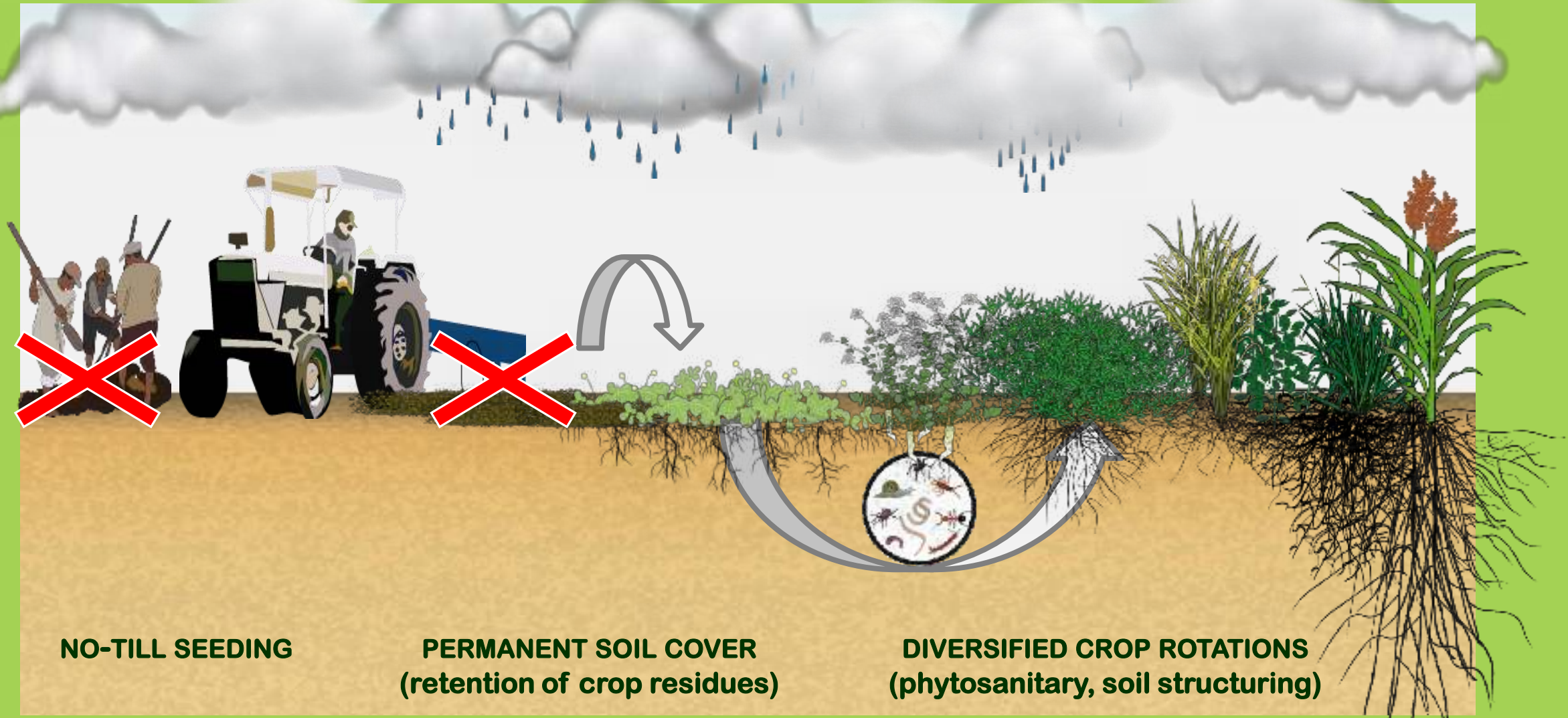
Crop Residue Management to Sustain Soil Productivity

Sandra Corsi (FAO Plant Production and Protection Division)

CONSERVATION AGRICULTURE

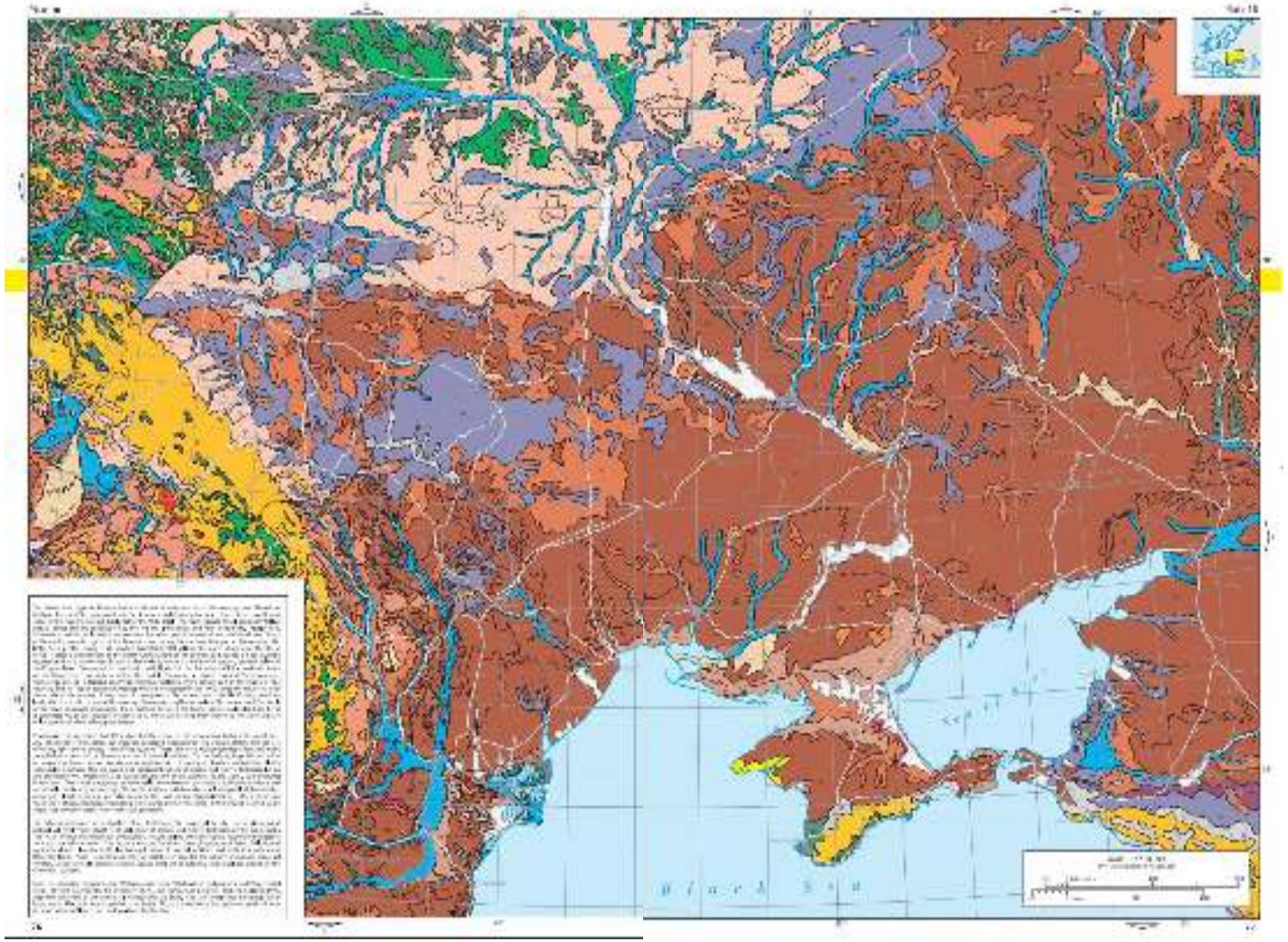


Lucien Séguy (CIRAD)

UKRAINE'S SOILS - AMONGST THE MOST FERTILE IN THE WORLD

DISTRIBUTION OF SOIL TYPES

68% OF UKRAINE'S ARABLE LAND IS CHERNOZEM



GOOD SOILS NEED GOOD MANAGEMENT

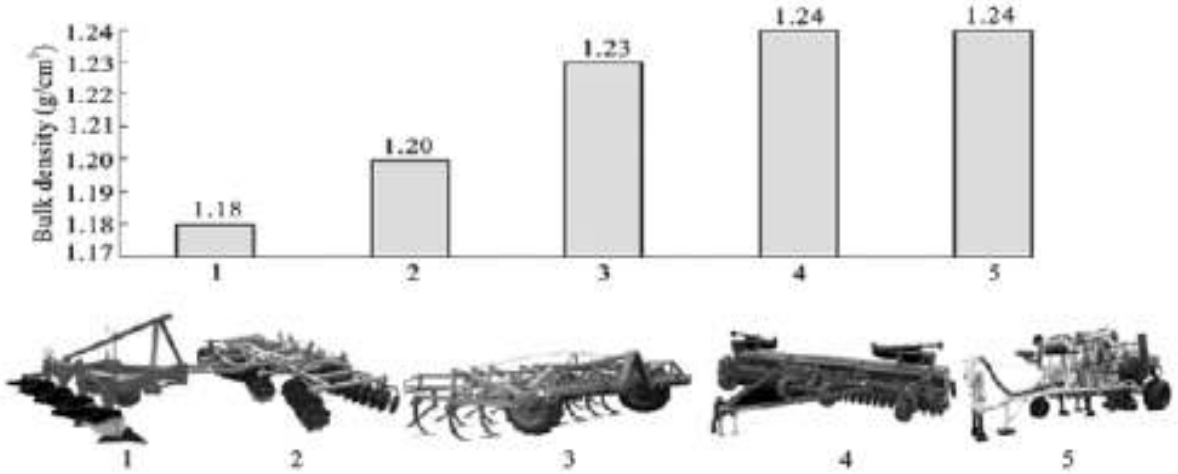
CHERNOZEM'S AGROPOTENTIAL IS HIGHEST AT BULK DENSITY 0.9-1.3 g/cm^3 UNDER NO-TILL-BASED SYSTEMS

Fridland et al., 1981

IN UKRAINE ONLY 0.6 MILLION ha ARE UNDER NO-TILL-BASED SYSTEMS

Non-official estimation

CHERNOZEMS' BULK DENSITY BY MANAGEMENT



1. Ploughing 20-22 cm; 2. Disking 10-12 cm; 3. Spring cultivation 6-8 cm; 4. and 5. No-till systems

Kravchenko et al. 2011: Chin. Geogra. Sci. 21(3) 257-266

BULK DENSITY: INDIRECT MEASURE OF SOIL PORE SPACE THAT DEPENDS ON SOIL ORGANIC MATTER CONTENT AND TEXTURE

TILLAGE TRIGGERS OTHER FORMS OF SOIL DEGRADATION

CLIMATE CHANGE WILL INCREASE CLIMATE VARIABILITY AND FREQUENCY OF EXTREME EVENTS

THE COST OF SOIL EROSION

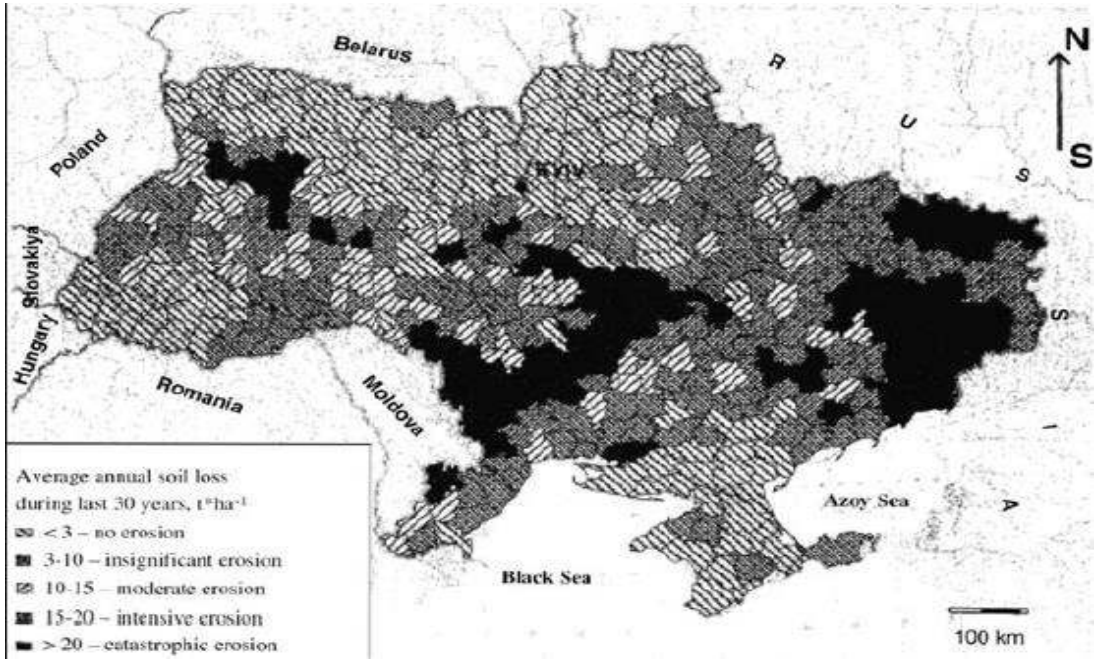
TO PRODUCE 1 T OF GRAIN,
UKRAINE LOSES 10 T OF SOIL

EVERY YEAR UKRAINE LOSES 500 MILLION t OF SOIL FROM 32.5 MILLION ha ARABLE LANDS: 15 t/ha/year OF SOIL

THE COST OF N (964 000 t), P (676 000 t), K (9 700 000 t) LOST IS USD 5 BILLION

MAPFU official statistics: Bulygin S., 2006. Ukraine. Pp 199-204. Soil Erosion in Europe (Boarman J. and Poesen J. Editors), John Wiley and Sons

ARABLE LAND ANNUAL SOIL LOSS 1976-2006



Bulygin, 2006

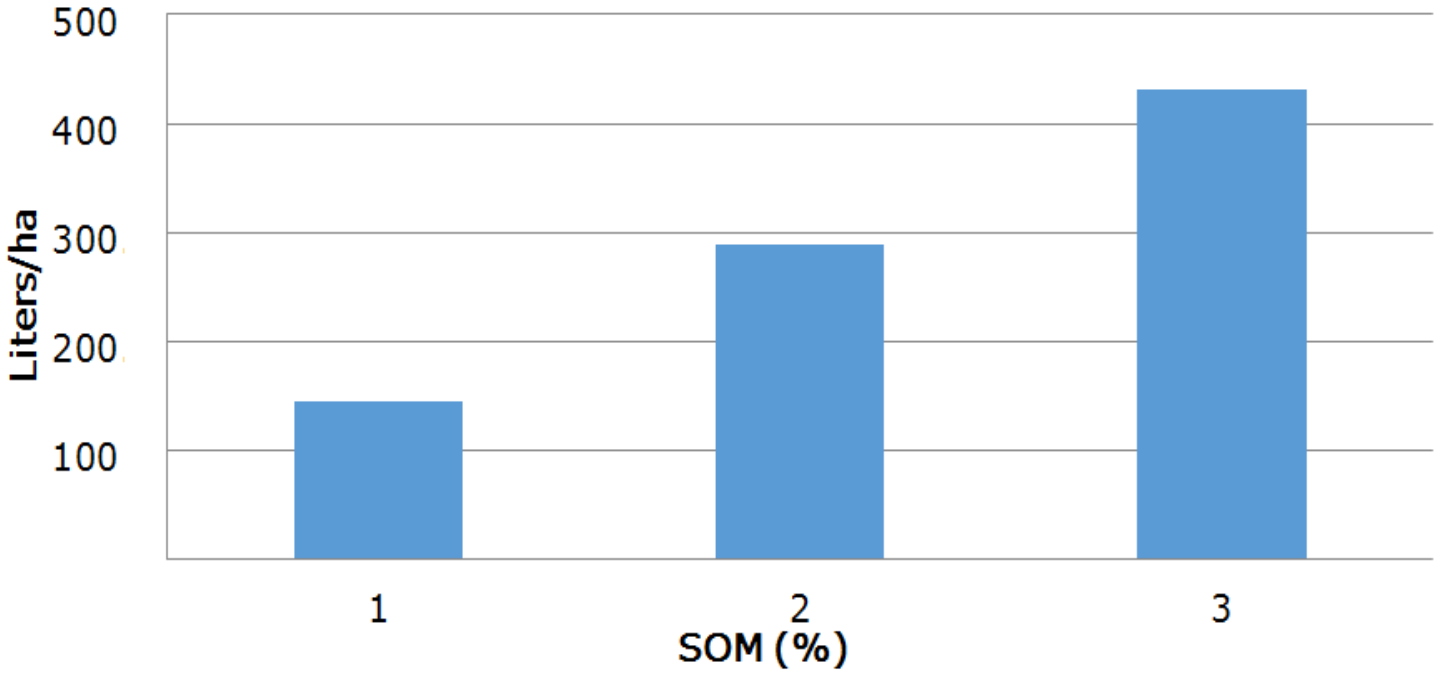
CROP RESIDUE RETENTION IMPROVES WATER INFILTRATION

TILLAGE NO-TLLAGE

STUBBLE RETENTION IMPROVES SNOW PRECIPITATION INFILTRATION

CROP RESIDUE IMPROVES SOIL ORGANIC MATTER CONTENT

WATER HOLDING CAPACITY AND SOIL ORGANIC MATTER



1 part of SOM retains 4 – 7 parts of soil water

1% SOM in the top 30 cm of soil can hold 140 000 liters of water/ha

CROP RESIDUE IMPROVES CROPS' RESILIENCE TO DRY SPELLS

TILLAGE

NO-TILLAGE + COVER CROPS MIX

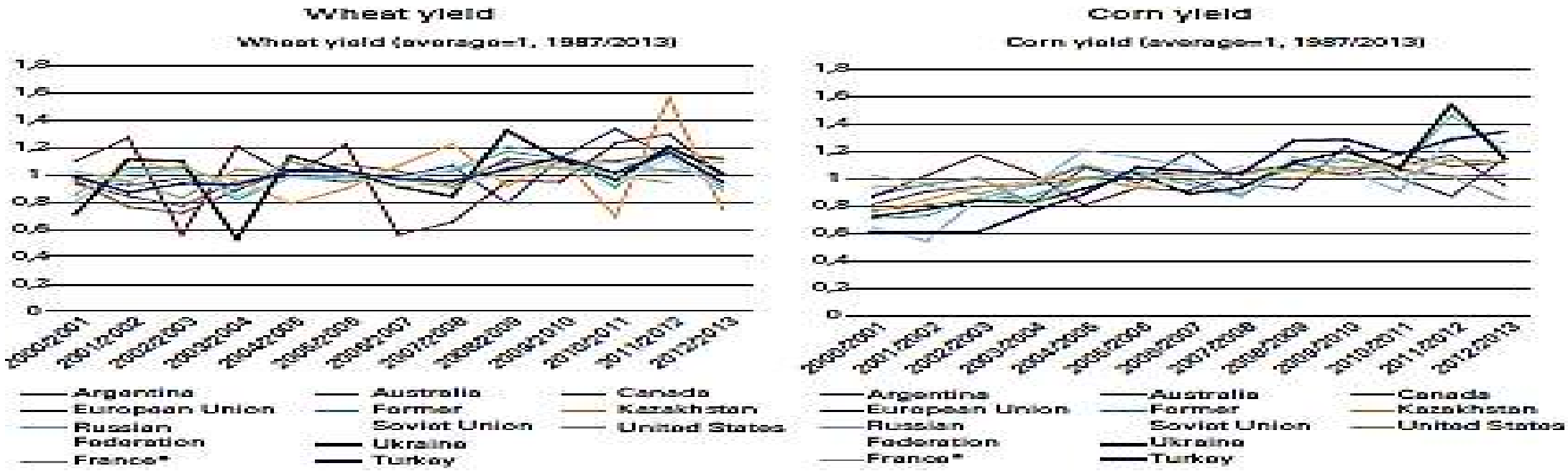
CROP RESIDUE RETENTION TO STABILIZE YIELDS

EVERY 3 YEARS, CEREALS' YIELDS VARY BY 20-25%

HIGH VOLATILITY OF WHEAT AND MAIZE YIELDS -ESPECIALLY IN THE STEPPE ZONE- AFFECTS UKRAINE'S TRADE BALANCE

MAPFU official statistics: Bulygin S., 2006. Ukraine. Pp 199-204. Soil Erosion in Europe (Boarman J. and Poesen J. Editors), John Wiley and Sons

VOLATILITY OF WHEAT AND CORN YIELDS

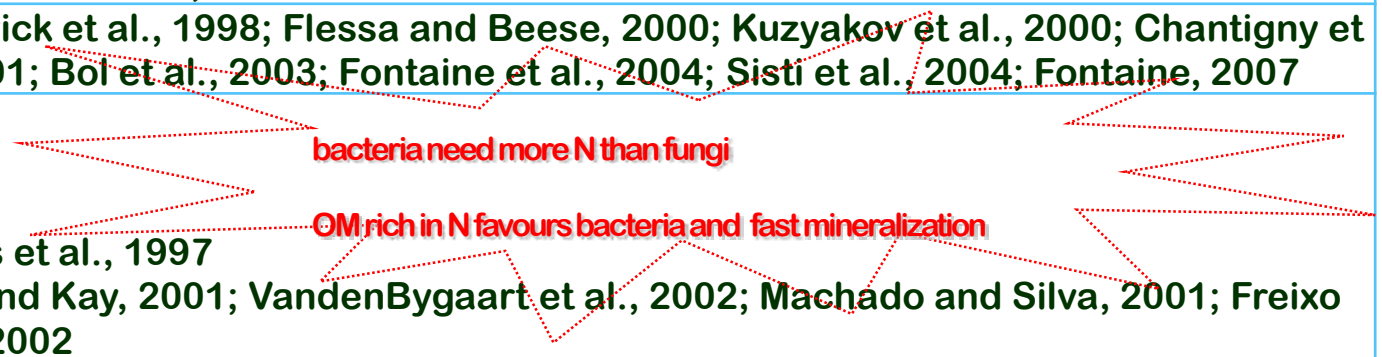


DEVIATION FROM AVERAGE 1987-2012

STOCKTAKING ON CROP RESIDUE MANAGEMENT

TO IMPROVE SOIL FERTILITY / EROSION / COMPACTION, WEED MANAGEMENT, PROFIT

GOOD MANAGEMENT	LITERATURE
NO-TILL INCREASES SOM ACTIVE FRACTIONS	Franzluebbers et al., 1995; Stockfisch et al., 1999; Tebrügge and During, 1999; Horáček et al., 2001
C ACCUMULATES IN THE SOIL WHEN THE N BALANCE OF THE ROTATION IS POSITIVE • Changing monocrop to multicrop rotation • Adding green-manure crop	Havlin et al., 1990; Entry et al., 1996; Mitchell et al., 1996; Robinson et al., 1996; Robinson et al., 1996; Buyanovsky and Wagner, 1998; Gregorich et al., 2001; Lopez-Fando and Pardo, 2001 Diekow et al., 2005; Sidiras and Pavan, 1985; Bayer and Mielniczuck, 1997; Boddey, 1997; Alves et al., 2002, 2003, 2006; Sisti et al., 2004; Bayer and Bertol, 1999; de Maria et al., 1999; Amado et al., 1999, 2001; Bayer et al., 2000 a,b; Dick, 1994; Karlen et al. 1994; Bandick and Dick 1999; Kandeler et al., 1999; Dilly et al., 2003; Balota et al. 2004; Nurbekov, 2008
POOR MANAGEMENT	
REMOVAL OF CROP RESIDUES	
MIXING OF CROP RESIDUES • Residues mixed into the soil decay more rapidly	Magdoff and Weil, 2004
• Readily decomposable residue mixed with native soils induces a priming effect	Chadwick et al., 1998; Flessa and Beese, 2000; Kuzyakov et al., 2000; Chantigny et al., 2001; Bol et al., 2003; Fontaine et al., 2004; Sisti et al., 2004; Fontaine, 2007
ROTATIONS THAT DO NOT GUARANTEE A POSITIVE N BALANCE AND C/N RATIO OF THE DECOMPOSING RESIDUE < OR > 25 DO NOT CONTRIBUTE TO SOC ACCUMULATION • fallow-based crop rotations • maize (/ barley - wheat) - soybean	Angers et al., 1997 Yang and Kay, 2001; VandenBygaart et al., 2002; Machado and Silva, 2001; Freixo et al., 2002



FROM BROAD PRINCIPLES TO SPECIFIC RECOMMENDATIONS - THE ROLE OF RESEARCH

POLICY-MAKERS AND FARMERS NEED TO HAVE A CLEAR INDICATION OF:

- HOW MANY CROP RESIDUES NEED TO BE PRODUCED AND RETAINED ON DIFFERENT SOILS TO HARMONIZE THE USE (REMOVAL) OF CROP RESIDUES WITH SOIL HEALTH (PREVENTING EROSION, MAINTAINING SOIL CARBON AND CONTROLLING WEEDS)?

  E.G.: maintain SOC - equatorial tropics - 1.5 t of C/ha/year applied via crop residues
  3 t/ha/year of maize stover
  arid tropics - 2.5 t of C/ha/year applied via crop residues
  5 t/ha/year of maize stover
  temperate - 5 t of C/ha/year applied via crop residues
  10 t/ha/year of maize stover

- WHAT ARE THE RETURN ON THE INVESTMENTS IN THE DIFFERENT AGRONOMIC PRACTICES / TECHNOLOGIES?

- WHAT ARE THE BEHAVIORAL CHANGES THAT NEED TO TAKE PLACE TO IMPROVE CROP RESIDUE MANAGEMENT?

PARADIGM CHANGES DEPEND ON STRONG POLICY SUPPORT

TO RECONCILE SHORT TERM PRIORITIES WITH LONG TERM INVESTMENTS IT REQUIRES

COHERENT POLICY INCENTIVES THAT

ENSURE **SUFFICIENT INVESTMENTS IN INTEGRATED, MULTIDISCIPLINARY RESEARCH**

CONTACT DETAILS

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USEFUL RESOURCES

SUSTAINABLE CROP PRODUCTION INTENSIFICATION

FAO *Save and Grow* per crop
http://www.fao.org/ag/save-and-grow/

CONSERVATION AGRICULTURE

FAO Conservation Agriculture home
http://www.fao.org/conservation-agriculture/en/

Conservation Agriculture crop rotations for eastern Europe & central Asia
http://www.fao.org/3/a-i7154r.pdf

Ukraine: Soil fertility to strengthen climate resilience
Preliminary assessment of the potential benefits
of Conservation Agriculture
http://www.fao.org/3/a-i3905e.pdf

CROP RESIDUE MANAGEMENT

Corsi, Friedrich, Kassam, Pisante, Sà, 2012.
Soil Organic Carbon Accumulation and Greenhouse Gas Emission Reductions from Conservation Agriculture.
http://www.fao.org/fileadmin/user_upload/agp/icm16.pdf

Raffa, Bogdanski, Tittonell, 2015.
How does crop residue removal affect soil organic carbon and yield?
A hierarchical analysis of management and environmental factors.
https://www.cabdirect.org/cabdirect/abstract/20153370819