INDIRECT LAND USE CHANGE comparison of economic models

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You can only model ILUC

There is only one reality

So you cannot know what *would* have happened without biofuels

So you cannot *measure* ILUC

You must use models…

"keeping everything else the same…"

2020 **scenario** with extra biofuel

compared to

2020 baseline scenario without extra biofuel

We are NOT talking about differences between **now** and 2020,
(which are mixed up with time-trends)

2 models are needed to find emissions

Biofuel comes from energy in a crop otherwise used for food

crop price increases

less consumption for food

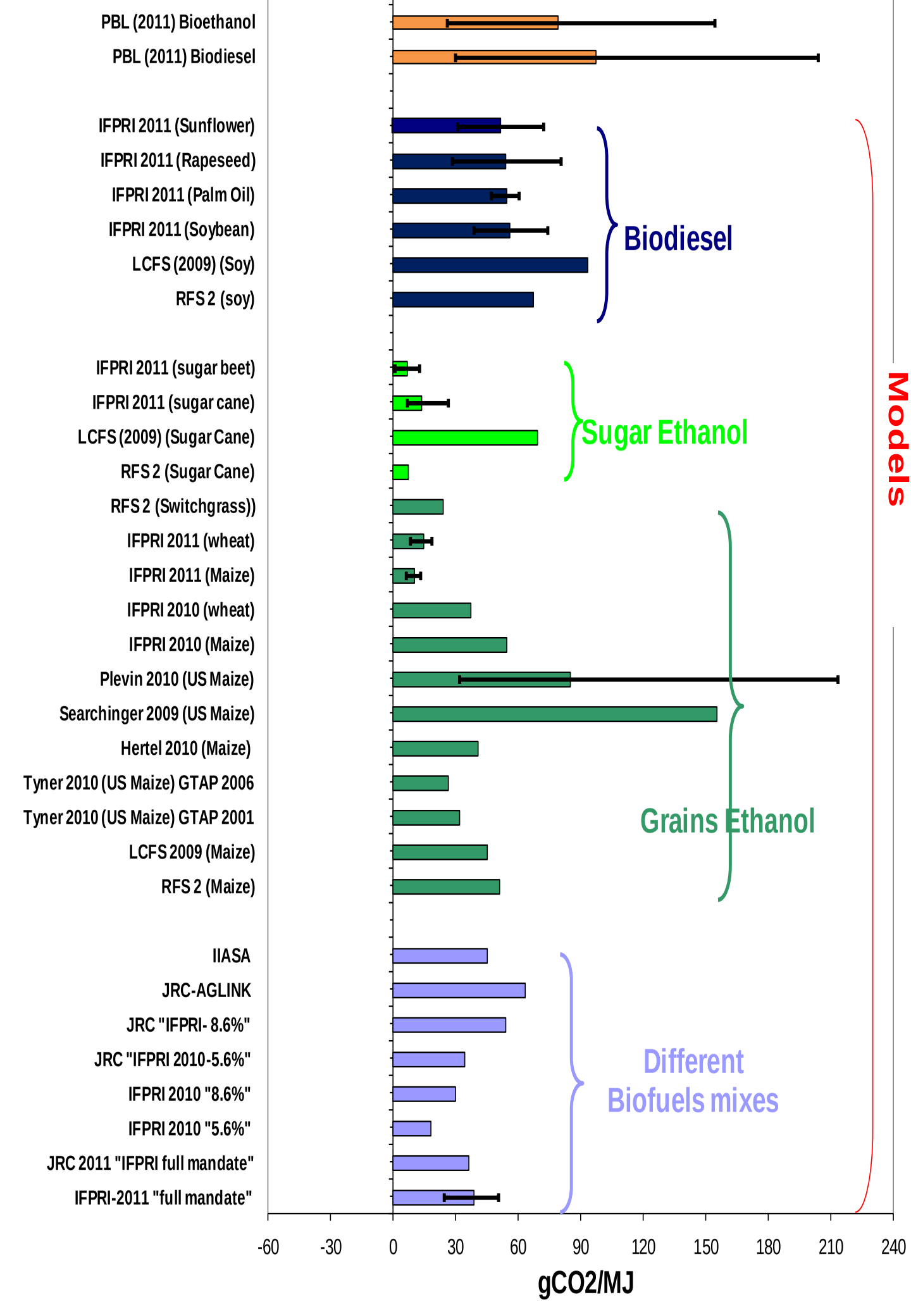
higher crop yields

crop area expansion

economic model

land emissions model

emissions from land use change


PBL (2011) Bioethanol
PBL (2011) Biodiesel
IFPRI 2011 (Sunflower)
IFPRI 2011 (Rapeseed)
IFPRI 2011 (Palm Oil)
IFPRI 2011 (Soybean)
LCFS (2009) (Soy)
RFS 2 (soy)
Biodiesel
IFPRI 2011 (sugar beet)
IFPRI 2011 (sugar cane)
LCFS (2009) (Sugar Cane)
RFS 2 (Sugar Cane)
Sugar Ethanol
RFS 2 (Switchgrass))
IFPRI 2011 (wheat)
IFPRI 2011 (Maize)
IFPRI 2010 (wheat)
IFPRI 2010 (Maize)
Plevin 2010 (US Maize)
Searchinger 2009 (US Maize)
Hertel 2010 (Maize)
Tyner 2010 (US Maize) GTAP 2006
Tyner 2010 (US Maize) GTAP 2001
LCFS 2009 (Maize)
RFS 2 (Maize)
Grains Ethanol
IIASA
JRC-AGLINK
JRC "IFPRI- 8.6%"
JRC "IFPRI 2010-5.6%"
IFPRI 2010 "8.6%"
IFPRI 2010 "5.6%"
JRC 2011 "IFPRI full mandate"
IFPRI-2011 "full mandate"
Different Biofuels mixes
Models
-60
-30
0
30
60
90
120
150
180
210
240
gCO2/MJ

JRC MODELS COMPARISON

To compare model results we at least need to compare the results per unit quantity of biofuel, vs. baseline (no policy)

JRC elicited estimates of marginal LUC ha per extra ("marginal") Mtoe of:

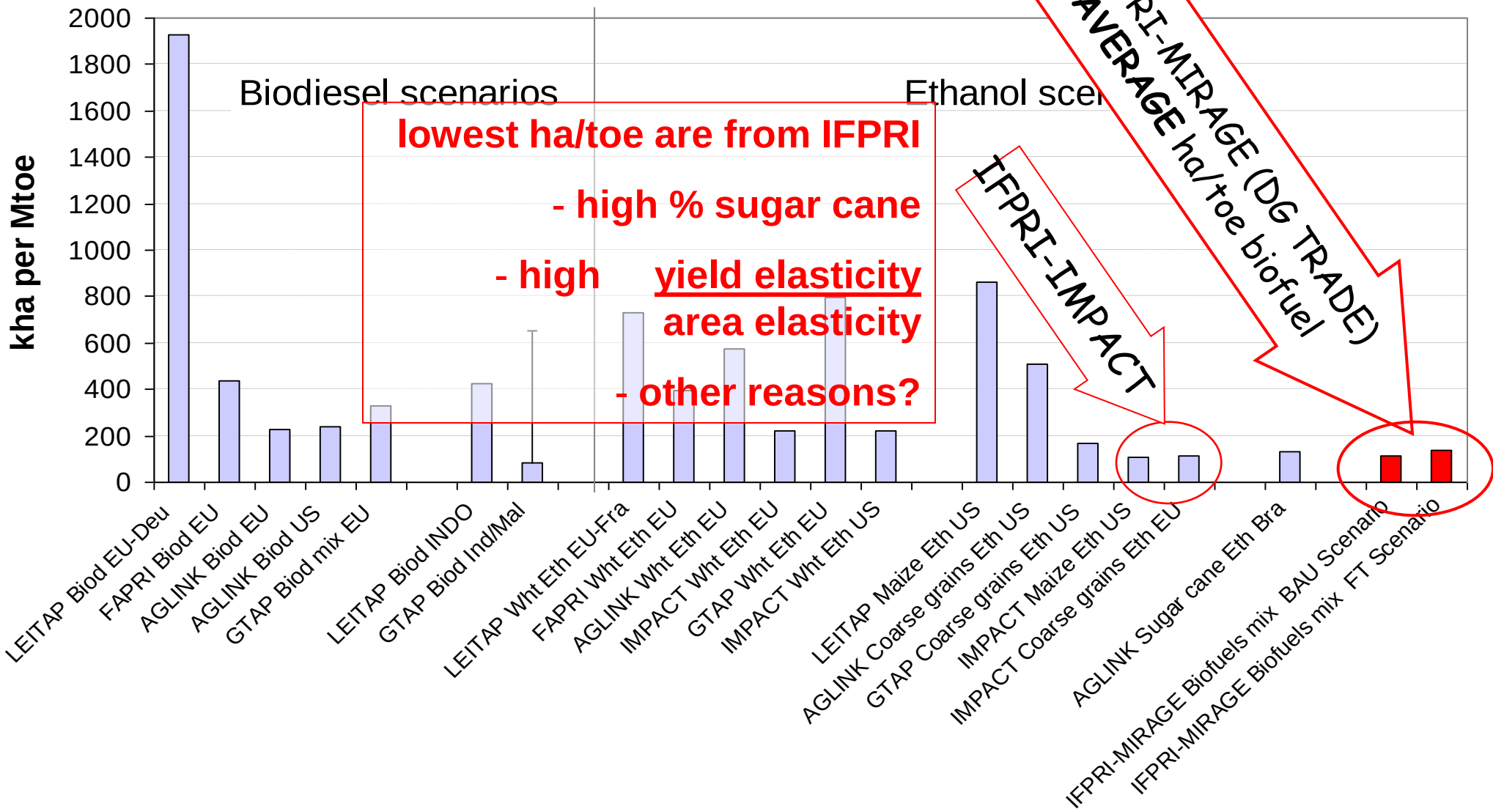
- ethanol from EU crops
- biodiesel from EU crops
- ethanol in US
- Some models also gave results for: palm oil biodiesel
  sugar cane ethanol

…All using the models' existing parameters
…and compared to the model's **existing** baseline.

Institution: model

FAPRI (US): CARD
LEI (EU): LEITAP
PURDUE (US): GTAP
LEI/JRC: CAPRI (EU-only)
IFPRI(US): IMPACT
OECD: AGLINK-COSIMO
LCAssociates (US): GTAP

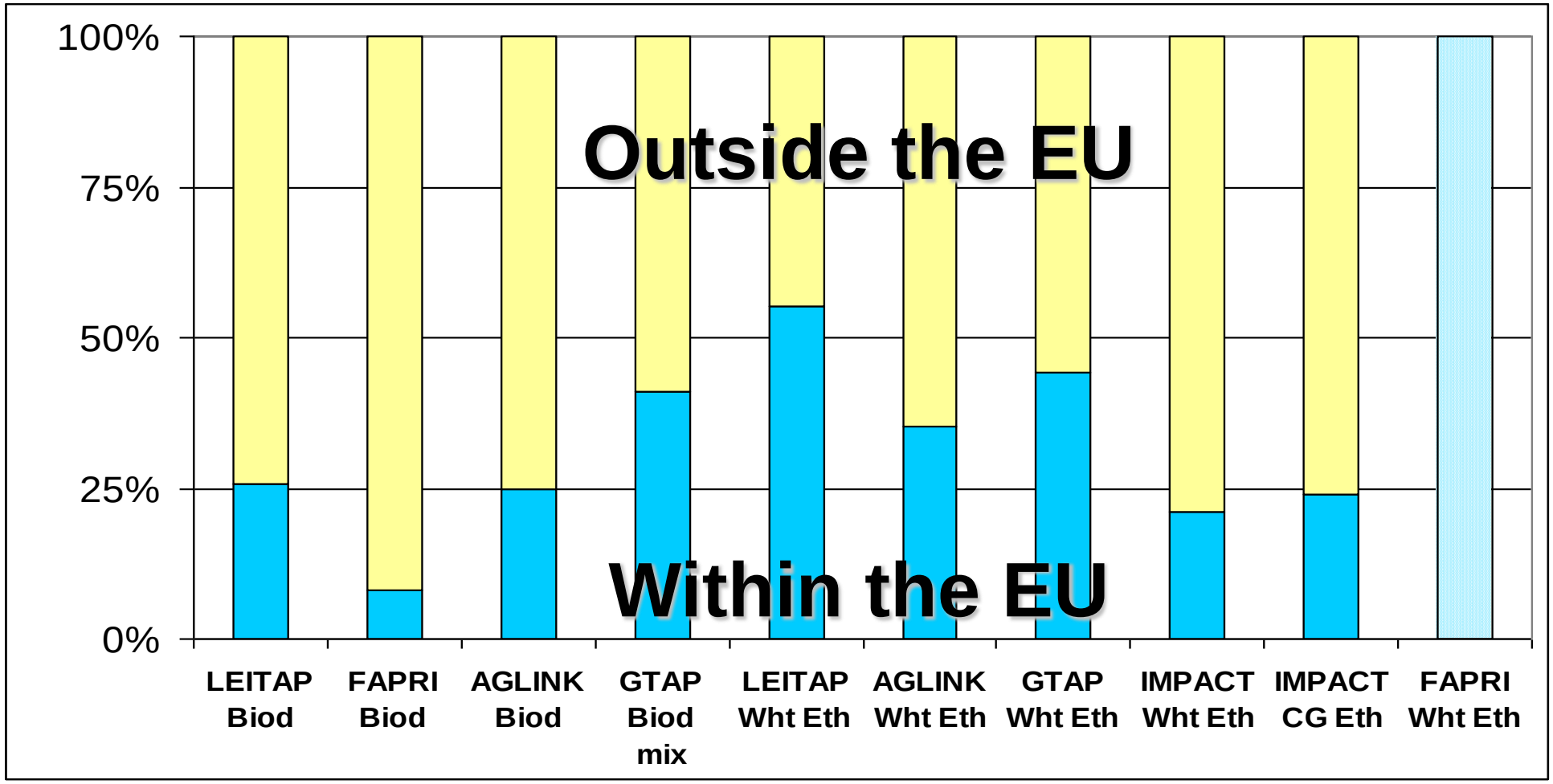
ILUC area in JRC model comparison



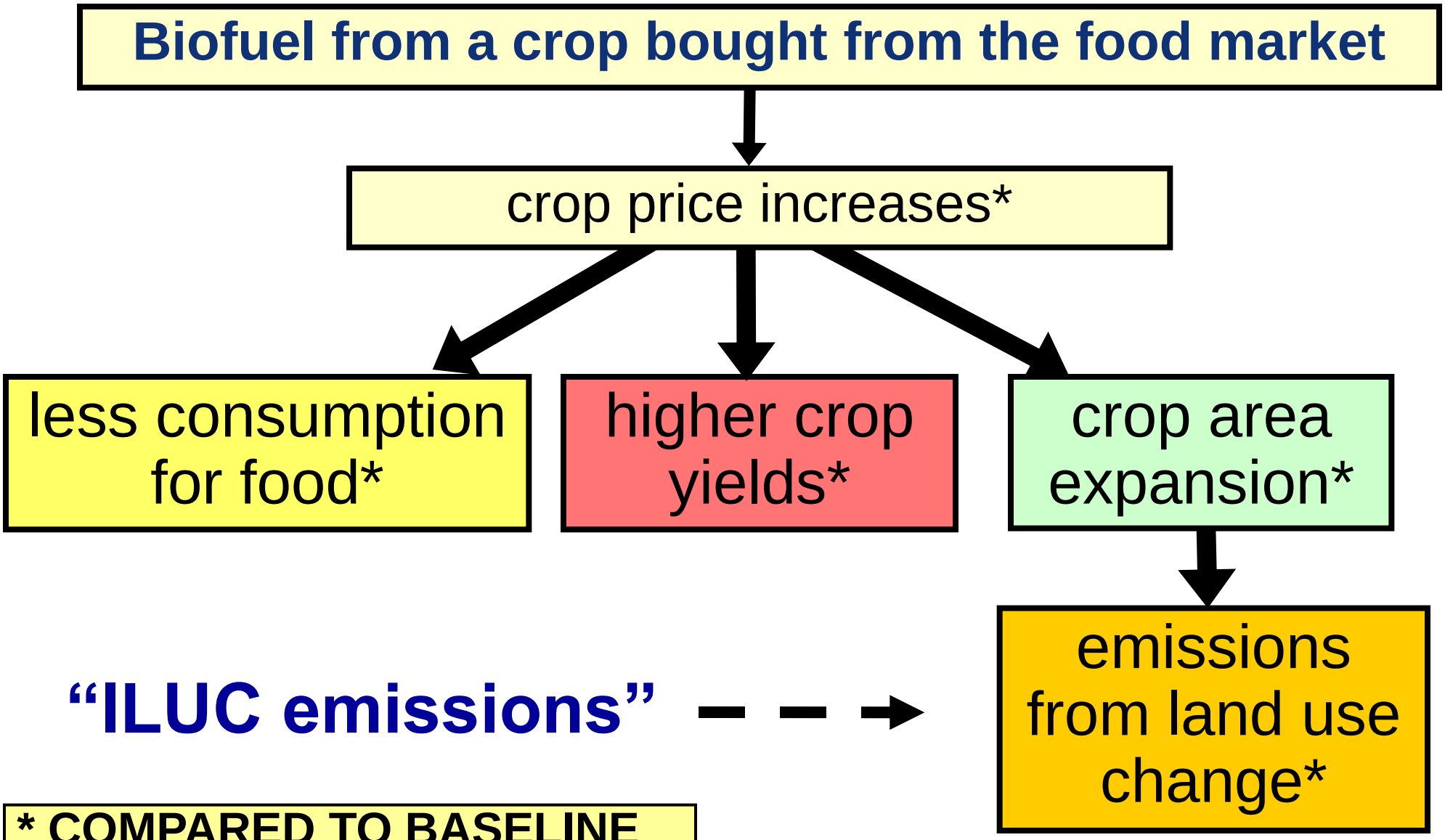
All models show significant land use change

Results: where ILUC occurs

For EU biofuels most land use change is outside EU

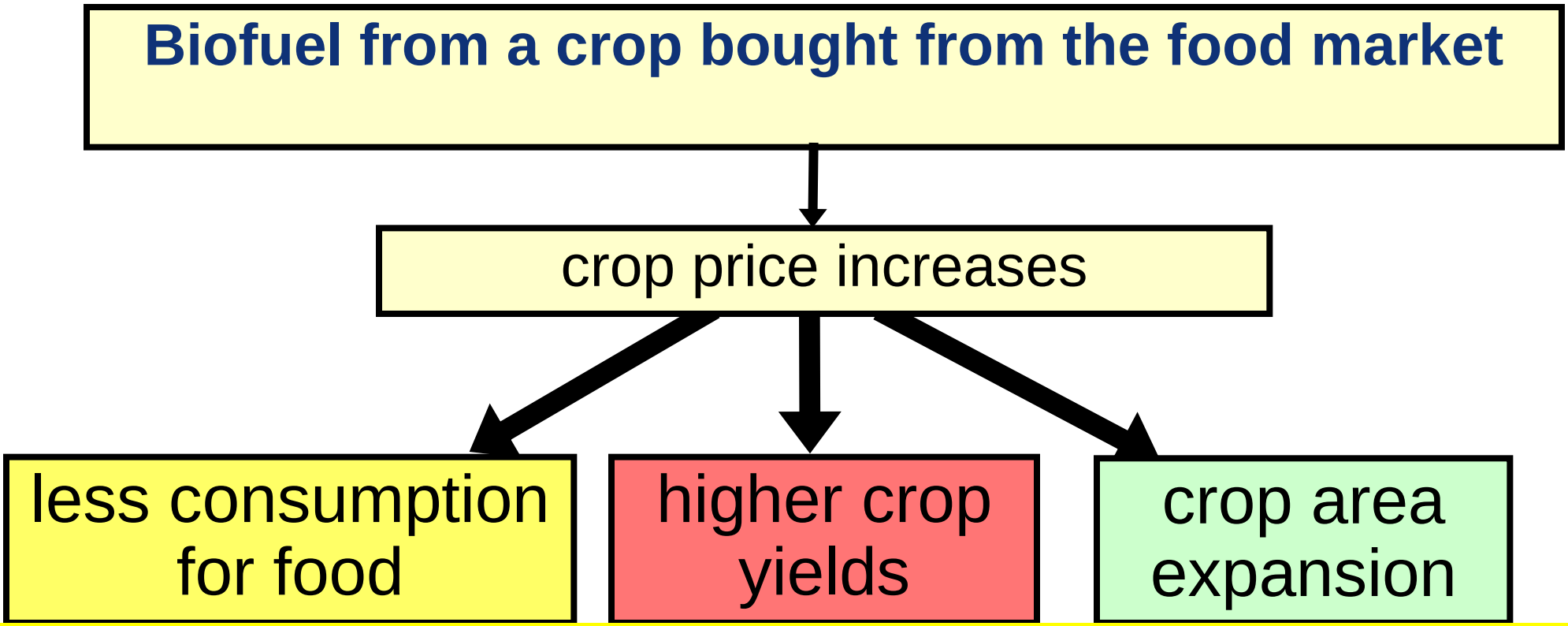


How models estimate ILUC emissions



*** COMPARED TO BASELINE**

How models estimate ILUC emissions



The crop used for biofuels must come from one of these 3 sources

How models estimate ILUC emissions

Biofuel from a crop bought from the food market

crop price increases

NO PRICE INCREASE = NO ILUC = NO BIOFUELS

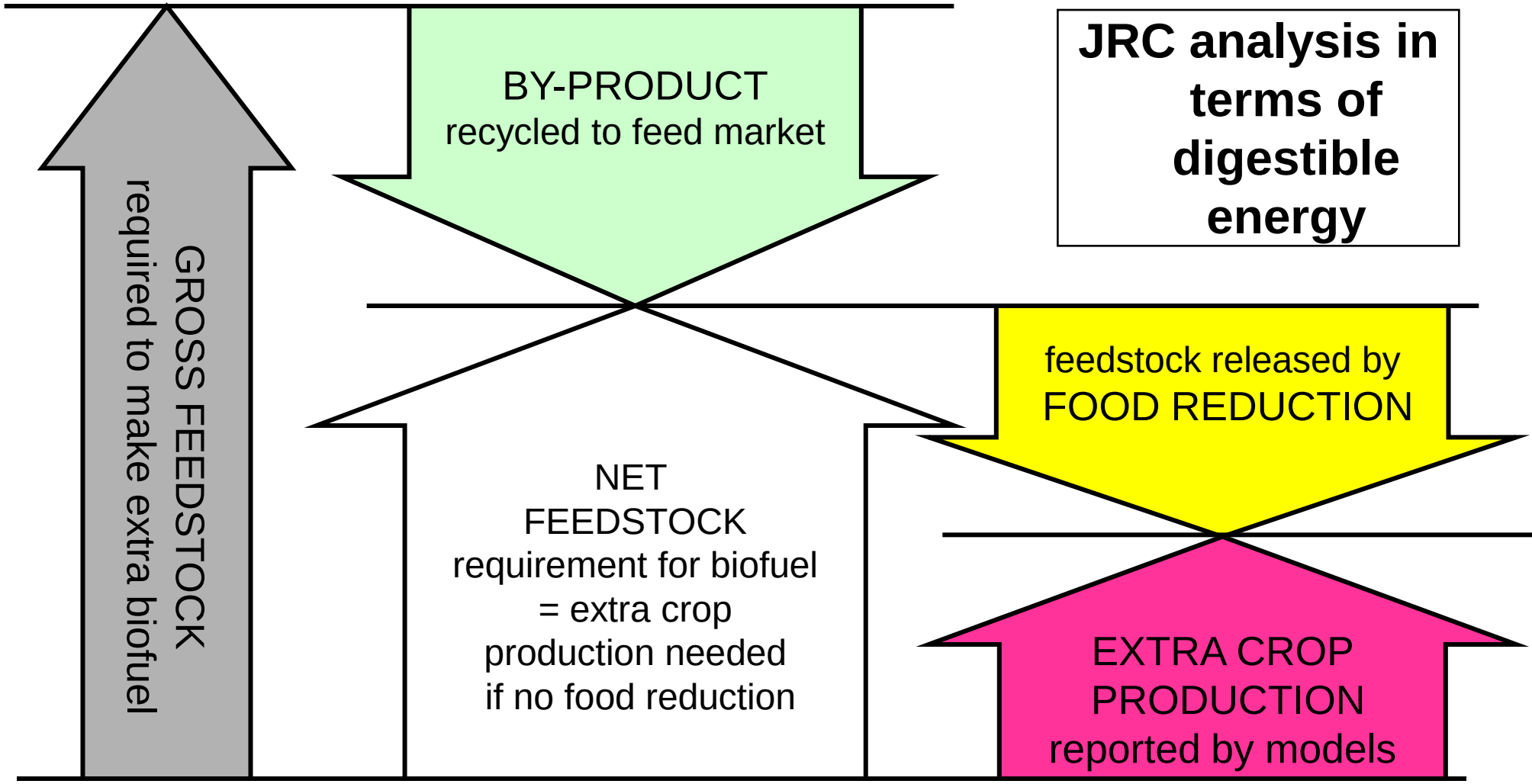
less consumption for food

higher crop yields

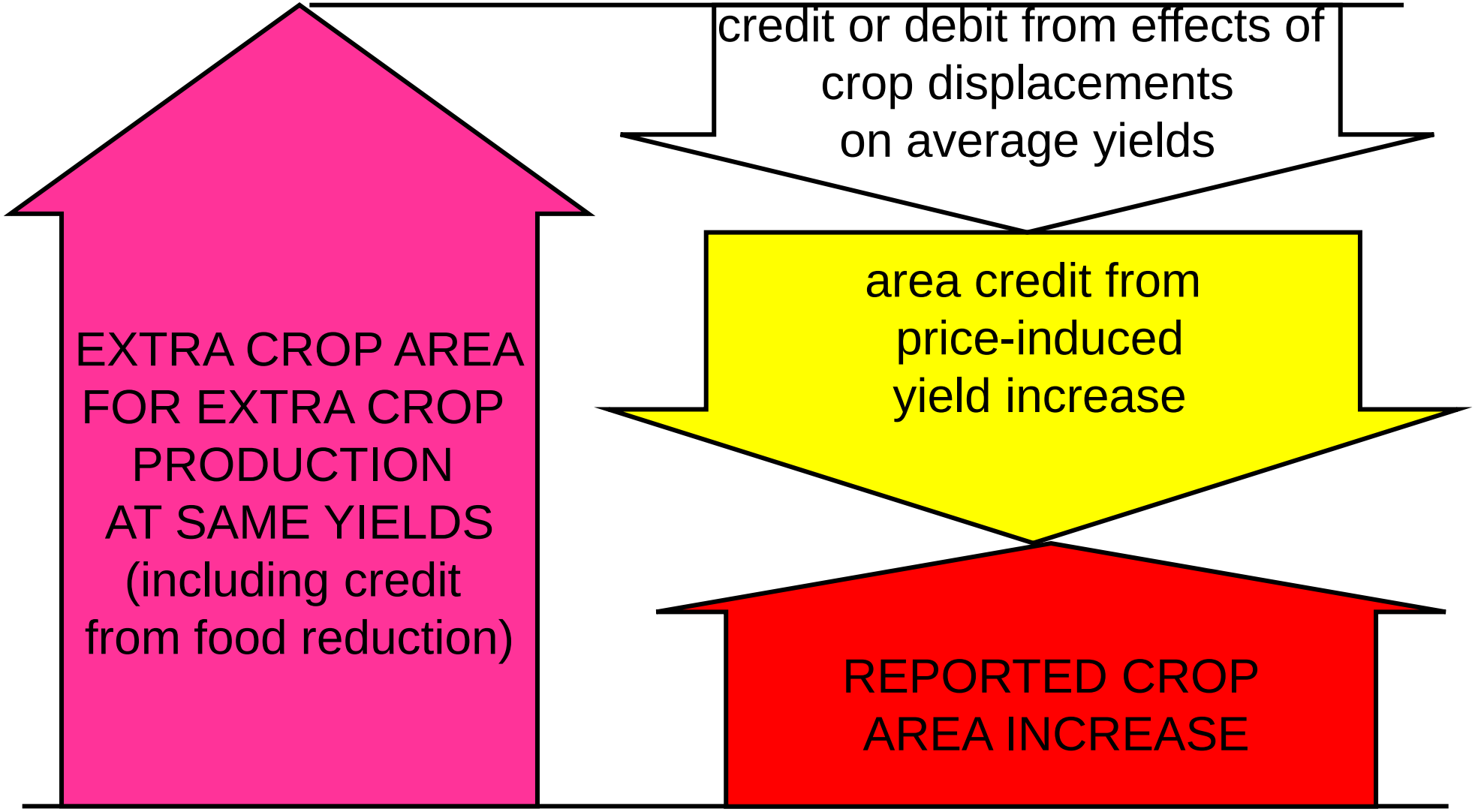
crop area expansion

The crop used for biofuels must come from one of these 3 sources

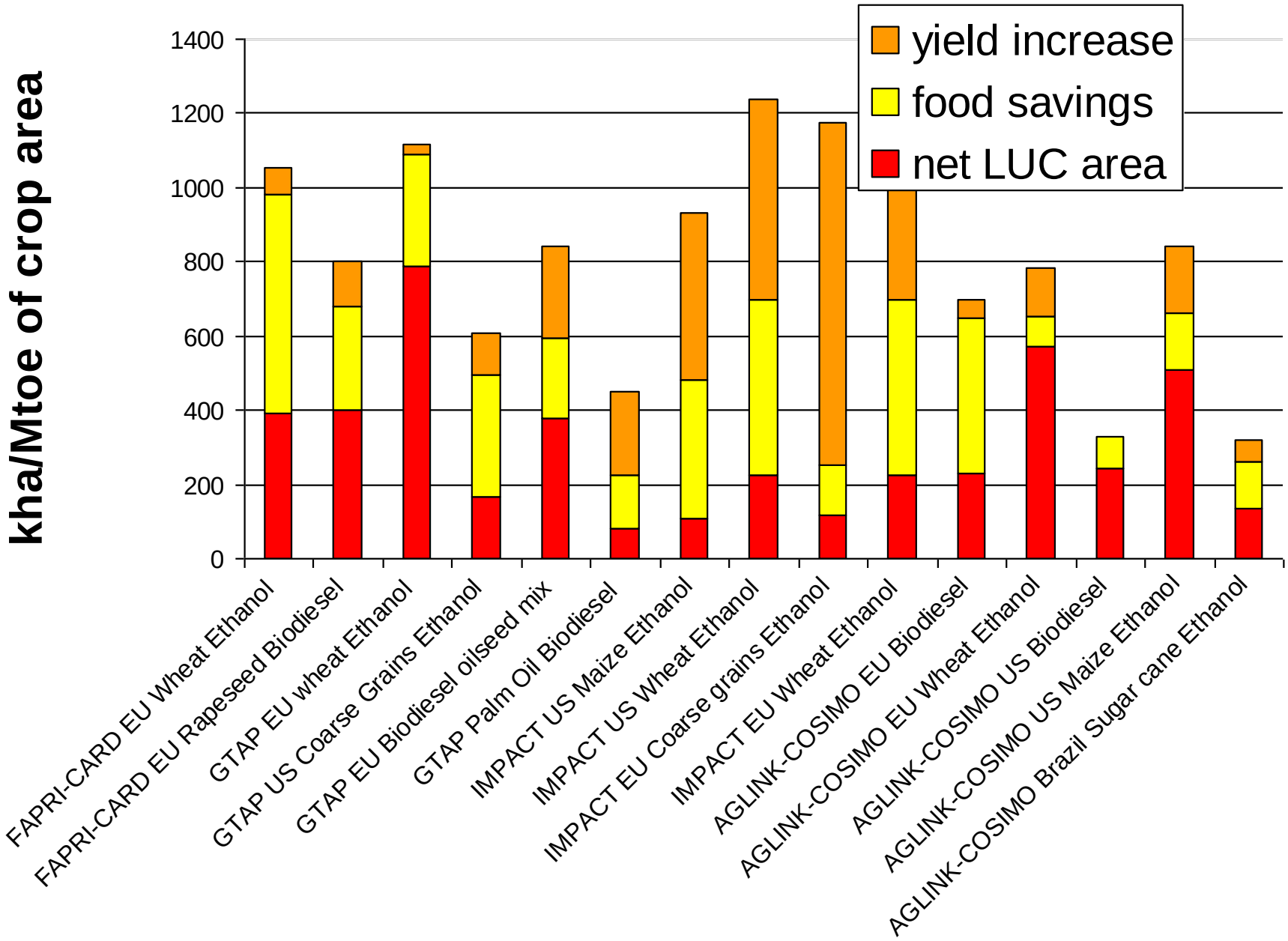
where do models say net biofeedstock comes from?



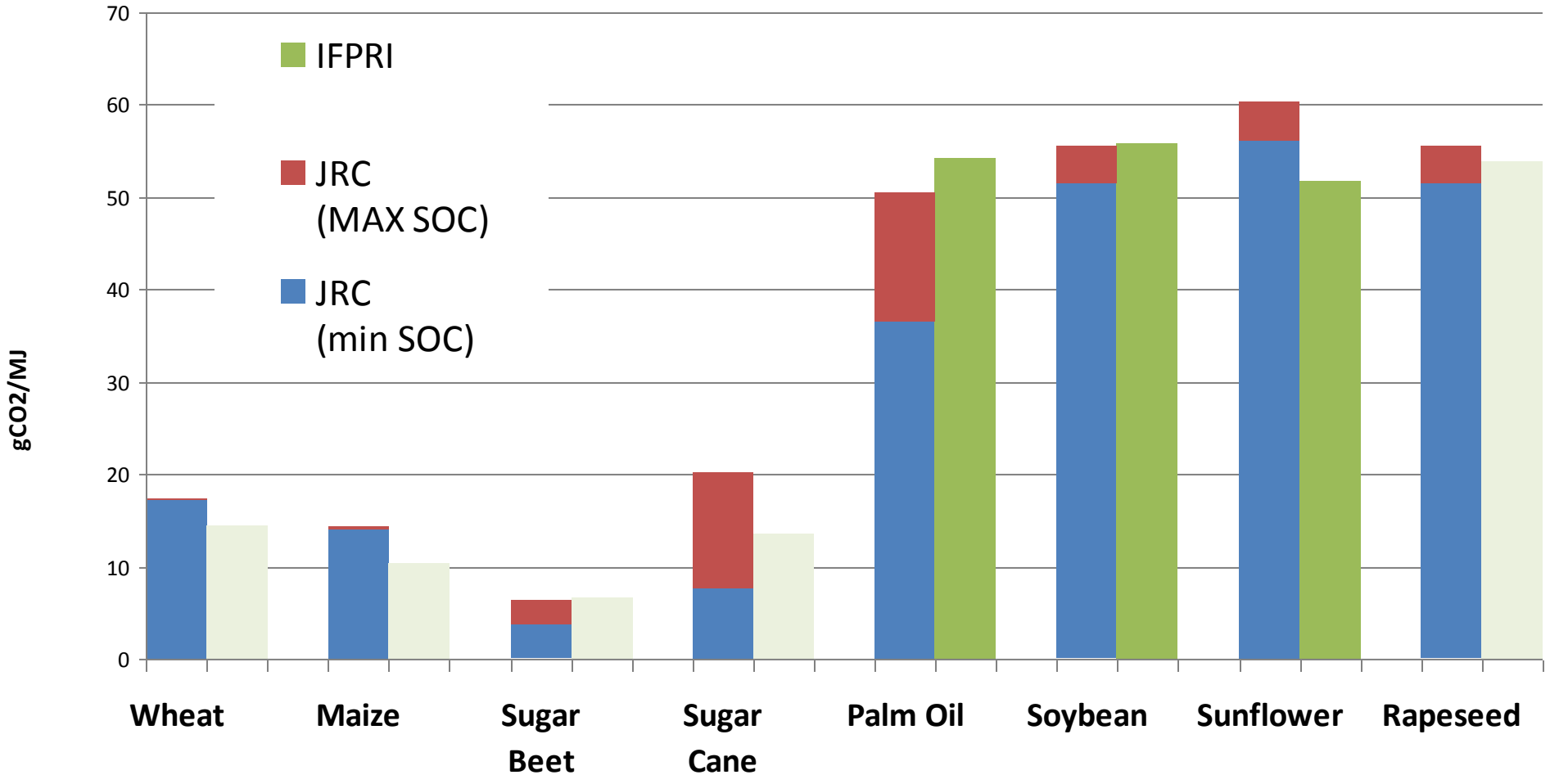
+ ….JRC's breakdown in terms of crop area



Food-reduction credit and yield increases effects

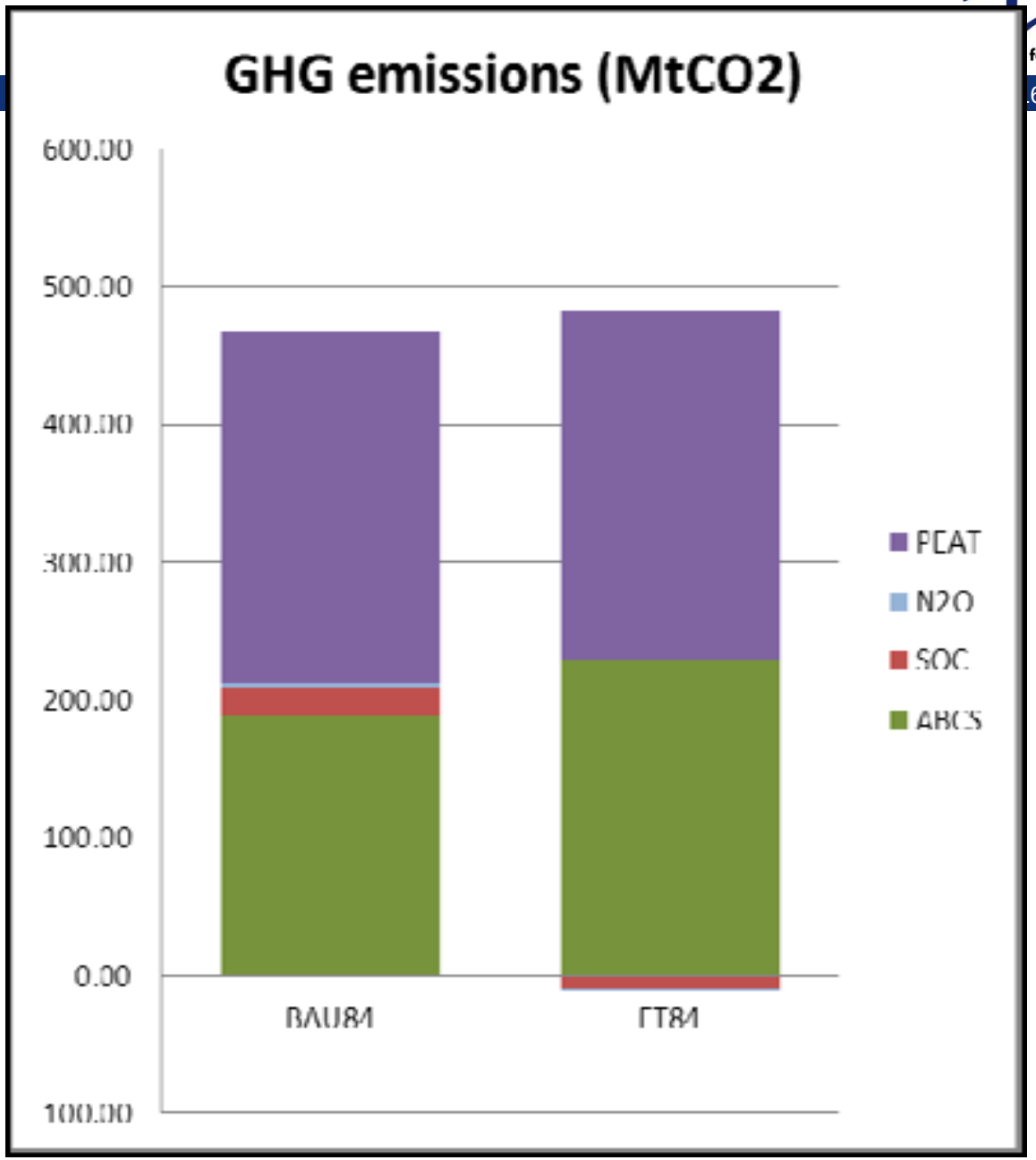


JRC vs IFPRI LAND ALLOCATION



PEAT DRAINAGE

NOW ACCOUNTS FOR ~HALF OF TOTAL EU BIOFUEL ILUC EMISSIONS!



ALTERNATIVE ILUC APPROACHES: HISTORICAL

[Overmaars et al. 2011] (Netherlands Environment Assessment Agency PBL)

- for EU biodiesel from rapeseed/canola

- **EU rapeseed energy-yield**
- **Big range of by-product credits**

} tonnes of crops displaced

2 assumptions: crops displaced inside region

OR crops displaced in world (single world market)

Historical ratios $\frac{\Delta \text{ yield}}{\Delta \text{ area}}$ $\frac{\Delta \text{ forest}}{\Delta \text{ pasture}}$

Database of Carbon emissions from land use change

ALTERNATIVE ILUC APPROACHES: HISTORICAL

[Overmaars et al. 2011] (Netherlands Environment Ass ent Agency PBL)

- for EU biodiesel from rapeseed/e

- **EU rapeseed energy-yield**
- **Big range of by-product credits**

Biggest uncertainty

es of crops displaced

2 assump

narket)

Historical

e

Data

ge

idea from IASA:

“ Allocate ILUC to by-products by energy allocation (the same way EU legislation allocates direct emissions to by-products)”

UNCERTAINTIES IN ALL MODELS

Reasons why models may overestimate ILUC emissions

- If trees from deforestation are sold, not all the carbon loss should be attributed to biofuels
- Some models do not adequately value by-products

Reasons why models may underestimate ILUC emissions

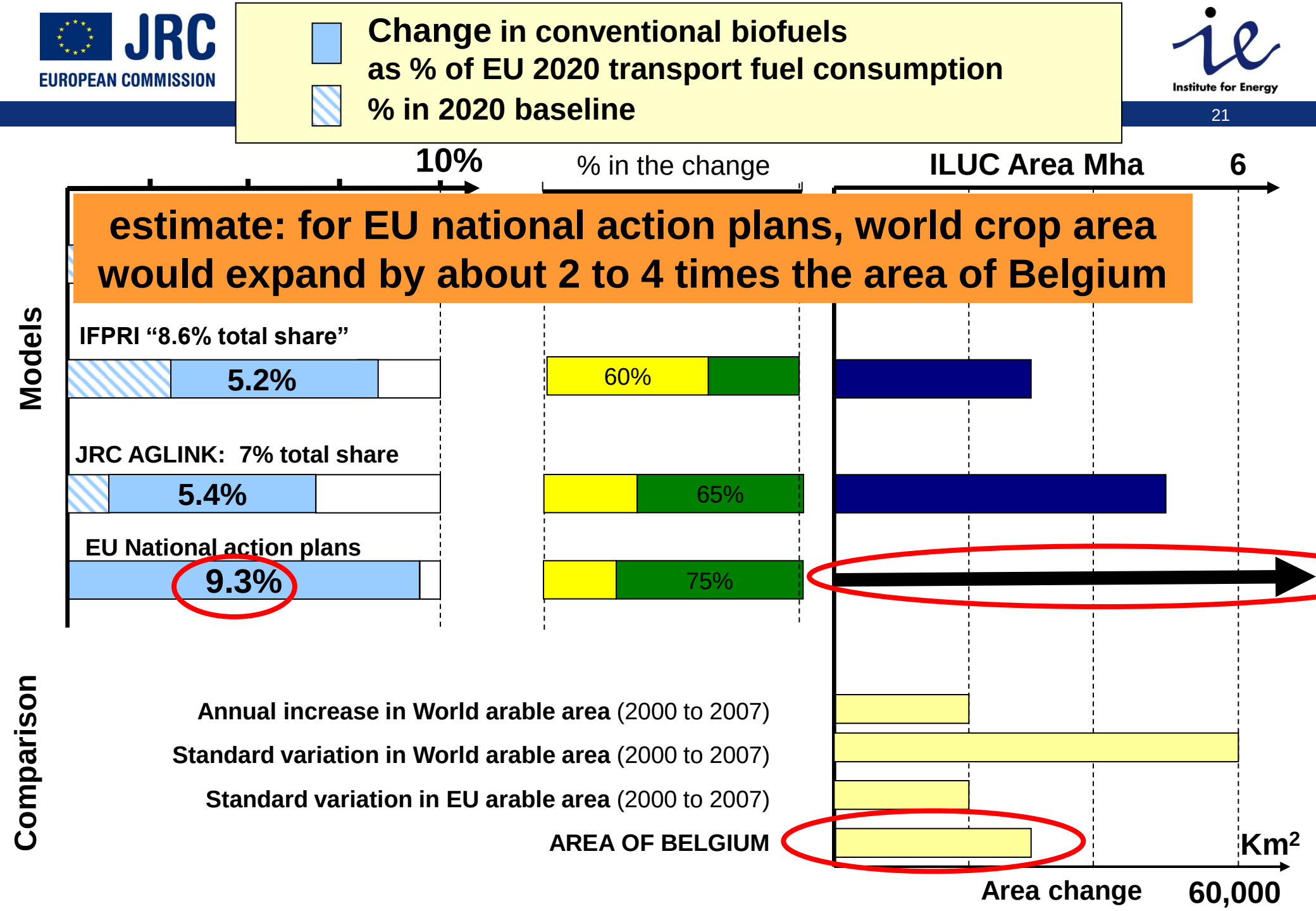
- Emissions from tropical peat drainage
- All models (except GTAP) assume yield on new land to be (nearly) the same as the average yield. It is often much lower.
- Extra emissions from yield intensification (fertilizer etc.)
- Higher animal feed costs shifts meat production to ranches, but ranch area is not considered in most models
- Models attribute to biofuels the GHG benefits of eating less food

Uncertainties which could go either way

- Uncertainties in the datasets for global land use changes the fraction of forest
- Structural changes are typically difficult to predict by economic models

END

next: odd slides for answering questions


Change in conventional biofuels
as % of EU 2020 transport fuel consumption
% in 2020 baseline
10%
% in the change
ILUC Area Mha
6
estimate: for EU national action plans, world crop area would expand by about 2 to 4 times the area of Belgium
Models
IFPRI "8.6% total share"
5.2%
60%
JRC AGLINK: 7% total share
5.4%
65%
EU National action plans
9.3%
75%
Comparison
Annual increase in World arable area (2000 to 2007)
Standard variation in World arable area (2000 to 2007)
Standard variation in EU arable area (2000 to 2007)
AREA OF BELGIUM
Km²
Area change
60,000

Models treat GHG savings which are due to less food consumption as a benefit of biofuel use.

Is that the right thing to do?

modeling in terms of emissions

"savings from global livestock: - 48gCO2e/MJ ethanol"

The argument goes…

"Biofuels increase feed prices *Liska and Perrin 2009*

→*meat gets more expensive*

→*people (esp. in China etc.) eat less meat*

→*meat has a very high **average** carbon footprint*

→*therefore biofuels save GHG from less meat"*

- so biofuels get a credit for people eating less
- actually, higher cattle feed prices makes **intensive** meat production more expensive, encouraging cattle ranching, which has much higher emissions per kg meat. **So the meat-emissions could actually increase because of bioethanol.**

CONCLUSIONS

1. **Even with uncertainties, the most likely value for ILUC is clearly significantly above zero (JRC expert workshop conclusion).**
2. **It can only be calculated from models**
3. **Models show consistent variations of emissions with crop type**
4. **Directives are often based on uncertain data** (e.g. the direct emissions in RED for some biofuels used IPCC N_2O emissions with a factor 9 uncertainty)
5. **Uncertainties in models can be handled with Monte-Carlo analysis**
6. **IFPRI results for the Commission are at the low end of the range**
7. **Models should converge in future**

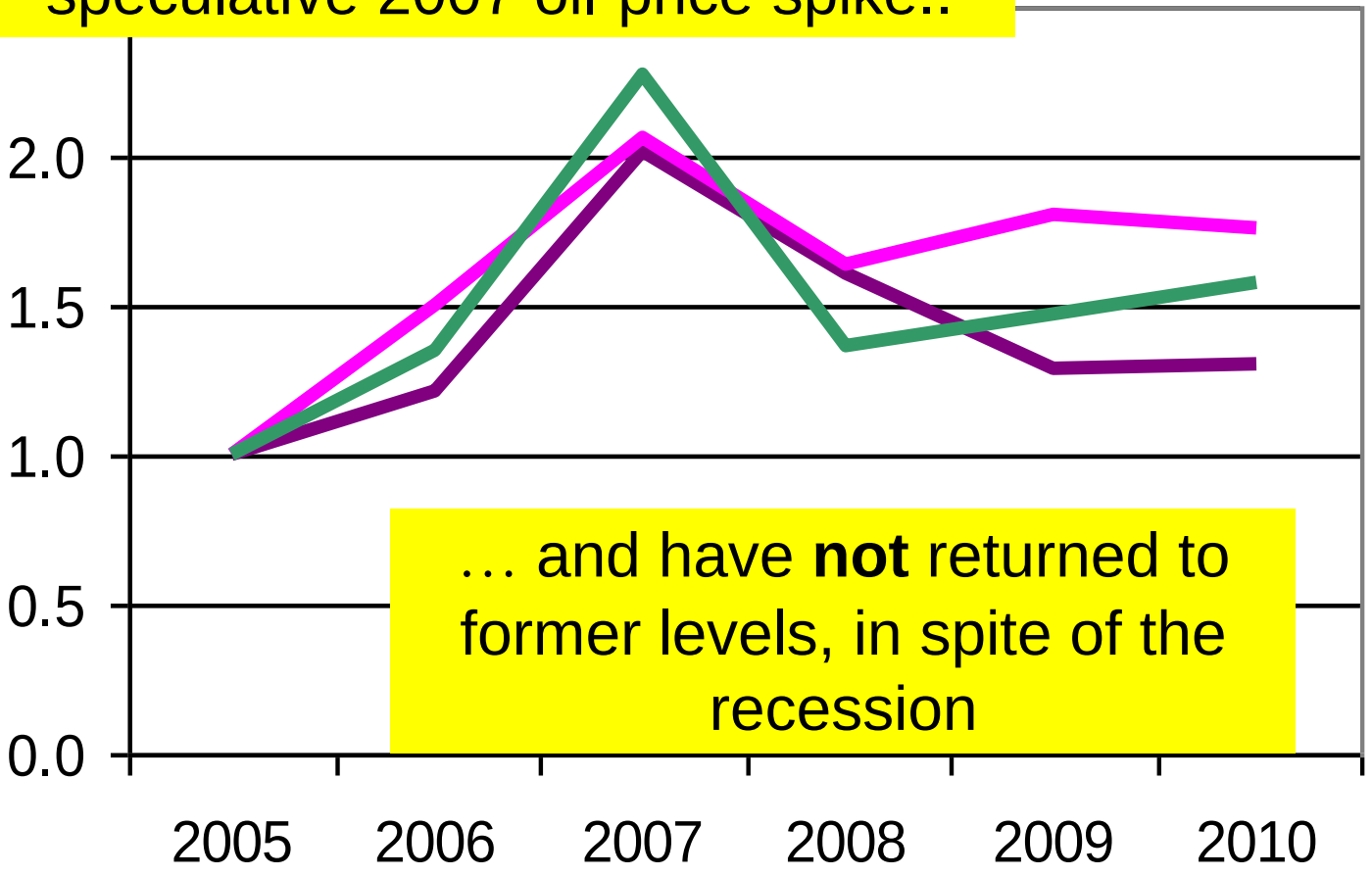
- the ratio of yield/area changes should make sense historically
- savings by food reduction should be eliminated anyway
- reporting of land use changes will reduce certainty in % forest

FOOD PRICE SPIKE

biofuels have already increased crop prices

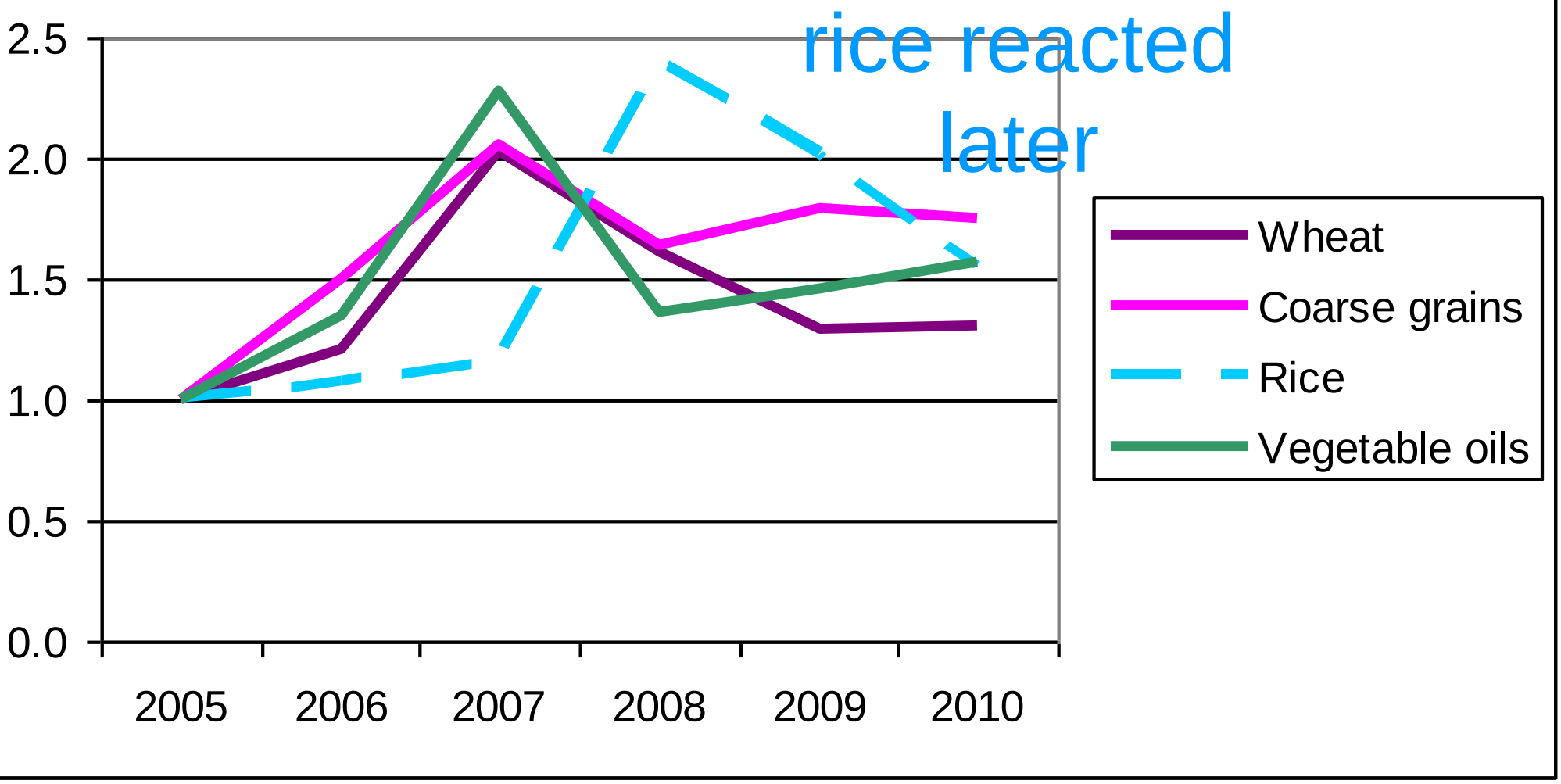
changes in crop prices (2005=1)

biofuels feedstocks tracked the speculative 2007 oil-price spike..



… and have **not** returned to former levels, in spite of the recession

biofuel feedstock prices are now linked to oil price



E4 tech

The E4tech study is valuable. It only has the problem that 4 separate problems coincide in the EU-wheat ethanol scenario

E4tech assume that almost all extra production in EU comes from higher yield in the biofuel scenario (historical extrapolation).

But there is no limit: if you ask for 200% more crop, you get 170%(?) more yield automatically!

For EU wheat scenario they get a 12% higher average wheat yield in EU, compared to no biofuels *in the same year.* **That would require an incredible price increase, according to all estimates of yield elasticity.**

The rate of yield increase per year doubles: that means at least double the crop price.

“almost all stakeholders agreed” (almost all stakeholders were from biofuels or farming industry)

2. The area of "otherwise abandoned" EU land is calculated assuming it has EU-average wheat yield. This underestimates the area required by at least a factor 2.

yields on abandoned land were less than half EU average:

1. **EU Land abandoned in the past decade was in counties with *national average* wheat yields ~65% of EU average [calc from EUROTAT data]**
2. **National data (UK 2004 farm survey) shows cereals yield on marginal UK farms is ~64% of UK average wheat yield.**
3. **The worst field on a farm has on average 63% of the average farm yield. (English farm survey 2004)**

0.65 x 0.64 x 0.63 = 0.18

Any 2 of these 3 factors more than doubles the amount of "abandoned land" required.

3. Very low values for foregone carbon sequestration by forest re-growth on abandoned EU land, due to reporting error by Winrock.

4. Strange baseline: abandoned arable land somehow appears in EU 2020 scenario by altering FAPRI 2020 scenario in an unclear way.

then, when their EU bioethanol demand is put back, it fits on “otherwise abandoned” EU land.

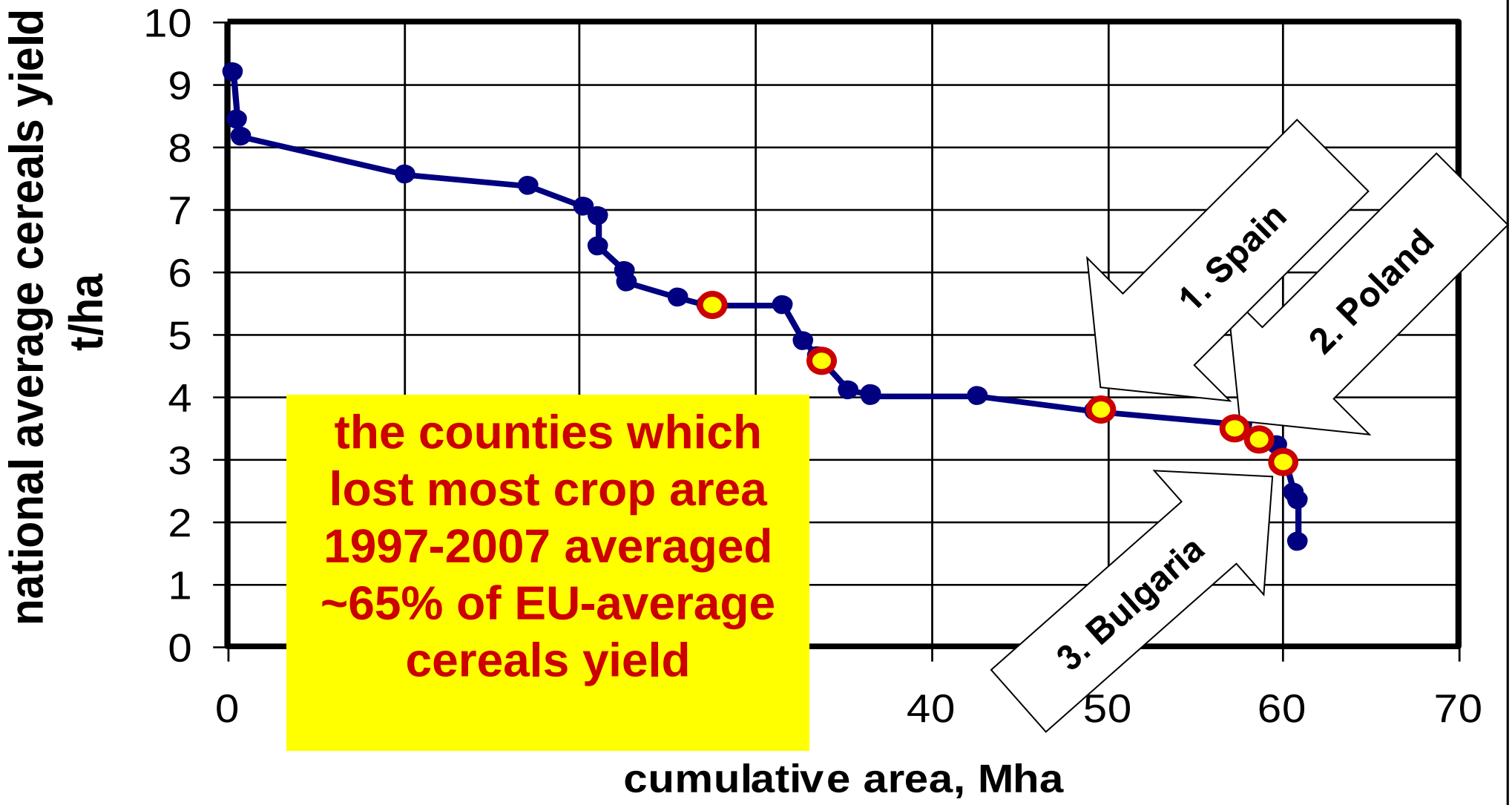
by contrast, all models** in JRC comparison show most LUC occurs *outside* EU.

E4Tech use imported wheat as a sensitivity but only in isolation from the other problems.

**** except for the FAPRI-CARD run for JRC, were this was *assumed* in the scenario set-up.**

MARGINAL YIELD SLIDES

national average cereals yields, vs. cumulative cereals area EU 2004



Main uncertainties [DG ENER "literature review"]

- Predictions on yield increases are uncertain
- Complex drivers for deforestation (attribution to logging; access)
- Uncertainties in the datasets for global land use
- Structural changes are typically difficult to predict by models

Why models do models underestimate emissions? (JRC)

- Neglecting emissions from tropical peat drainage (for palm oil)
- Yield on the extra-land is lower than average yield
- Extra emissions from yield intensification (fertilizer etc.)
- Meat production displaced to ranches, but ranch area is not considered in many models
- Models attribute to biofuels the GHG benefits of eating less food

JRC SPATIAL ALLOCATION

The JRC spatial allocation methodology

1. Use as input data agro-economic models results (IFPRI-MIRAGE and JRC AGLINK-COSIMO)

2. Locate geographically where the land use change predicted by models could occur, based on:

- Land suitability
- Existing cropland
- Land availability

3. Estimate the resulting GHG emissions: SOC (Soil Organic Carbon), N_2O (Nitrous Oxide), ABCS (Above and Below-ground biomass Carbon Stocks)

Higher resolution then previous models (~10 x 10 Km grids)

MARGINAL CRUDE

- Tar-sand crude costs ~40$/barrel to extract.

- Its output is limited by time to build the infrastructure, including permissions.

Marginal crude oil comes from more expensive projects:-

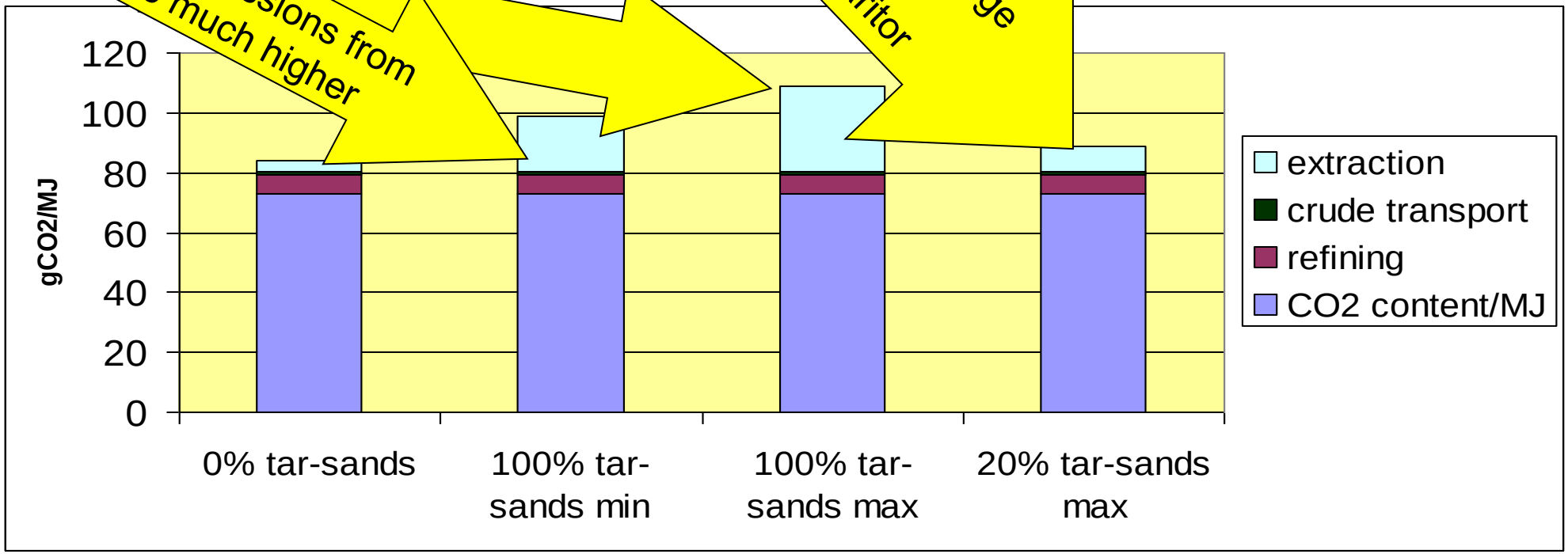
- small new oilfields
- technically-difficult fields (arctic, deepwater…)
- emissions for marginal-crude are actually lower than for average-crude

TAR-SANDS

- **Marginal crude oil probably will have more tar sands in the long term**
- **tar sands now 1% of … crude, (0.1% of EU crude imports)**
- **… 2035 will be 8% of wor… [IEA 2010]**

yes, **extraction** emissions from tar-sands are much higher

…but it will not make a huge difference to the fossil fuel comparitor



why does ILUC matter?

1. Overall policy may be increasing GHG emissions
2. We may be encouraging production of biofuels in ways that increase GHG emissions
3. We fail to send appropriate signals for innovation to biofuel industry
4. The GHG contribution foreseen from biofuel under the integrated approach will not be realised
5. The GHG intensity target for fuel set in the Fuel Quality Directive will not really be achieved

ILUC MISCONCEPTION:

"the ILUC area is less than the year to year variation in world crop area"

- For the full policy, it isn't
- anyway biofuels will not stop variations in crop price and area: they **just shift the variation to around a higher trend**
- that doesn't stop deforestation etc.

year to year variation in world crop area

(~ area of Hungary)