Sustainable Agriculture: Breeding agricultural system components

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7 billion people in the world

1.5 billion overweig

illion undernourished

1.3 billion tonnes of food wasted each year

200+ million more hungry after 2007/8 price spikes

1.5 billion depend on degrading land

1.4 billion live on <USD1.25 / day

12 million ha of agricultural land degraded each year

11.4 billion USD lost to extreme weather in 2011

Global challenges in the 21st century define new research agendas

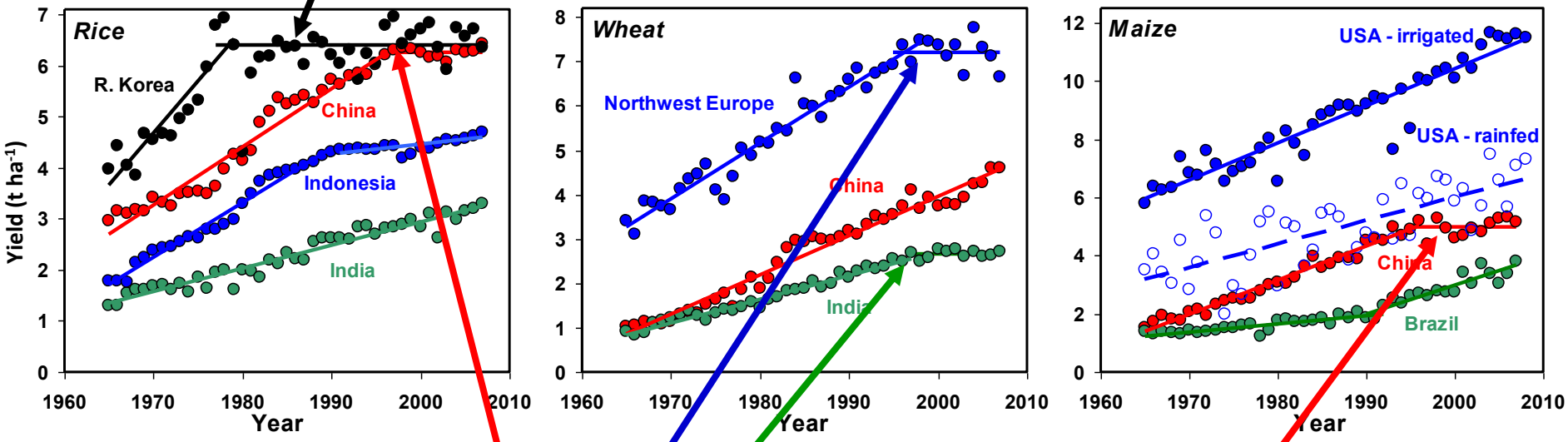
- Growing global population in a closed system
- Recognition of links between local and global food security, health, poverty and social/political stability
- Increased demand per capita for food, water, fiber and energy--tradeoffs loom large; need for disruptive technologies and more accurate planetary accounting

And there is evidence that yield gains in major cereals are slowing

By 2010, yield plateaus are evident for several cereal crops in some major production areas: Korea and China for rice, wheat in northwest Europe and India, maize in China and……..perhaps also for irrigated maize in the USA

Cassman, 1999. PNAS, 96: 5952-5959

Grassini et al., 2011. FCR 120:142-152



Cassman et al., 2003, ARER 28: 315-358

Cassman et al., 2010, Handbook of Climate Change

Slide courtesy of Ken Cassman

What must researchers do differently toward food security in the 21st century challenged by population growth, environmental degradation and climate change?

Realize we are managing systems for multiple outputs as a function of inputs and dynamic conditions

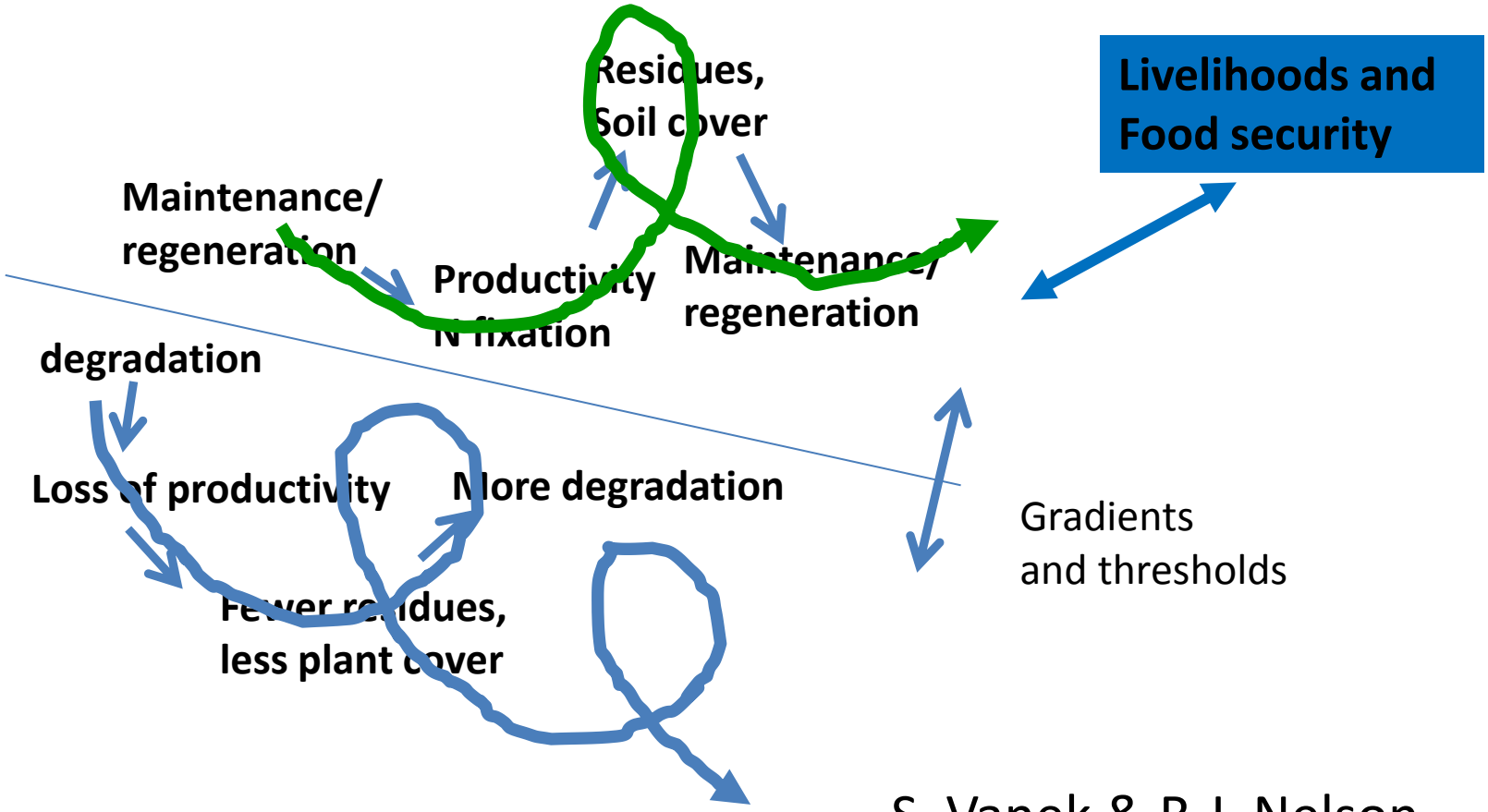
We breed crops….
We are moving to breed agricultural system components
AS SYSTEM COMPONENTS, not just to maximize crop yield:

Cover crops, trees, non-income bearing food species for nutritional security in food-insecure regions (1 in 2 children born in the US are enrolled in the WIC program)

•Regenerative and restorative agricultural practices must be the direct focus of systematic research at various scales

Genetics x Environment x Management

Feedbacks for degradation and restoration



S. Vanek & R.J. Nelson

Yield is still critically important but:

-we are operating in constrained & often degraded systems

**How can we reverse degradation of ag systems at scale & grow income, wealth, health and productivity?*

**What are technologies/approaches that actually improve agricultural, economic, environmental and health outcomes?*

**We need systems for full accounting of ecosystem services and flux and improved system components, crop and non-crop*

Commodity-focused approaches to food system sustainability

Question: Is the goal to *account*, or
to *improve & reduce risk*, or
to improve to the point where we achieve *systems in balance?*

Tier 1 Sustainability

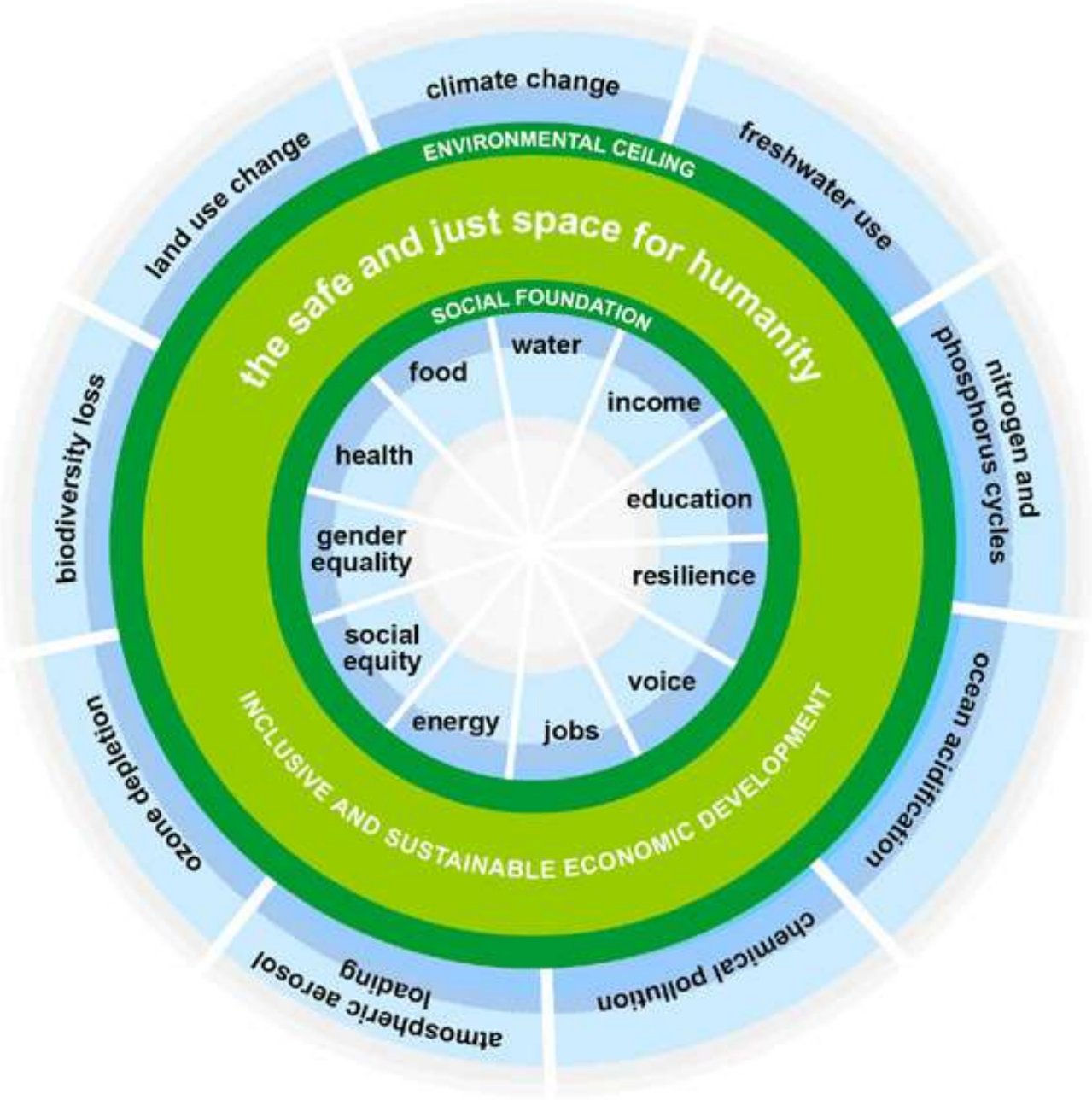
Describe consequences of current activities/practices in all dimensions with full transparency

Tier 2 Sustainability

"Continuous Improvement" Prioritize and innovate towards improvement

Tier 3 Sustainability

Set science-grounded targets for extent/nature of changes to bring us into long term safe space – with human needs met


climate change
freshwater use
nitrogen and phosphorus cycles
ocean acidification
chemical pollution
atmospheric aerosol loading
ozone depletion
biodiversity loss
land use change
ENVIRONMENTAL CEILING
the safe and just space for humanity
SOCIAL FOUNDATION
water
income
education
resilience
voice
jobs
energy
social equity
gender equality
health
food
INCLUSIVE AND SUSTAINABLE ECONOMIC DEVELOPMENT

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Questions?