Improved biomass output: examples, evidence and perspectives

Workshop: the World needs more Land Use Change

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Outline

- Need and perspectives for bioenergy
- Food availability (projections)
- Yield gaps
- Yield improvement
- Crop matrix
- Multiple cropping
- Conclusion

Policy environment

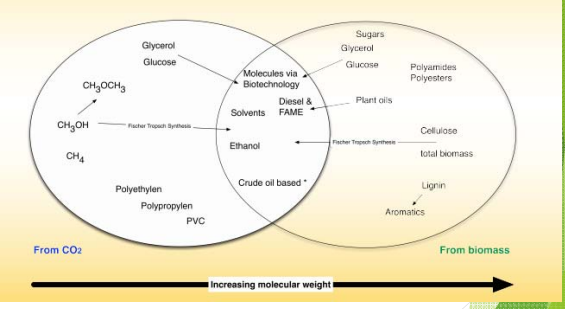
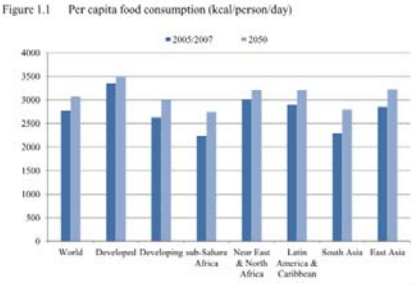


Figure from Michael Carus (nova Institut), presentation at the workshop on CCU. Hurth (Germany), 2016

FAO 2050 food projections



Source: N. Alexandratos and J. Bruinsma (2012) World agriculture towards 2030/2050: the 2012 revision. Rome: Food and Agricultural Organization of the UN

Land availability in 2050

- Suitable arable land for rainfed cultivation

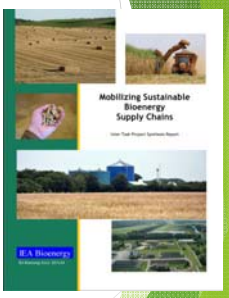
Table 4.6 Land with rain-fed crop production potential (world; million ha)

	Total	Potential	VS**	S	MS	mS	vmS	NS
Total land*	13 295	4 495	1 315	2 187	993	1 111	1 627	6 061
of which in agricultural use (1999/2001)	1 559	1 260	442	616	201	120	104	75
of which rain-fed land	1 283	1 063	381	516	166	93	84	43
of which irrigated land	276	197	61	100	35	27	20	32
Gross balance of land with rain-fed potential		3 236	873	1 571	792	991	1 523	
Under forest	3 736	1 601	453	854	293	342	530	1 263
Strictly protected land***	638	107	30	50	27	39	59	432
Built-up land	152	116	41	61	14	12	10	15
Net balance of land with rain-fed potential		1 412	349	606	458	598	923	

Source: N. Alexandratos and J. Bruinsma (2012) World agriculture towards 2030/2050: the 2012 revision. Rome: FAO

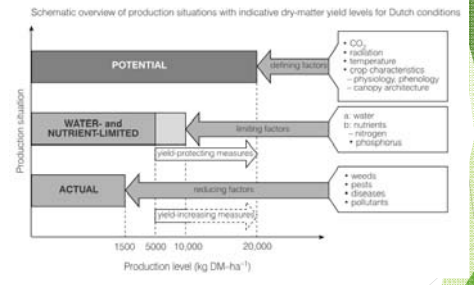
Crop residues: IEA

- Residue availability is immense
  - 6 billion tonnes of urban waste, of which 1 billion biodegradable
  - Globally, 14 billion tonnes of manure to be collected, 2.4 billion tonnes of crop residues
  - Total availability can provide 49-62 of Exajoules
  - In 2050, 90 Exajoules will be available at 2-3$/GJ



Source: Smith et al. (2015) Mobilisation of sustainable bioenergy supply chains. IEA Bioenergy, Paris

Yield gap



Source: Löwenstein et al (1995). Cited in Langeveld et al. (2010) The Biobased Economy. Earthscan, London

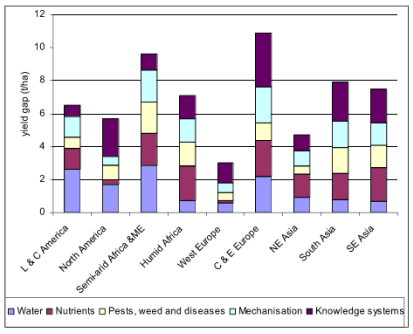
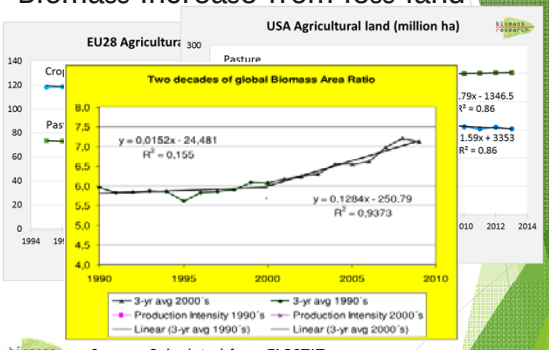


Figure 3.6 ***Maize****: Contribution of five production constraints, i.e. sub-optimal availability of water, nutrients, crop protection, labour/mechanisation and/or knowledge, to the yield gap in different parts of the World.*

Source: Hengsdijk and Langeveld (2009). Yield trends and yield gap analysis of major crops in the world. Wageningen, WOT

Biomass increase from less land



Source: Calculated from FAOSTAT

Improved crop yields

- Yield improvement varies over time
- More research basis of improvement
- Improved soil management leads to enhanced input efficiency
- Example: Cerrado (Brazil)
  - Before: high acidity, aluminium toxicity, phosphorus fixation
  - After: no aluminium toxicity, high yields

More productive crops

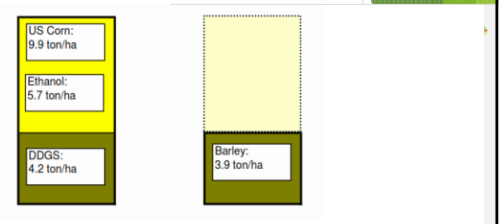


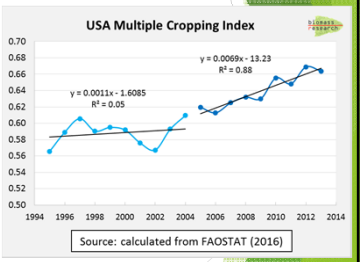
Figure 16.5 Biomass production and use of barley and ethanol-corn in the USA
Source: crop yields from FAOSAT (2010-2013). DDGS yield calculated from literature

Data source: FAOSTAT (2016)

Source: Langeveld et al. (2014) Outlook. In: Langeveld et al.. Biofuel Cropping systems. Routledge, London

Increase multiple cropping

- Multiple cropping: more frequent harvesting
- Green revolution: reduction of LGP (rice)
- Recent examples
  - China
  - US, EU
- Role of Climate change
- Good for soils, fertilizer & water efficiency



Source: calculated from FAOSTAT (2016)

Closing Multiple Cropping Gap

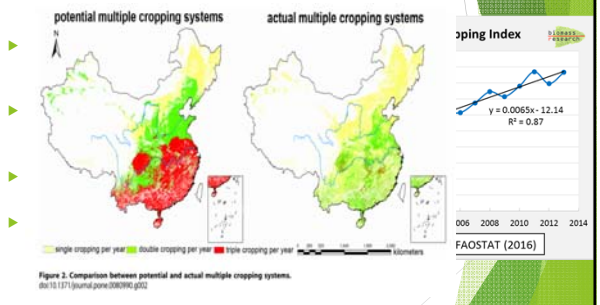
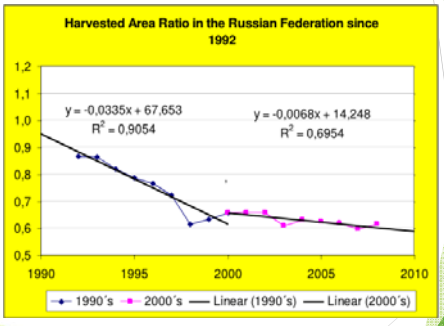


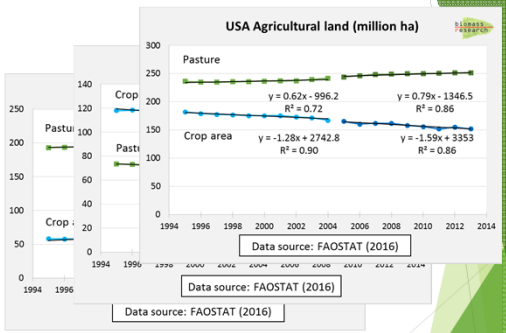
Figure 2. Comparison between potential and actual multiple cropping systems.

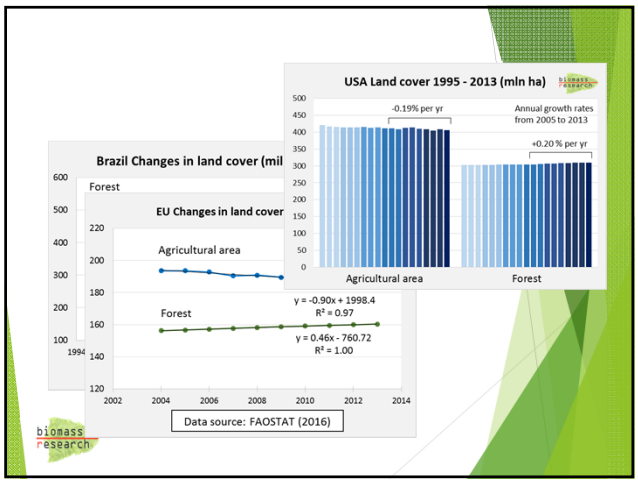
Good land policy is lacking



Discussion and conclusion

- Bioenergy is important
- Food production projected to increase towards 2050
- Undernutrition and deforestation: dedicated policies needed (enforcement!)
- Large area of suitable land available (grassland)
- Improvement of land, water, nutrient productivity
- Major increase of biomass:
  - Closing yield gaps
  - Crop substitution
  - Multiple cropping
  - Grassland productivity




USA Land cover 1995 - 2013 (mln ha)
-0.19% per yr
Annual growth rates from 2005 to 2013
+0.20 % per yr
Agricultural area
Forest
Brazil Changes in land cover (mil
Forest
EU Changes in land cover
Agricultural area
Forest
y = -0.90x + 1998.4
R² = 0.97
y = 0.46x - 760.72
R² = 1.00
Data source: FAOSTAT (2016)