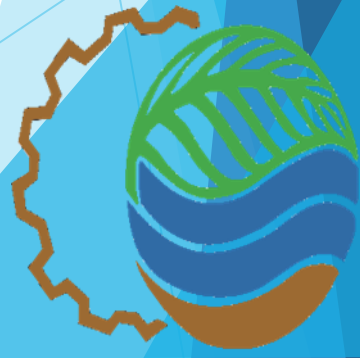


Enhancing Water Security Through Improved Agricultural Water Productivity: New Knowledge, Innovations and Applications

A Senzanje
Bioresources Engineering Programme
University of Kwazulu-Natal
Pietermaritzburg, RSA



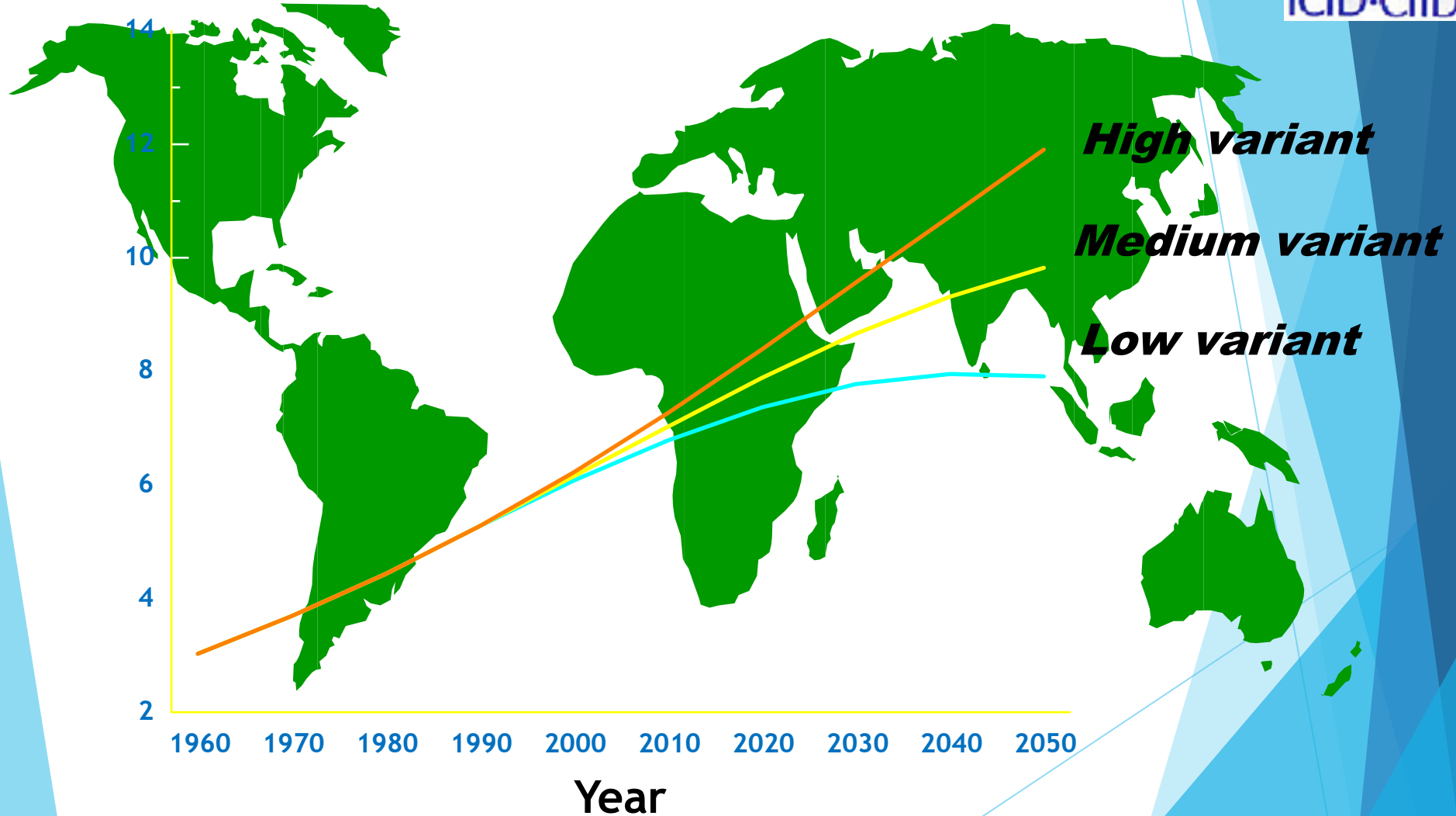
OUTLINE

- ▶ BACKGROUND & RESOURCE BASE
- ▶ AGRICULTURAL WATER MANAGEMENT & AGRICULTURAL SYSTEMS
- ▶ WATER PRODUCTIVITY
- ▶ INCREASING/IMPROVING WATER PRODUCTIVITY

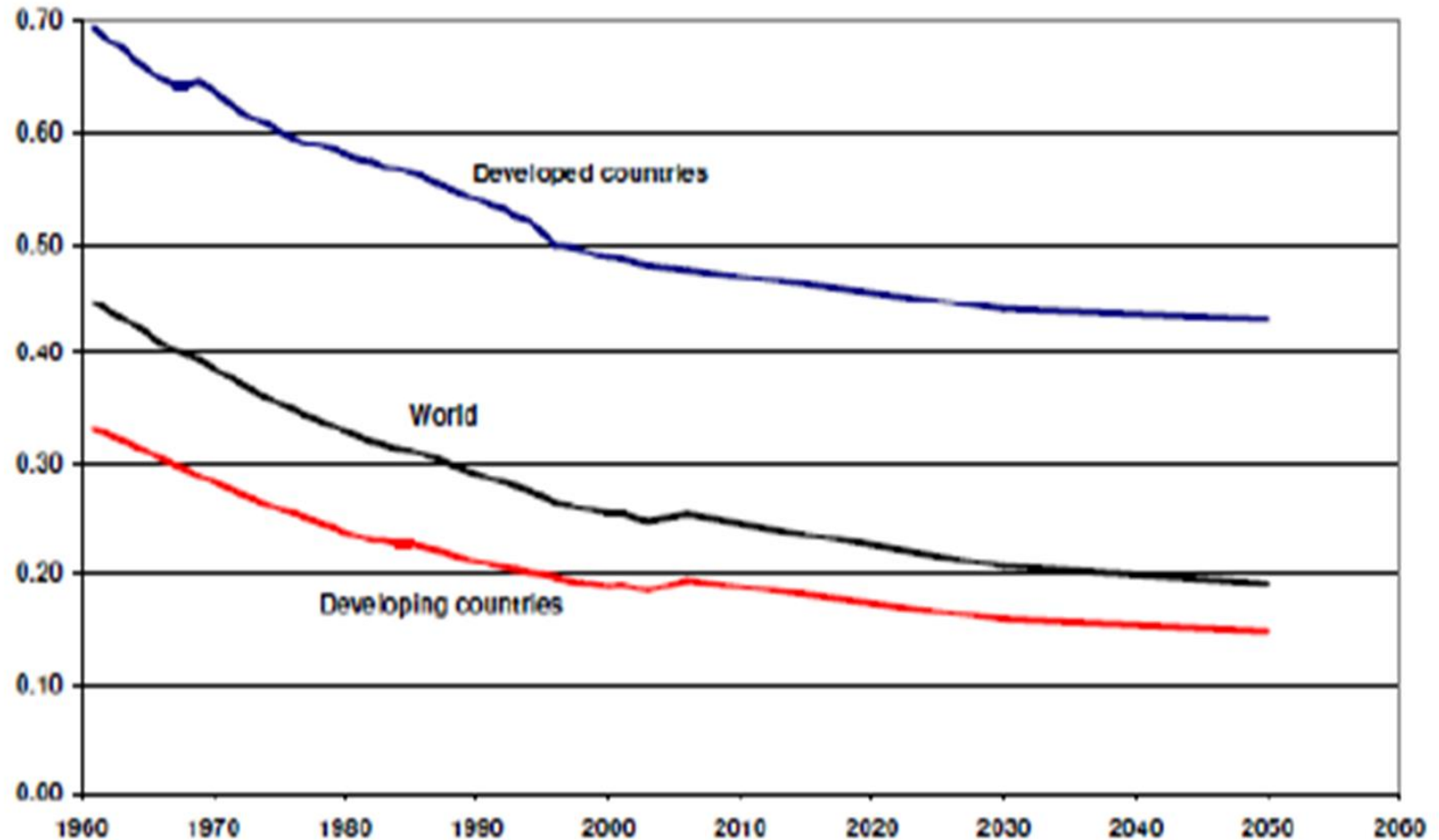
Global Population 1960 - 2050



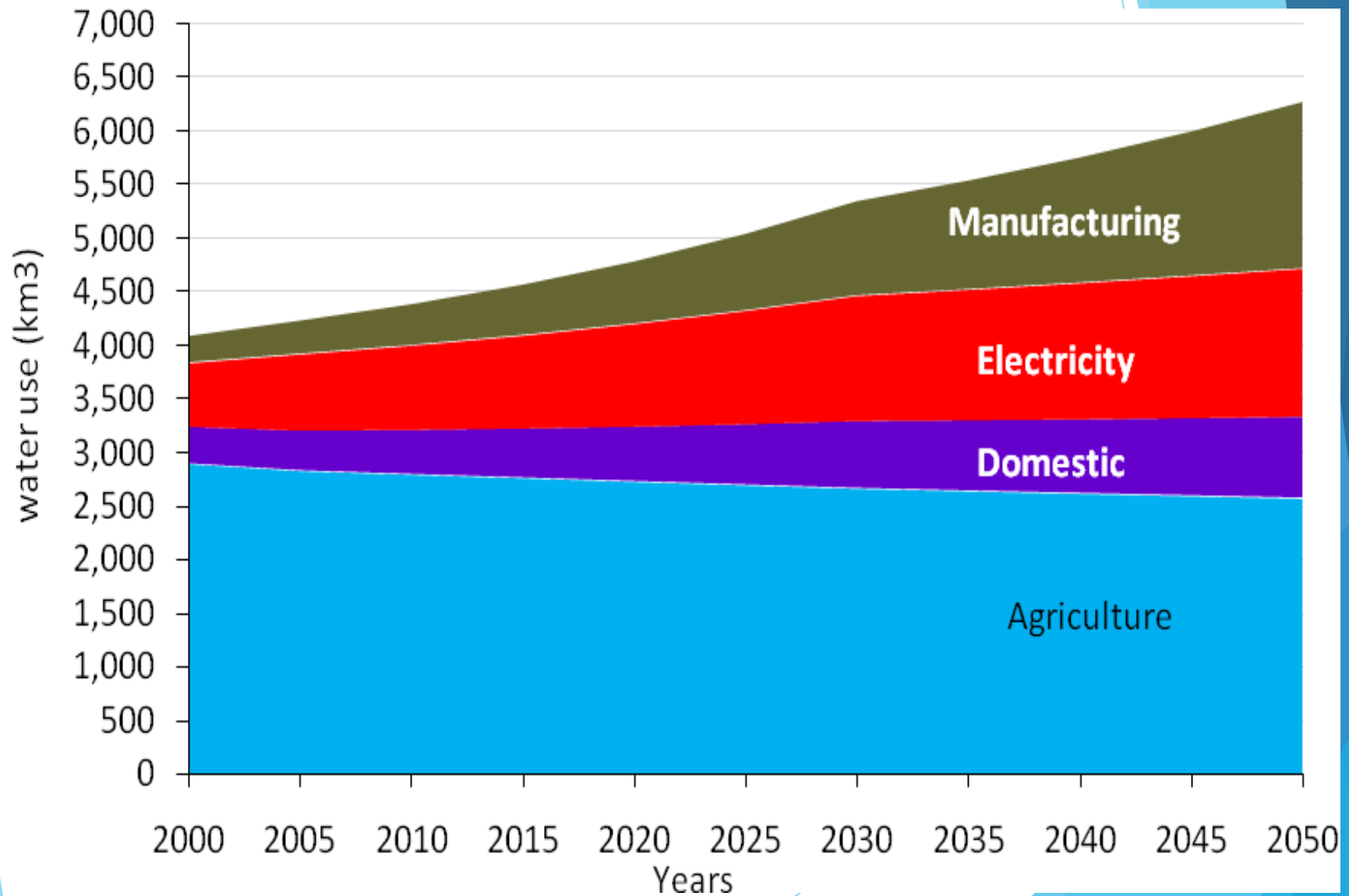
billion



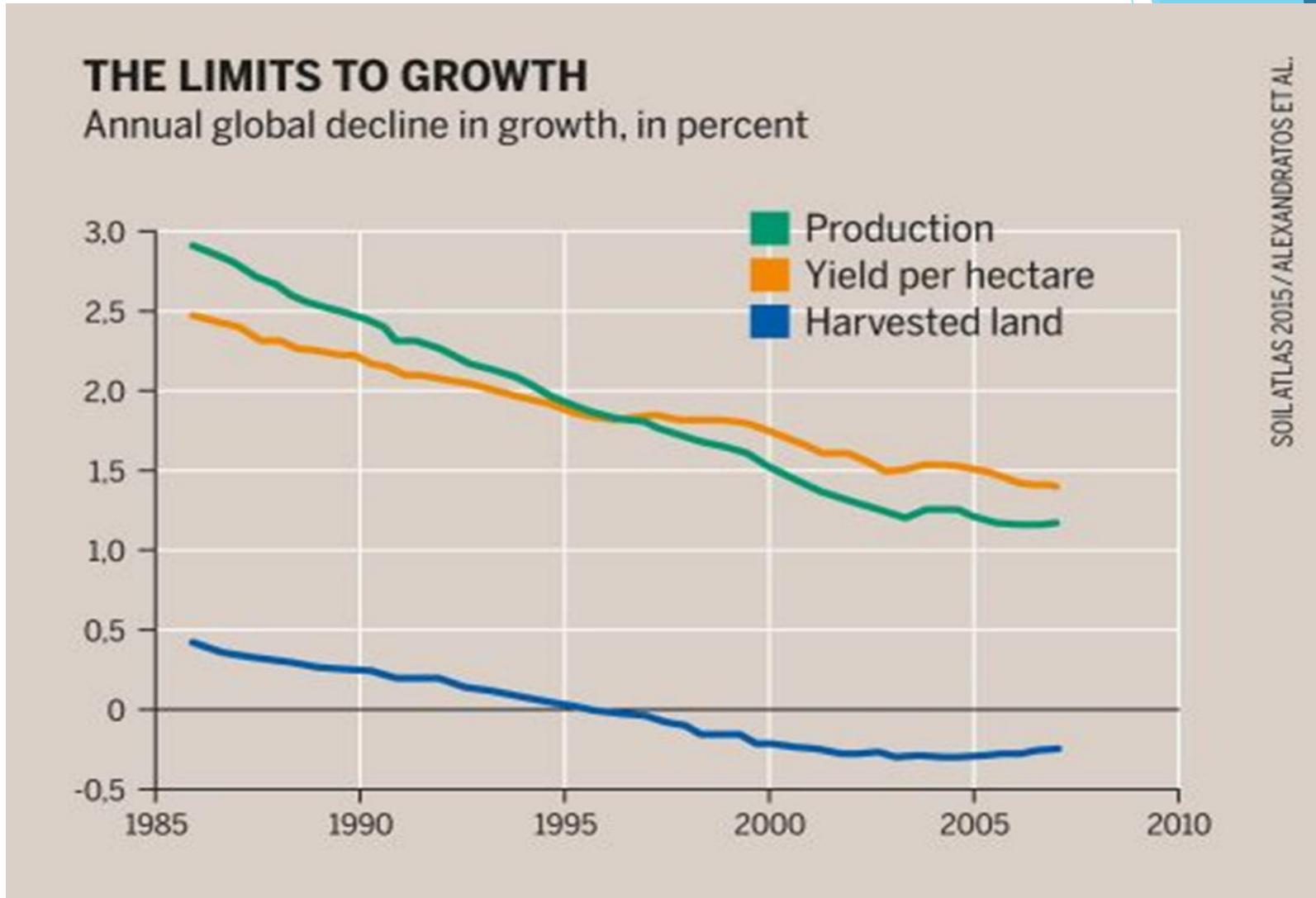
Arable Land per Capita (ha)



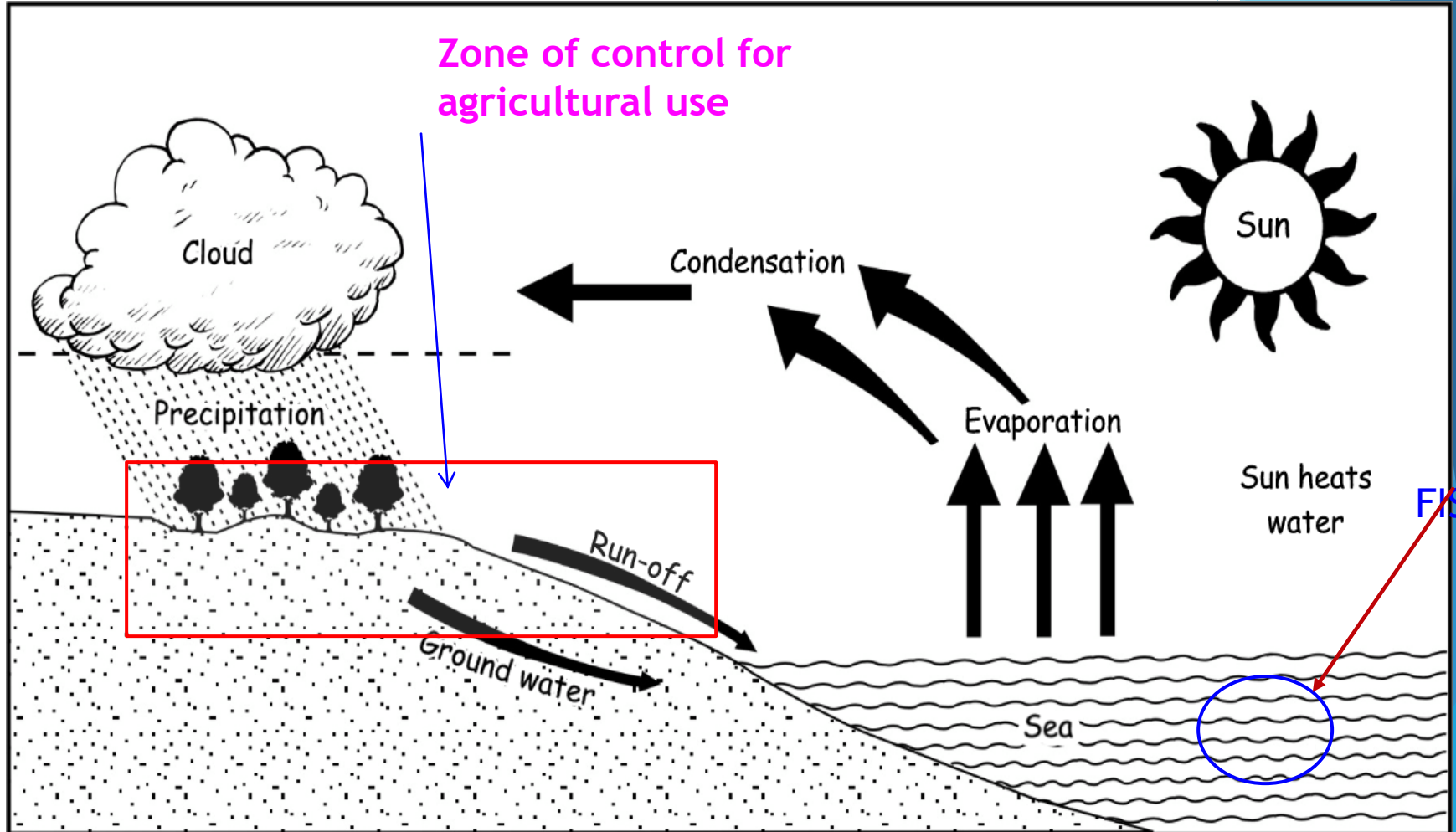
Sectoral Water Demand in the World



Annual Global Decline in Growth (%)

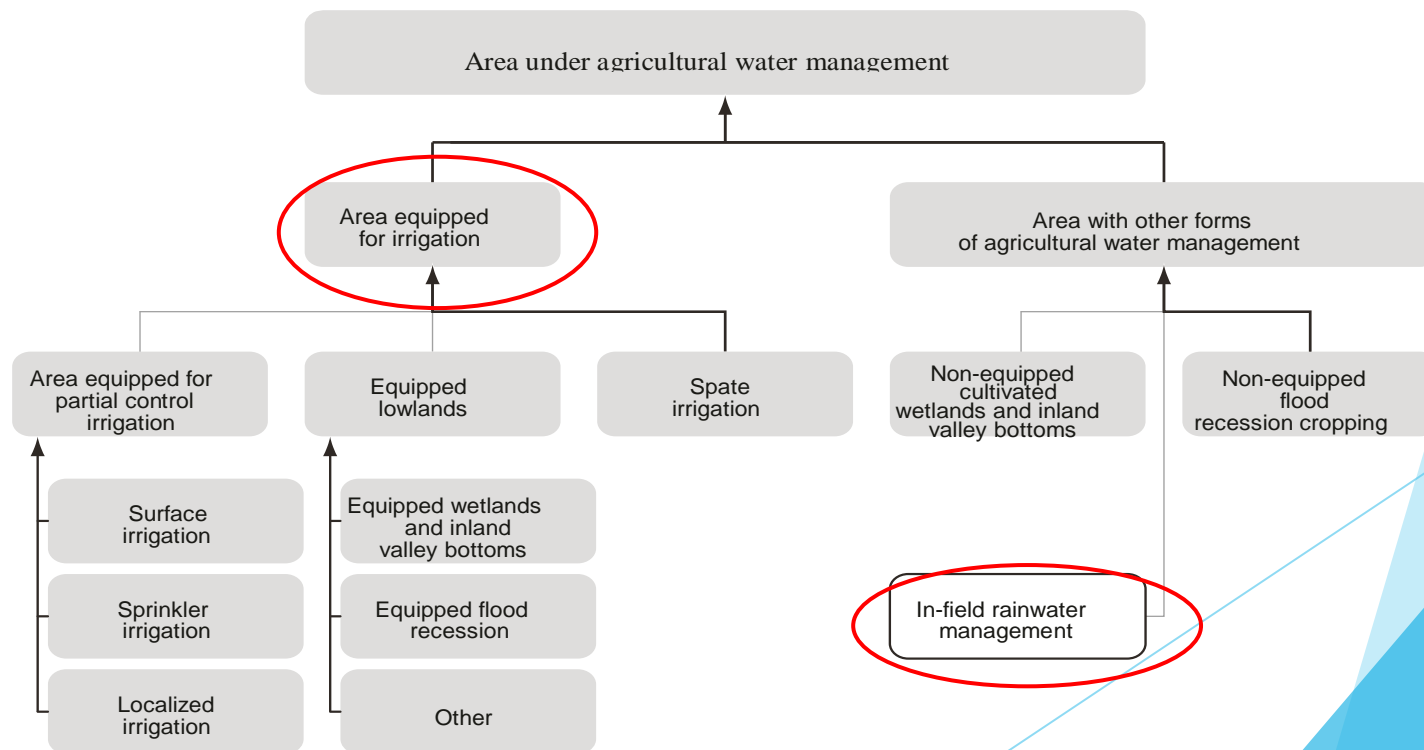


Hydrological Cycle & Water Control

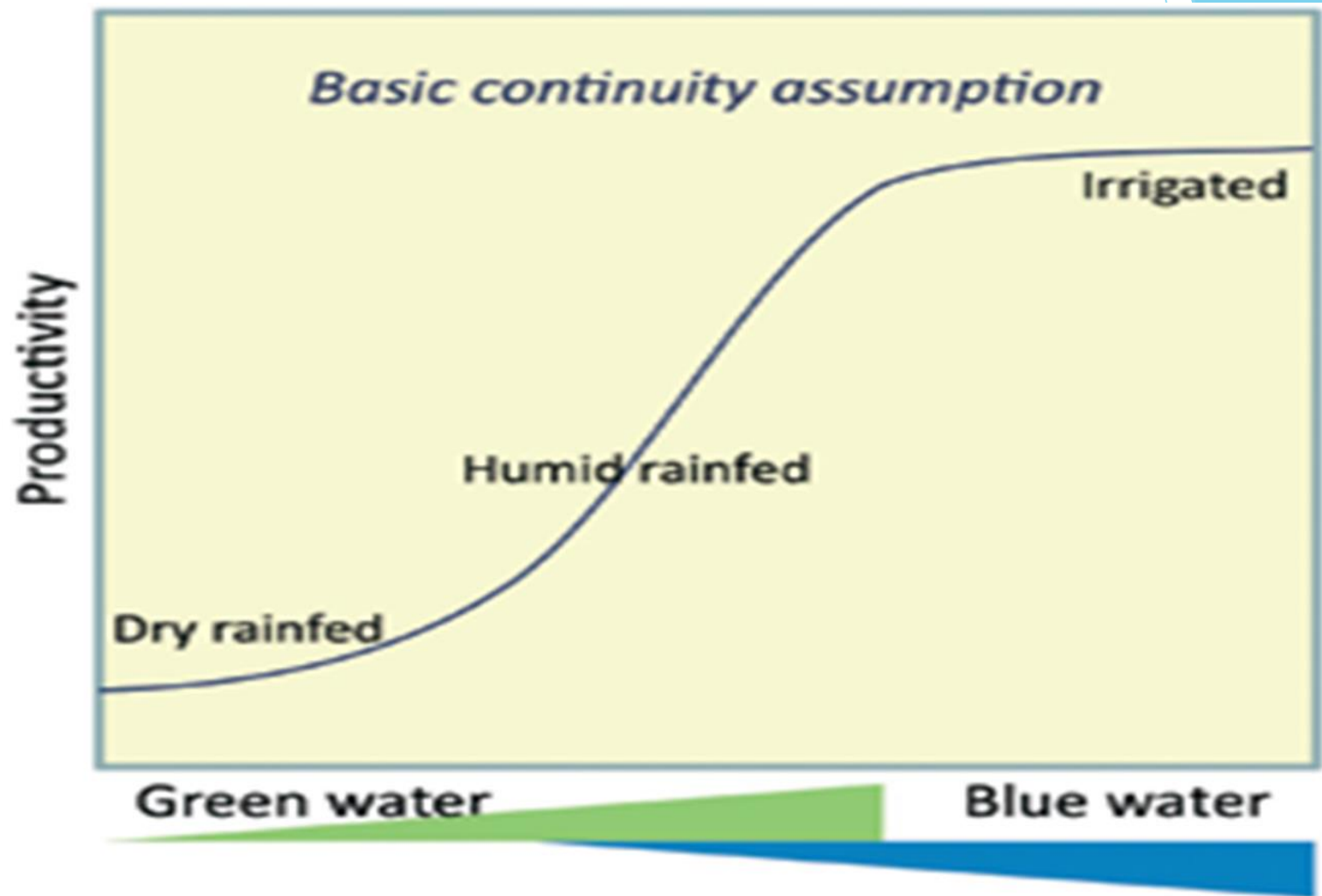


Agricultural Water Management (AWM)

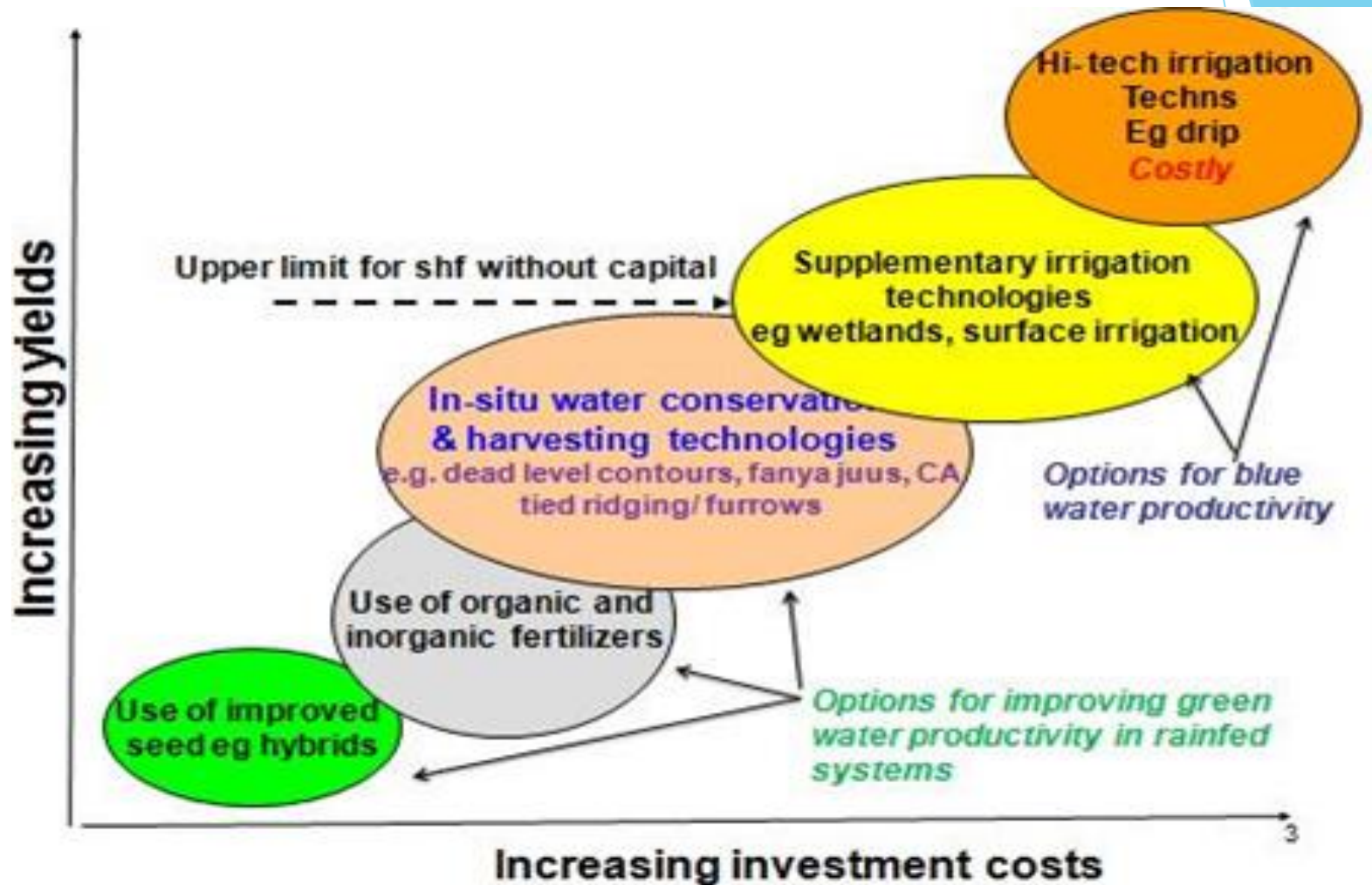
- ▶ AWM - *the management of water in agriculture in a continuum from rainfed systems to irrigated agriculture*, and includes the capture, storage and drainage of any water used for agricultural production (Merrey et al., 2006).



Green-blue Water Continuum (Hoff et al 2008)



Options for Improving Agricultural Water Management in Cropping Systems (Nyagumbo et al 2013)



Water Productivity

- ▶ Increasing WP is key to addressing water scarcity
 - ▶ More agric **output for same amount of water**
 - ▶ More agric **output from lesser amount of water**
- ▶ **Productivity** - measure of performance expressed as the ratio of output to input
 - ▶ **Total productivity** - ratio of total tangible outputs to tangible inputs
 - ▶ **Partial (or single factor) productivity** - ratio of total tangible output to input of one factor within a system (e.g., land, **water**, labour)

Water Productivity - 1

- ▶ **WP defined as:**

- ▶ Ratio of **output derived from water use to water input**

- ▶ or

- ▶ Ratio of **agricultural benefit to water use**

- ▶ **WP is defined for:**

- ▶ Given area

- ▶ Given time period

- ▶ **Simplest purpose of WP is to enable**

- ▶ Rapid comparison between water use systems in space & time

Water Productivity - 2

▶ WP & scale:

- ▶ WP systems can be defined at:
 - ▶ Plot, field, sub-basin & basin scales

▶ WP & water:

- ▶ Partial WP more realistic than total WP
 - ▶ $WP = (\text{kg of crop output}) / (\text{m}^3 \text{ of water used or consumed})$

Water Productivity - 3

- ▶ The **NUMERATOR**

- ▶ Beneficial agricultural outcome

- ▶ E.g. Crop yield, Biomass, Food equivalent, etc

- ▶ The **DENOMINATOR**

- ▶ Water directly consumed by the agricultural system

- ▶ E.g. ETc, Beneficial water, Process water, irrigation water, etc

- ▶ **OPPORTUNITIES FOR INCREASING WATER PRODUCTIVITY**

WP and Multiple Use Systems



Mome.gov.gh



Increasing WP Per Unit of Water

(New Knowledge, Innovations and Applications)

▶ **INCREASING PRODUCTIVITY PER UNIT OF WATER CONSUMED:**

- ▶ **CHANGE CROP VARIETY** - HIGH Y
- ▶ **CROP SUBSTITUTION** - FROM HIGH WATER CONSUMERS TO LOW WATER CONSUMERS
- ▶ **DEFICIT IRRIGATION** - LOW WATER IN NON-SENSITIVE CROP STAGES
- ▶ **PRECISION IRRIGATION** - REDUCE WASTE, APPLY WHERE NEEDED
- ▶ **SUPPLEMENTAL IRRIGATION** - TOP UP RAIN
- ▶ **IMPROVE WATER MANAGEMENT** - BETTER TIMING OF IRRIGATION TO REDUCE CROP STRESS, ETC
- ▶ **IMPROVE NON-WATER INPUTS** - IMPROVE AGRONOMIC PRACTICES (e.g. fertilisers) THAT INCREASE YIELD

Increasing Water Productivity

▶ **REDUCING NON-BENEFICIAL DEPLETION**

- ▶ **REDUCE NON-BENEFICIAL EVAPORATION** - USE MULCH, DRIP IRRIGATION, DECREASE AREAS OF FREE WATER SURFACES, ETC
- ▶ **REDUCE WATER FLOWS TO SINKS** - REDUCE IRRECOVERABLE DEEP PERCOLATION LOSSES & SURFACE RUN-OFF
- ▶ **MINIMISE SALINISATION OF RETURN FLOWS** - AVOID SALINISATION OF RECOVERABLE RETURN FLOWS
- ▶ **SHUNT POLLUTED WATER TO SINKS** - AVOID THE NEED TO DILUTE POLLUTED WATER WITH FRESH BLUE WATER
- ▶ **USE RETURN FLOWS** - RETURN FLOWS TO BE USED IN SYSTEM

Increasing Water Productivity

▶ RE-ALLOCATE WATER FROM LOW VALUE TO HIGH VALUE USE

- ▶ GET **VALUE FOR SCARCE RESOURCE**

▶ TAPPING UNCOMMITTED OUTFLOWS

- ▶ **IMPROVE MANAGEMENT OF EXISTING FACILITIES** - TO OBTAIN MORE BENEFICIAL USE FROM EXISTING WATER SUPPLIES
- ▶ **RE-USE RETURN FLOWS** - RETURN FLOWS PUMPED TO INCREASE IRRIGATED AREA
- ▶ **ADDING STORAGE FACILITIES** - STORE WATER

Into the Future

▶ IoT

- ▶ Advances in precision agriculture - water monitoring, irrigation scheduling

▶ 4IR

- ▶ Advances in irrigation materials science and technology

Conclusion

- ▶ *Would increasing/improving water productivity enhance food security and rural livelihoods?*