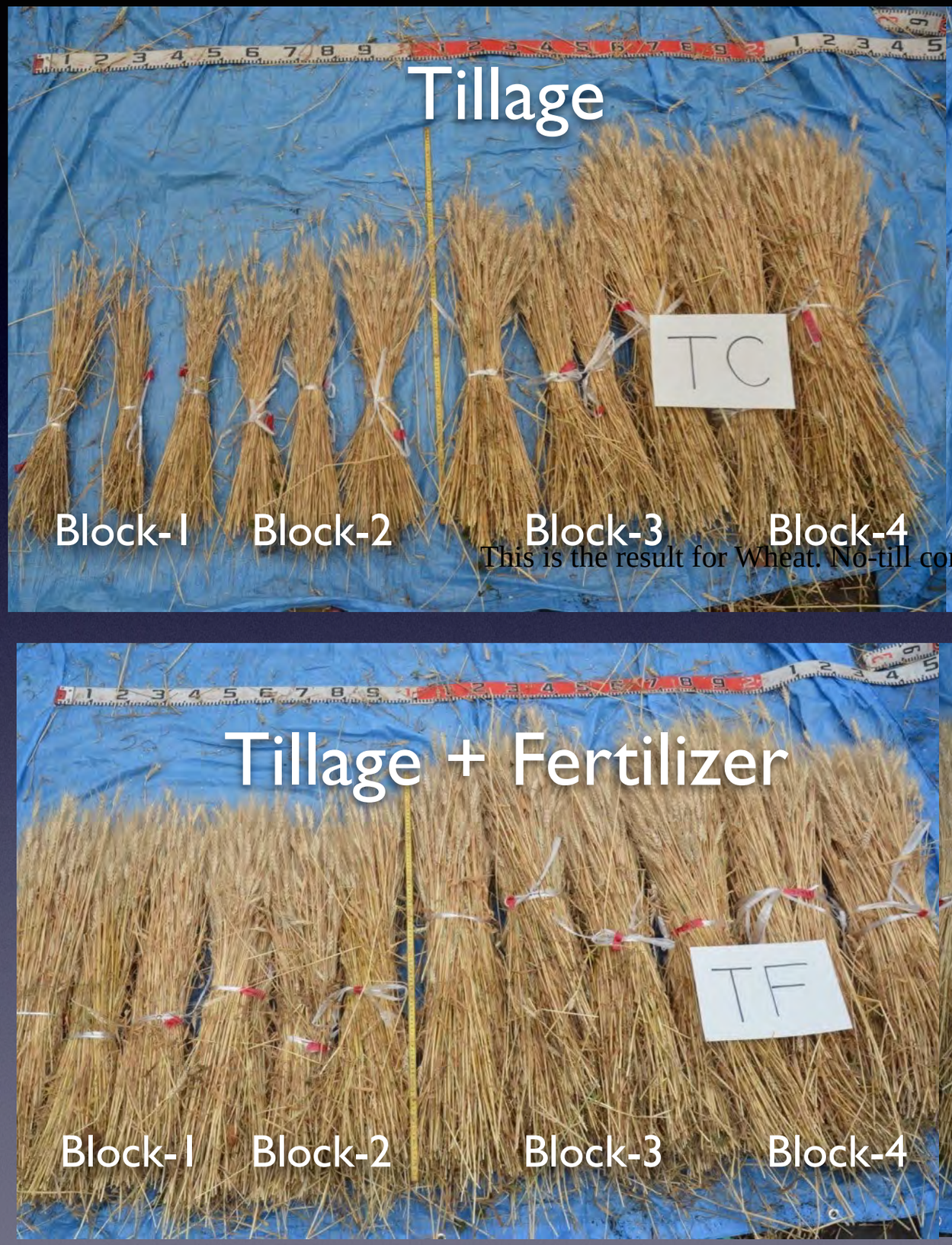
x 4 Blocks



Tillage

No-tillage + weeds

Wheat experiment



This is the result for Wheat. No-till corresponds to Fukuoka's management.

Soybean experiment

Day 67

Sep 8, 2014

Tillage

No-till + weeds

Tillage +fertilizer

No-till + weeds + fertilizer

Green Food web

Soil food web structure

2012

Wheat
Weed
Root
Predator
Herbivore

コムギ
雑草
根
捕食者
植食者

g m-2

耕起
耕起＋施肥
不耕起
不耕起＋施肥

TC
TF
NC
NF

0 100 0 100 200 0 100 200 300 0 100 200 300 400

Brown Food web

Litter
Earthworm
Bacteria
AM x10
Fungi x 10

落葉
ミミズ
細菌
AM菌
カビ

g m-2

PLFA

micro g g-1

0 100 0 100 200 0 100 200 300 0 100 200 300 400

Rehabilitate the decontaminated farmlands

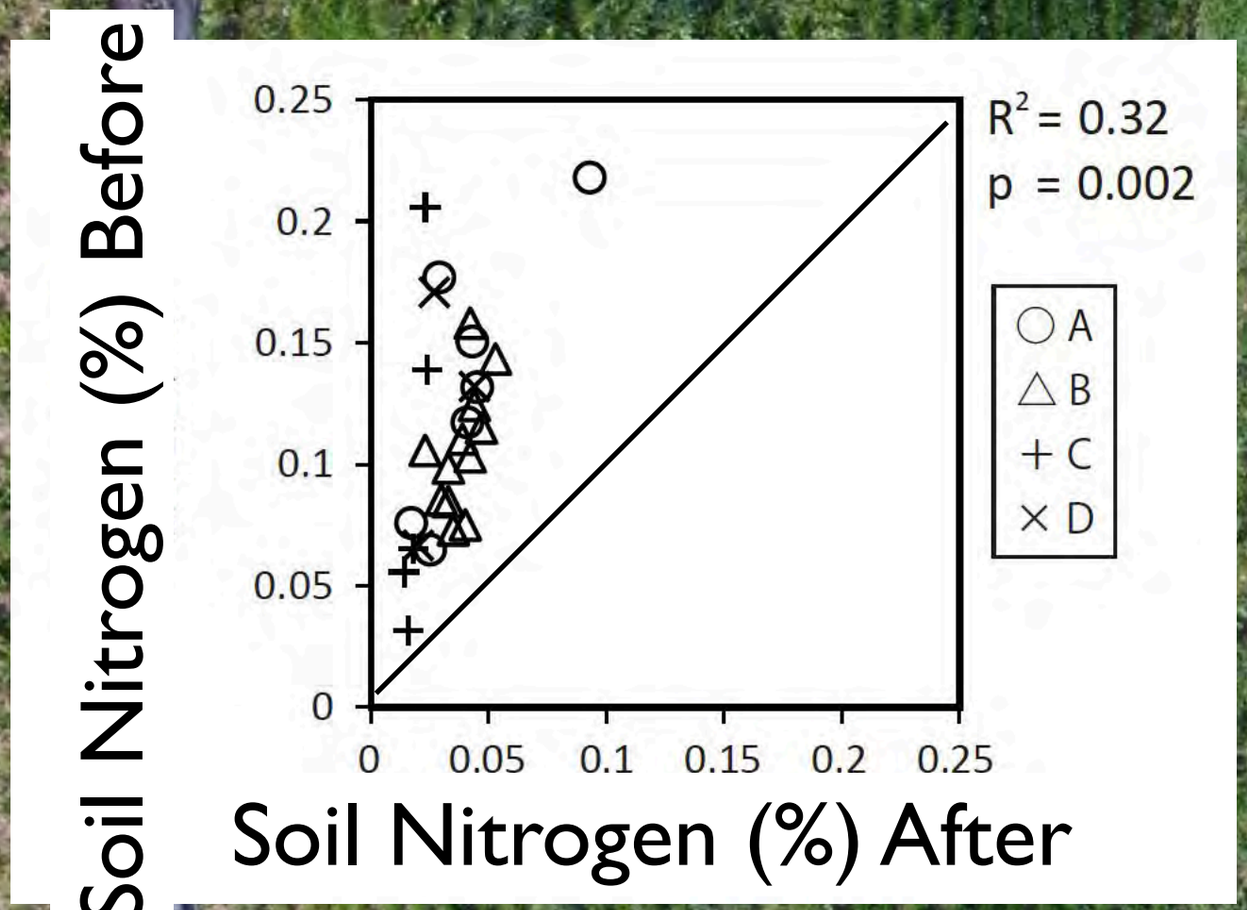
Farmland rehabilitation using "Natural farming"

No-tillage

No-tillage

Tillage

Tillage



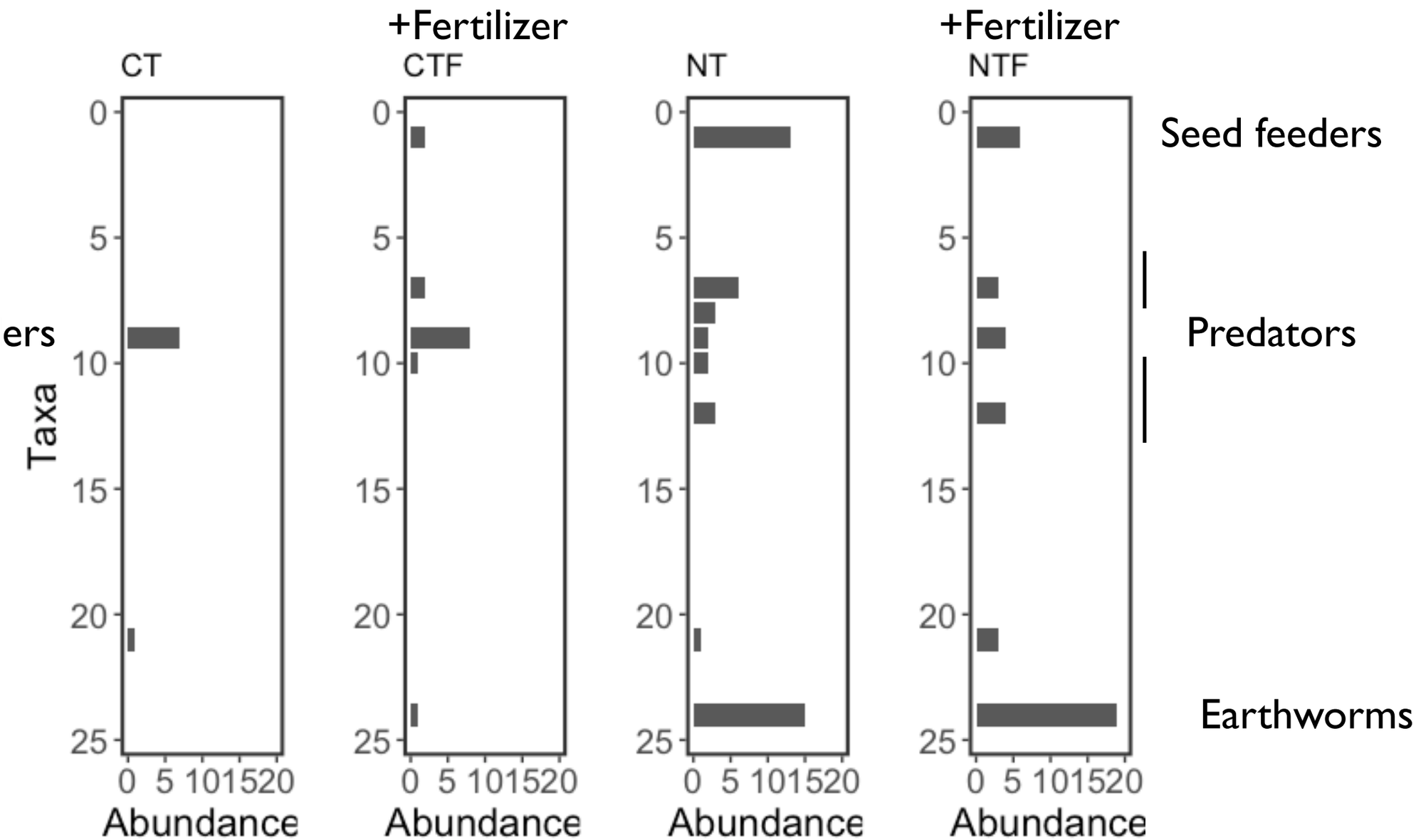
Yoshino et al. 2015

Iitate Village, April 6, 2018

Comparison of food web

July 14, 2020

Tillage **No-tillage**



個体数（1m²)

One straw revolution revisited

- Soil ecologists showed that soil biodiversity is sustaining ecosystem functioning.
- Tillage (cultivation) destroys soil biodiversity, hence soil ecosystem functioning declines.
- Conservation agriculture enhances soil biodiversity thus farmers can sustain their production.

- Fukuoka's idea of no-tillage with weeds (natural farming) is now supported by sound scientific evidences.
- Rehabilitation of decontaminated farmlands in Fukushima can be accelerated by adoption of Fukuoka's idea.

August 20, 2017, Kiev