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Precision agriculture in perennial tree crops: Focus on cocoa and oil palm

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Introduction

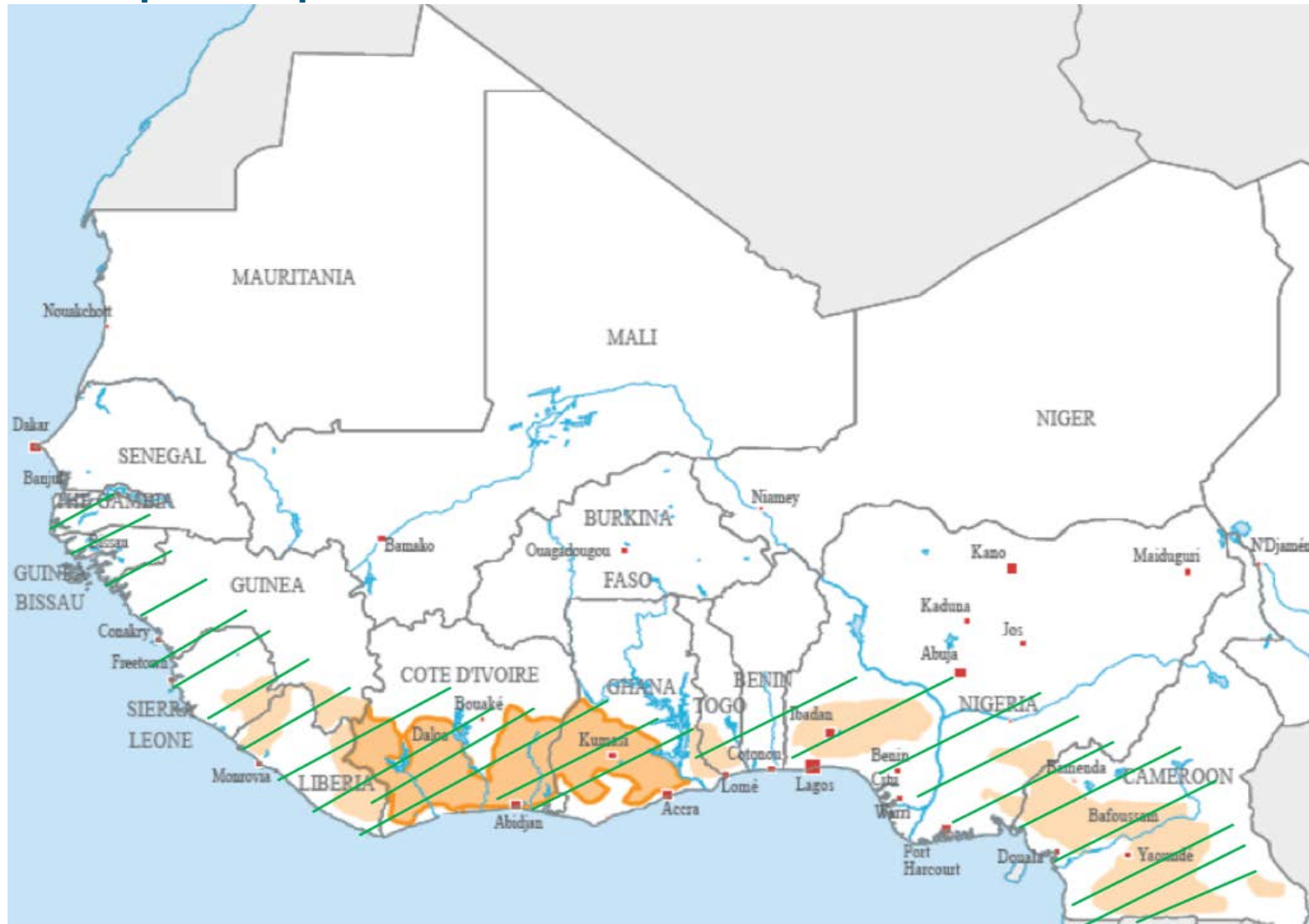
Cocoa and oil palm, important cash crops in West African countries

Cocoa- and oil palm production systems challenged by biophysical and socio-economic constraints


Sustainable cocoa- and oil palm-based cropping systems needed



Cocoa and oil palm production zones



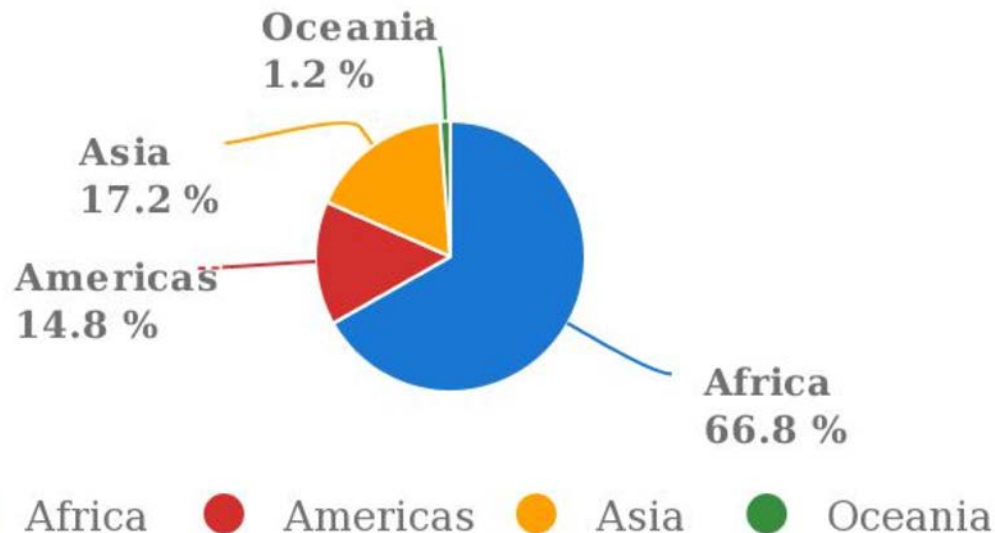
 Cocoa zones

 Oil palm zones

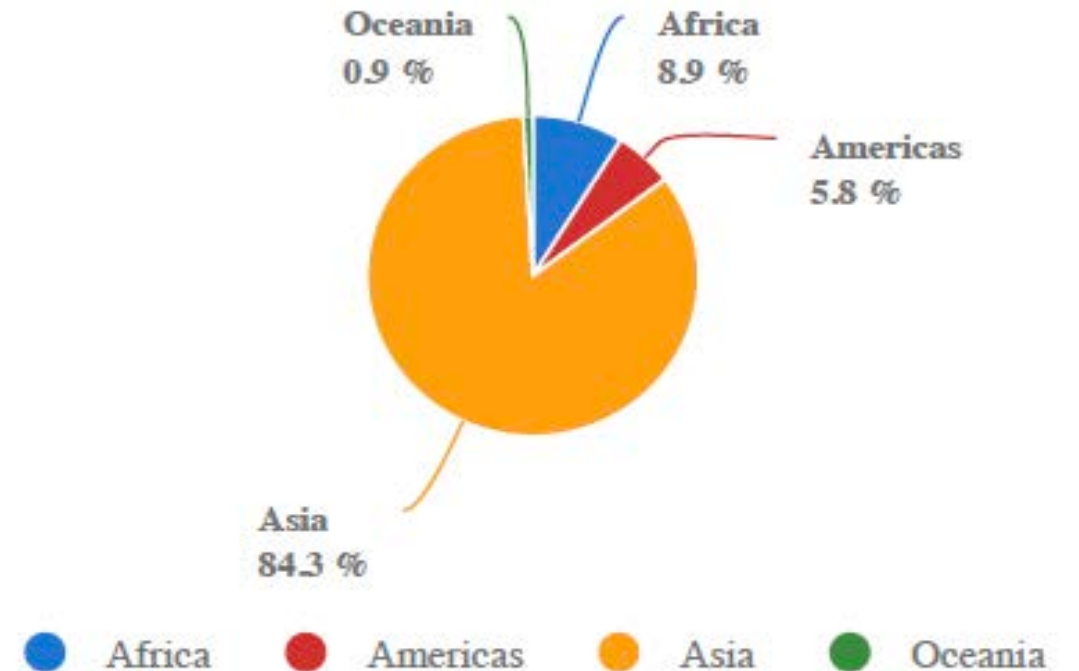
Cocoa and oil palm production

World's production of cocoa and oil palm production (million tonnes)

Tree crops	Years						
	1994	1998	2002	2006	2010	2014	2017
Cocoa	2.7	3.3	3.3	4.3	4.3	4.7	5.2
Oil palm	81.7	99.2	136.0	196.4	223.8	286.7	317.6



Share of cocoa beans by region (avg. 1994-2017)



Share of oil palm fruit by region (avg. 1994-2017)

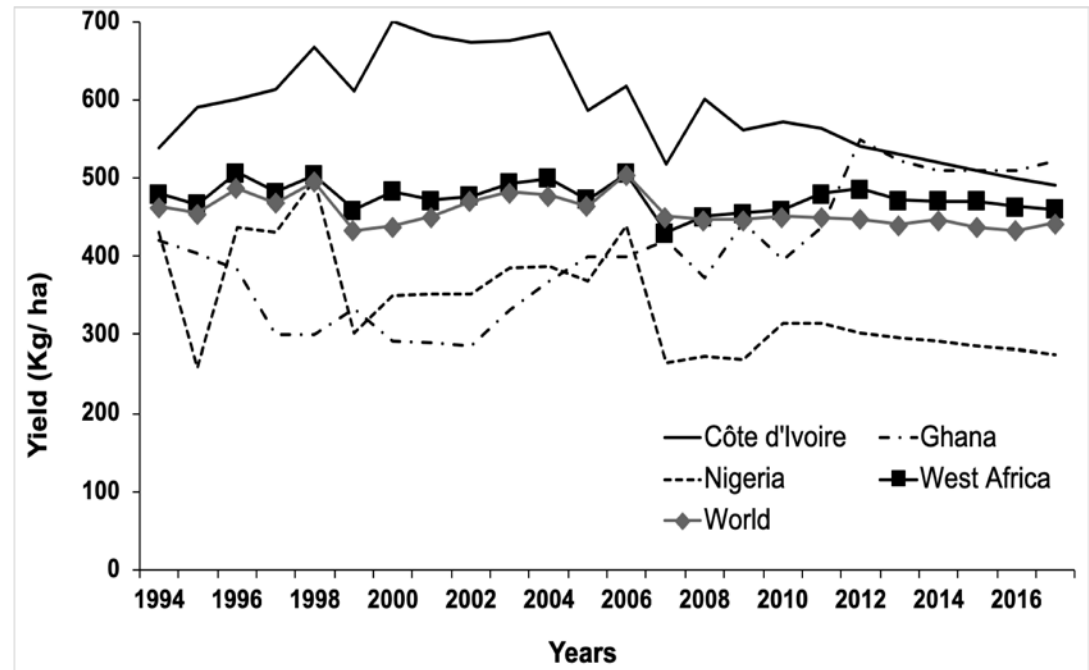


Cocoa production

Cocoa production (thousand tonnes) in West African countries

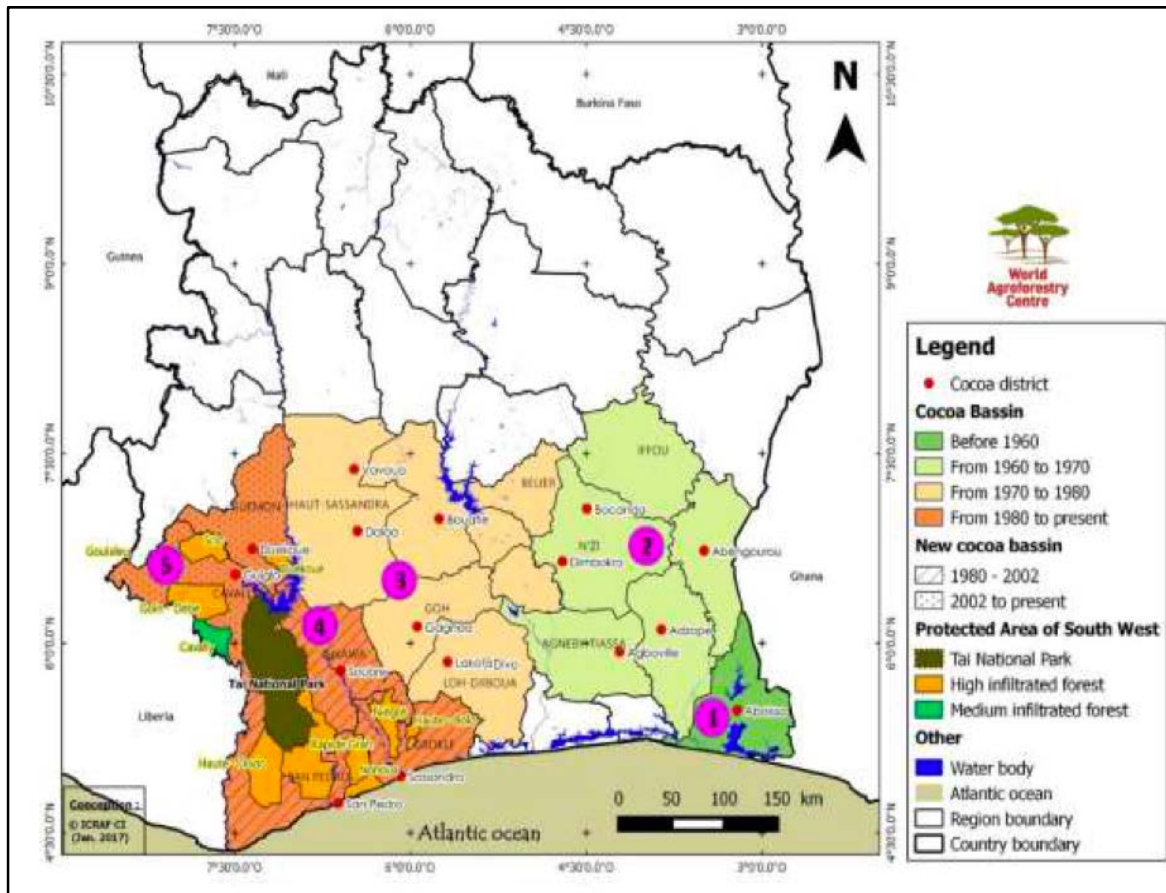
	1994	1998	2002	2006	2010	2014	2017
Côte d'Ivoire	809	1,201	1,265	1,409	1,301	1,613	2,034
Ghana	288	409	341	734	632	859	884
Guinea	5	9	3	13	15	8	11
Liberia	0	2	2	1	7	8	9
Nigeria	323	370	362	485	399	330	328
Sierra Leone	12	15	12	14	20	16	15
Togo	6	12	8	73	102	25	23
West Africa	1,442	2,018	1,990	2,729	2,476	2,858	3,302

Dramatic increase in cocoa production largely due to increased planted areas



Cocoa yield (kg ha⁻¹) in WA

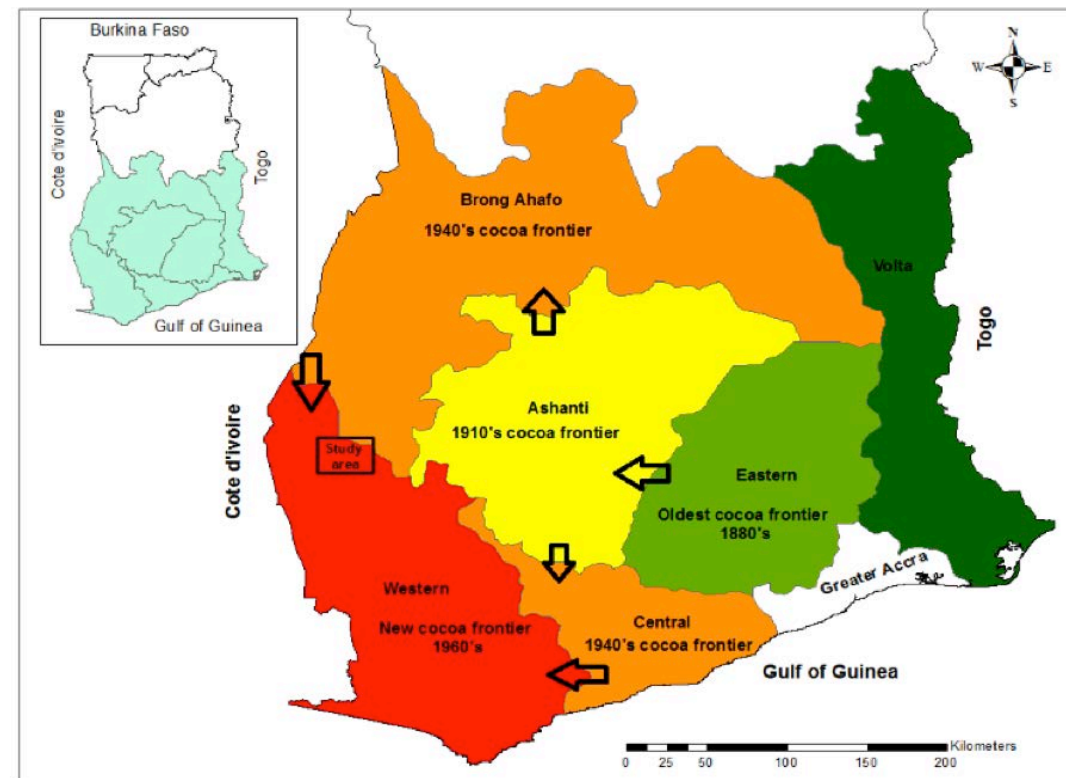
Cocoa production



Moving cocoa frontier in Ivory Coast,

Source: ICRAF 2019

Satisfying growing demand without compromising the environment!
Sustainable intensification, the way out



Moving cocoa frontier in Ghana

Source: Knudsen & Agregeraad, 2016

Search for fertile lands, high yields, and incomes drive the movement of cocoa frontier to intact forest

Improving production merely by extension of area through deforestation will be harder to accomplish in future

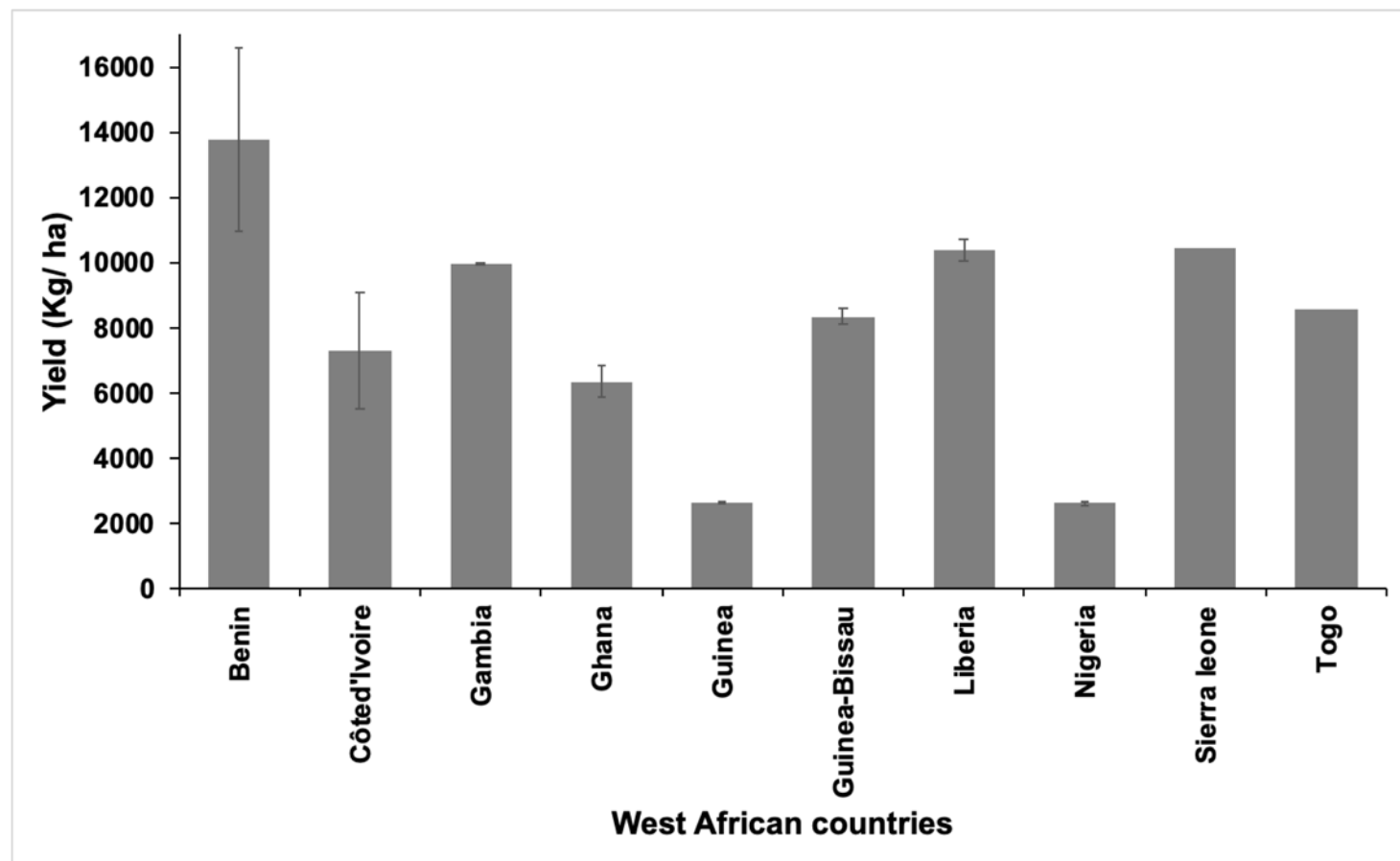


Oil palm production

Oil palm fruit production in WA (thousand tonnes) from 1994-2017

	Average	STD
Benin	358	170
Côte d'Ivoire	1,477	325
Gambia	35	0
Ghana	1,702	594
Guinea	829	10
Guinea-Bissau	79	4
Liberia	169	16
Nigeria	8,115	366
Sierra Leone	87	29
Togo	131	16
West Africa	13,189	1,105
World	186,298	75,589

Satisfying growing demand without compromising the environment!
Sustainable intensification, the way out.



Oil palm fruit yield in WA (kg ha⁻¹)

Production constrained by biophysical and socio-economic factors

Low farm gate price

High input cost

Limited access to finance

Reduced size of farm

Knowledge gaps

Low income

Low use of external inputs

Inadequate soil and crops management

○ Nutrient supply

○ Pest and disease

○ Planting materials

○ Aging plantations

Low productivity and large yield gap:

○ Exploit the true genetic potential

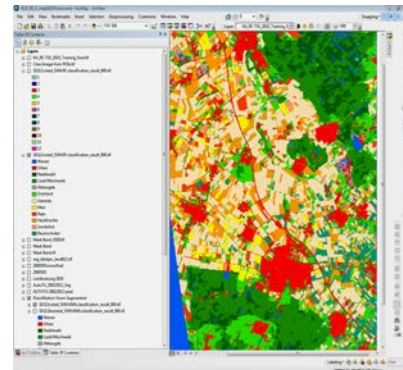
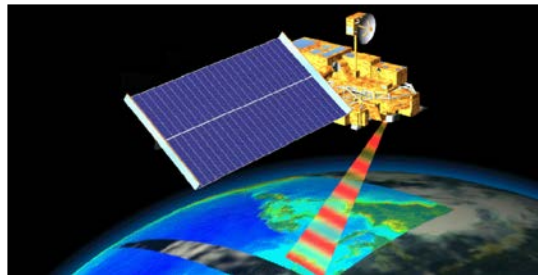
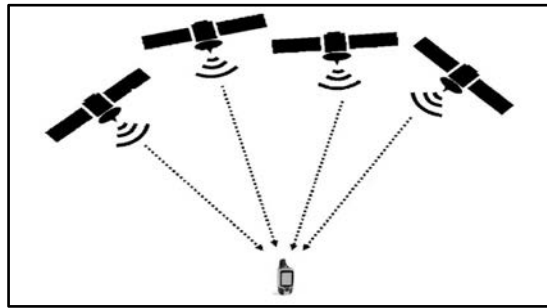
○ Implement BMPs

○ Integrate site-and crop-specific management technologies

Soil fertility depletion, climate change and variability

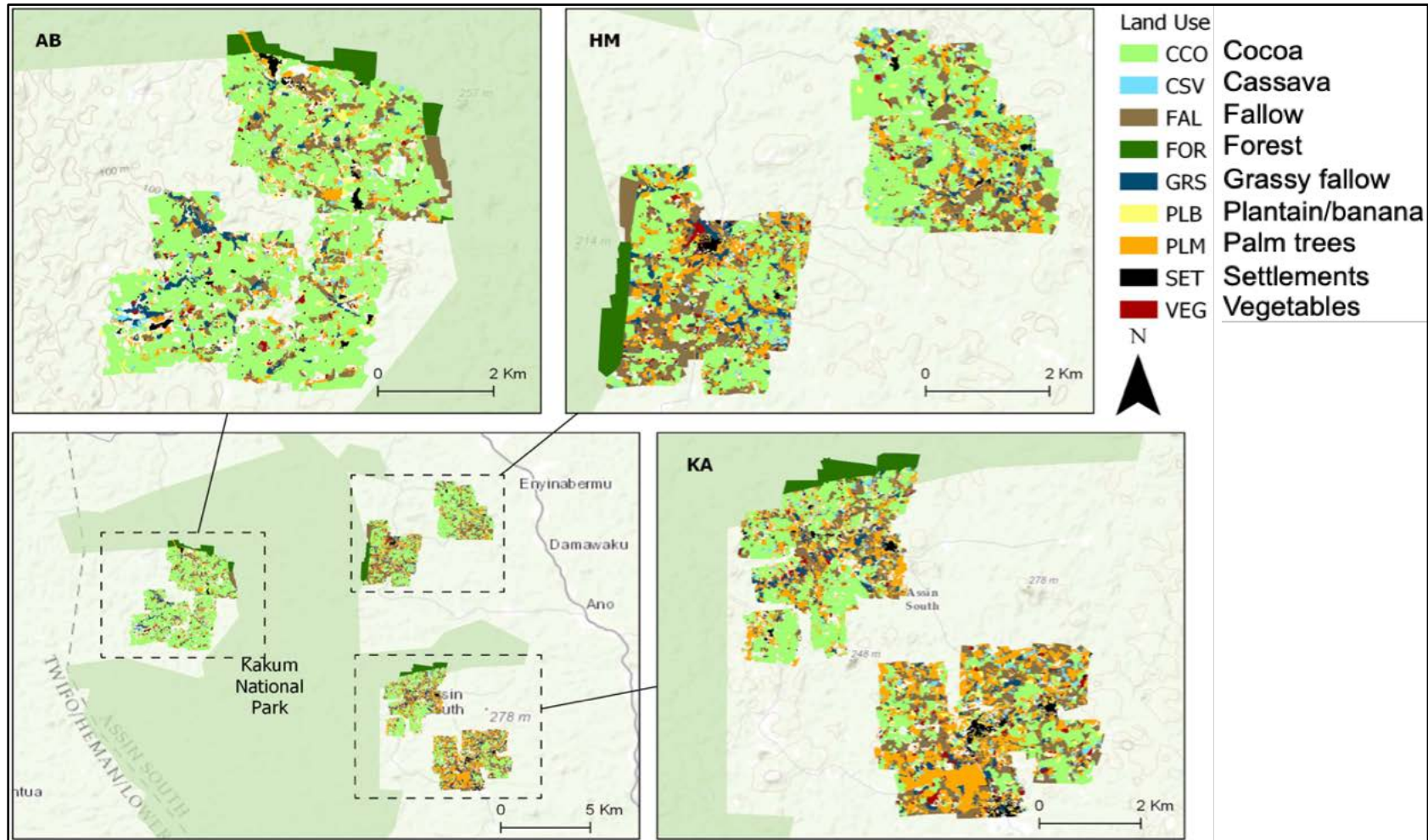


PA to cocoa- and oil palm-based production systems



GPS, RS, GIS, and DSS technologies for doing the right practice at the right location and time at the right intensity in tree crops

Drone imagery for land use mapping

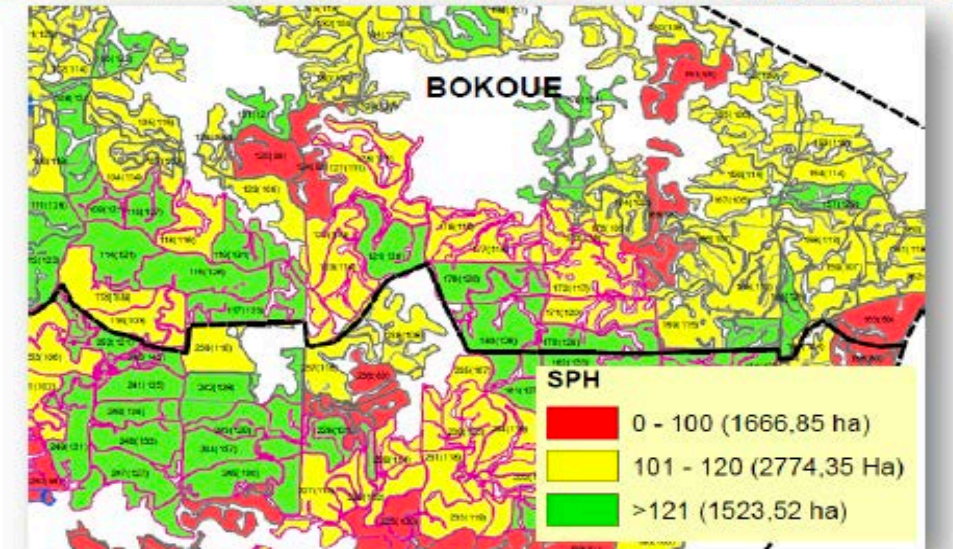
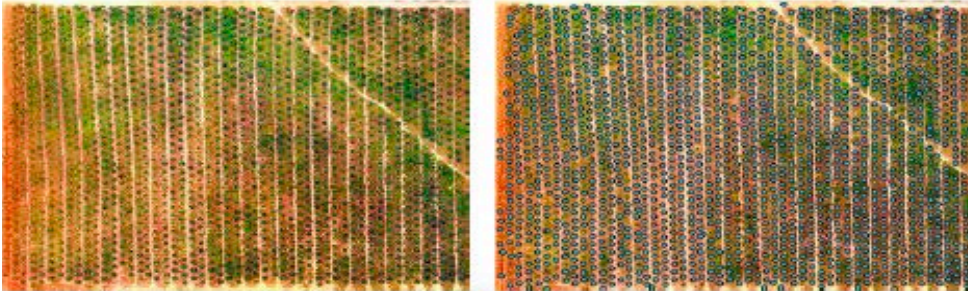


Land use classification in three cocoa farming regions, Ghana Central Region Aboabo (AB), Homaho (HM), and Kwameamoabeng (KA)

Drones imagery for plant density analysis and canopy monitoring



Optimal plant densities



Refilling of canopy gaps



Supply at vacant area

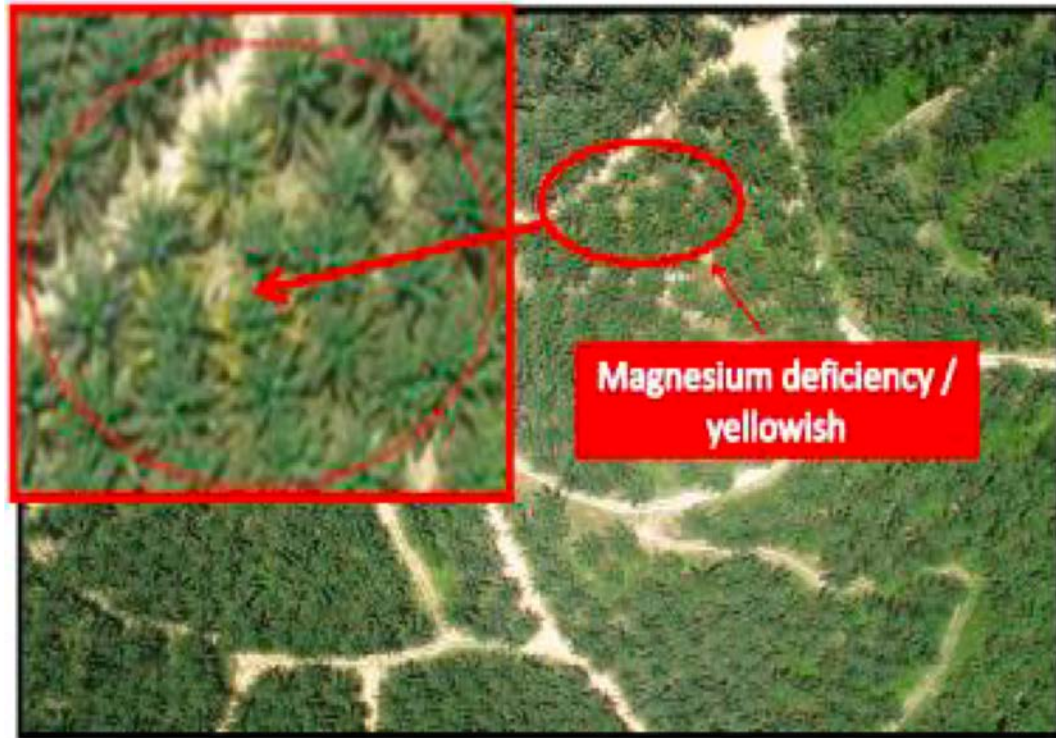
Drone imagery and field observation for disease identification

IC, Cocoa Land Health Surveillance:
Cocoa Swollen Shoot (CSSV) disease

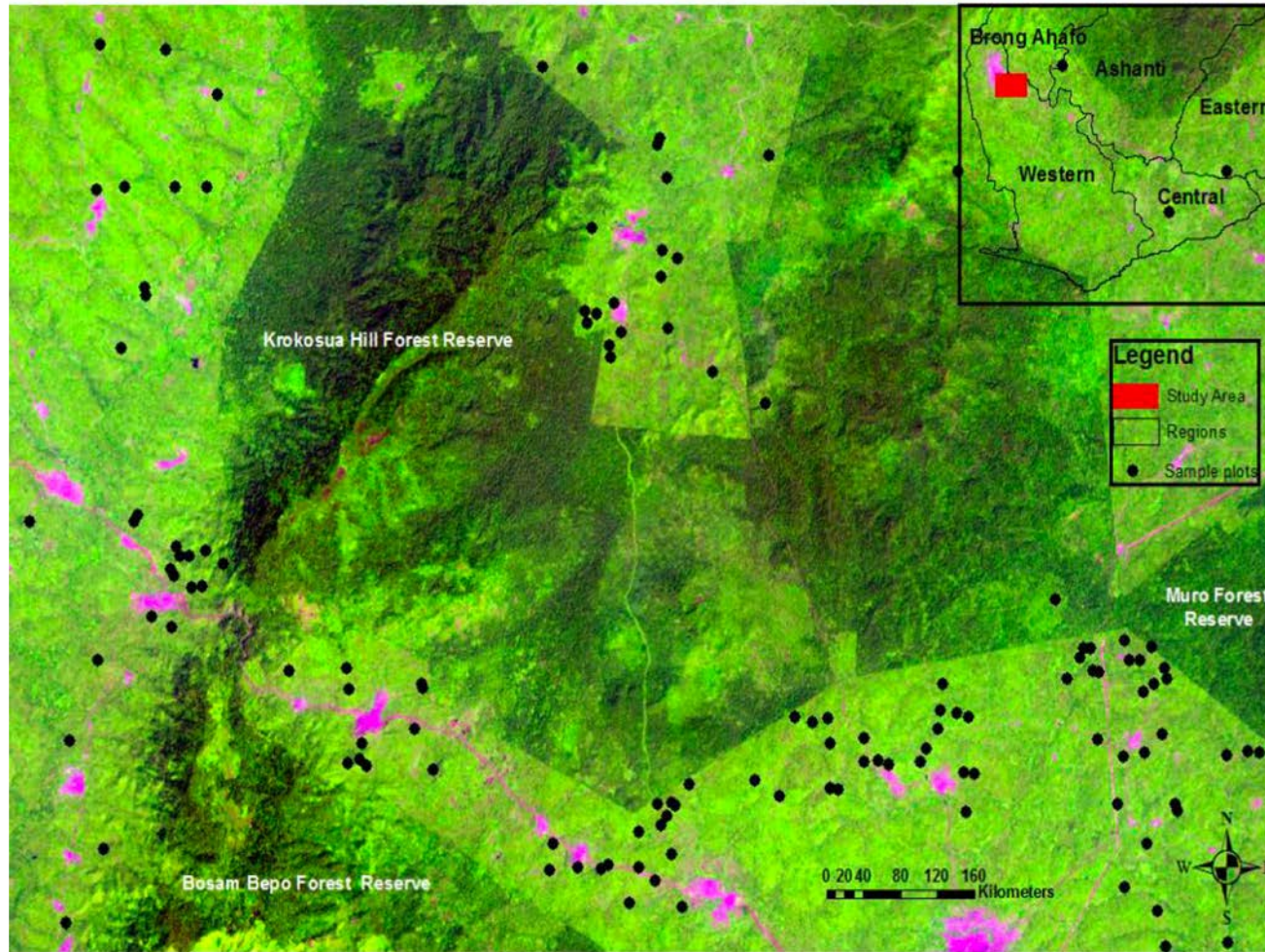




Drone imagery for nutrient deficiency, pest and disease identification



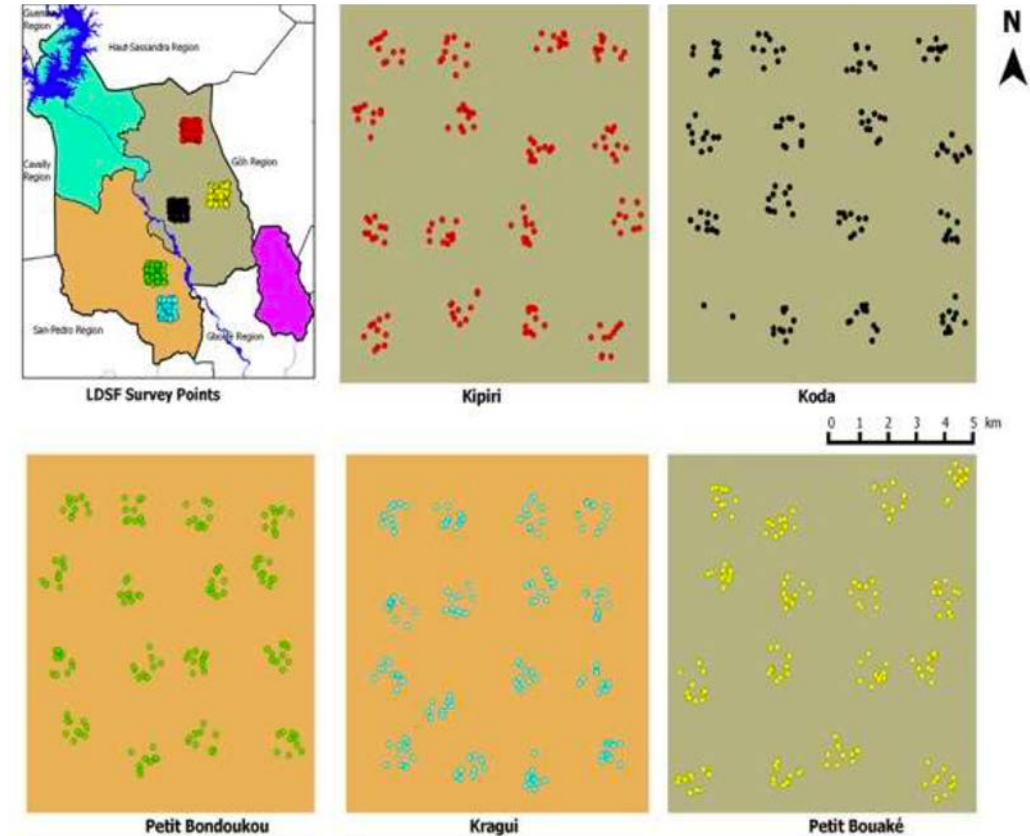
Managing soil variability



Soil sampling (black dots) within a cocoa growing landscape in the Western Region of Ghana.

Source: Benefoh, 2019

Precision fertilization based on precision soil test



Cocoa Land Health Surveillance in South West.

Vision for Change (V4C) project

Source: ICRAF, 2018, Vagen et al. 2008; Shepherd et al. 2014



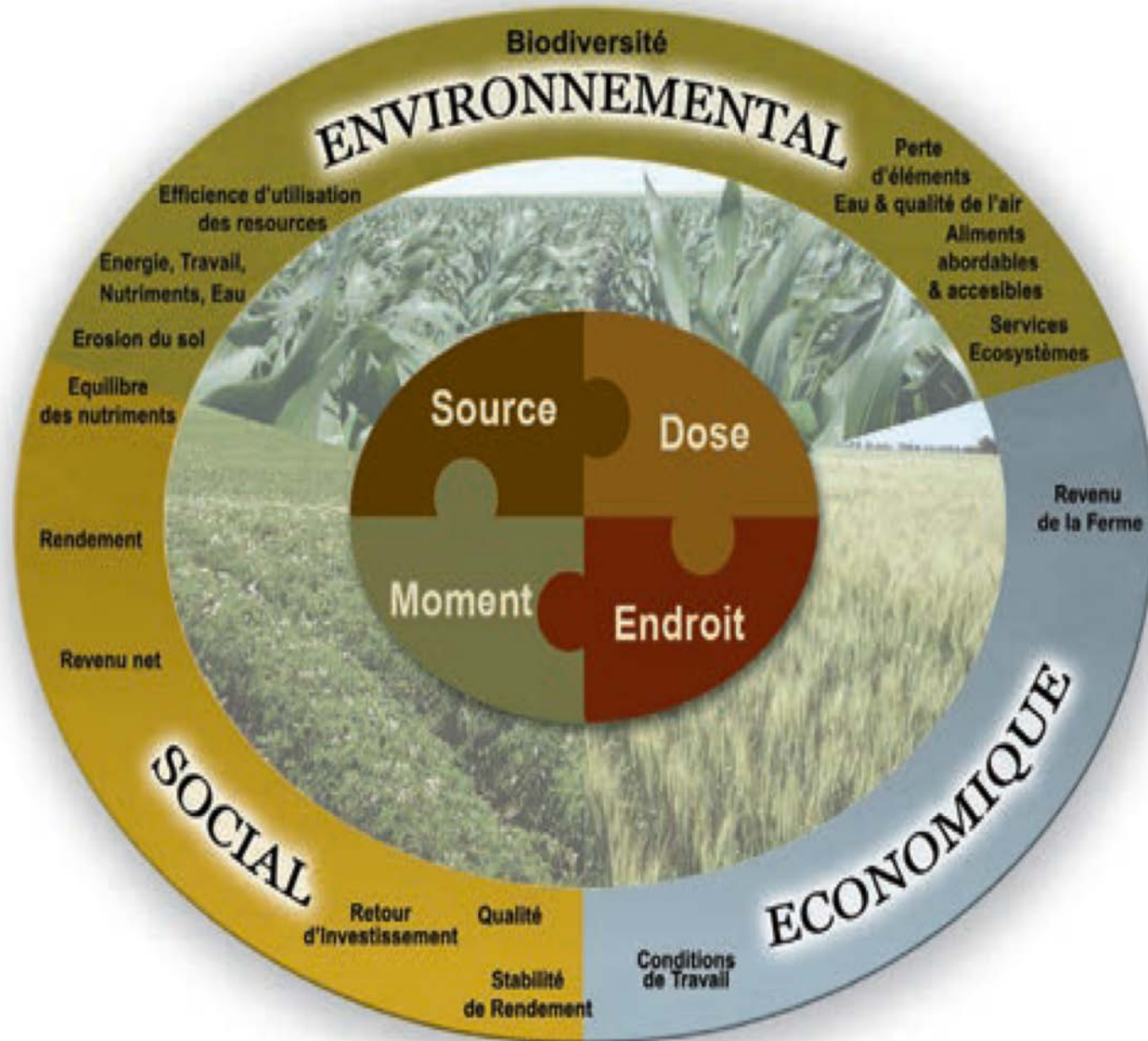
Using soil moisture sensors for precision water management



ICT-based fertigation minimizes depressive effects of nutrient and water stresses on tree crop



4R nutrient stewardship for precision nutrient management



Tree crops expansion raises environmental, social, economic, and political issues!

*4R for
Optimizing returns on inputs while preserving resources*



PA, opportunity for sustainable intensification in tree crops farming systems

Technology development and test, key for variable rate inputs application

WEST AFRICAN FORUM ON PRECISION AGRICULTURE

4R for a smallholder-tailored variable
rate nutrient application

Closing knowledge gaps,
key for PA adoption process

Thanks for your attention



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