GAINING EVIDENCE TO SUPPORT THE DEVELOPMENT OF A SUSAINABLE AGRICULTURAL SYSTEM THAT WILL FEED AND FUEL 9 BILLION PEOPLE

Foresight, requirements, future work

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LONG TERM EXPERIMENTS PROVIDE EVIDENCE

– A KEY EXAMPLE FOLLOWS

1. AGRICULTURAL ENERGY BALANCES, 10-25 GJ/HA IN AND 50-450 GJ/HA OUT (A LITRE OF DIESEL CONTAINS APPROX 40 MJ)
2. IT IS NOT PERPETUAL MOTION! EVERY TONNE OF N (ORGANIC AND MINERAL) WILL ENABLE THE 'CAPTURE' OF 55GJ OF SOLAR ENERGY
3. DATA FROM KUSTERS ET AL 1999-2000, LONG TERM AGRI-TRIALS IN GERMANY. OTHER LT TRIALS EXIST FROM 1843!
   DO WE KNOW WHAT'S SUSTAINABLE- YES! CAN WE TRANSLATE COMPLEX STATS/DATA/EVIDENCE- MAYBE
4. THE SCALE OF OUR REQUIREMENTS IS IMPORTANT. HUMANKIND REQUIREMENT FOR ENERGY IS 13 TW, 90 000 TW HITS THE EARTHS SURFACE EACH YEAR, WE REQUIRED AROUND 5% OF THE LAND SURAFCE AREA (29%) TO CAPTURE 13 TW AT 1% EFFICIENCY (ABOUT THE SAME AS CEREAL CONVERSION OF SUNLIGHT TO BIOMASS, 1-3%)

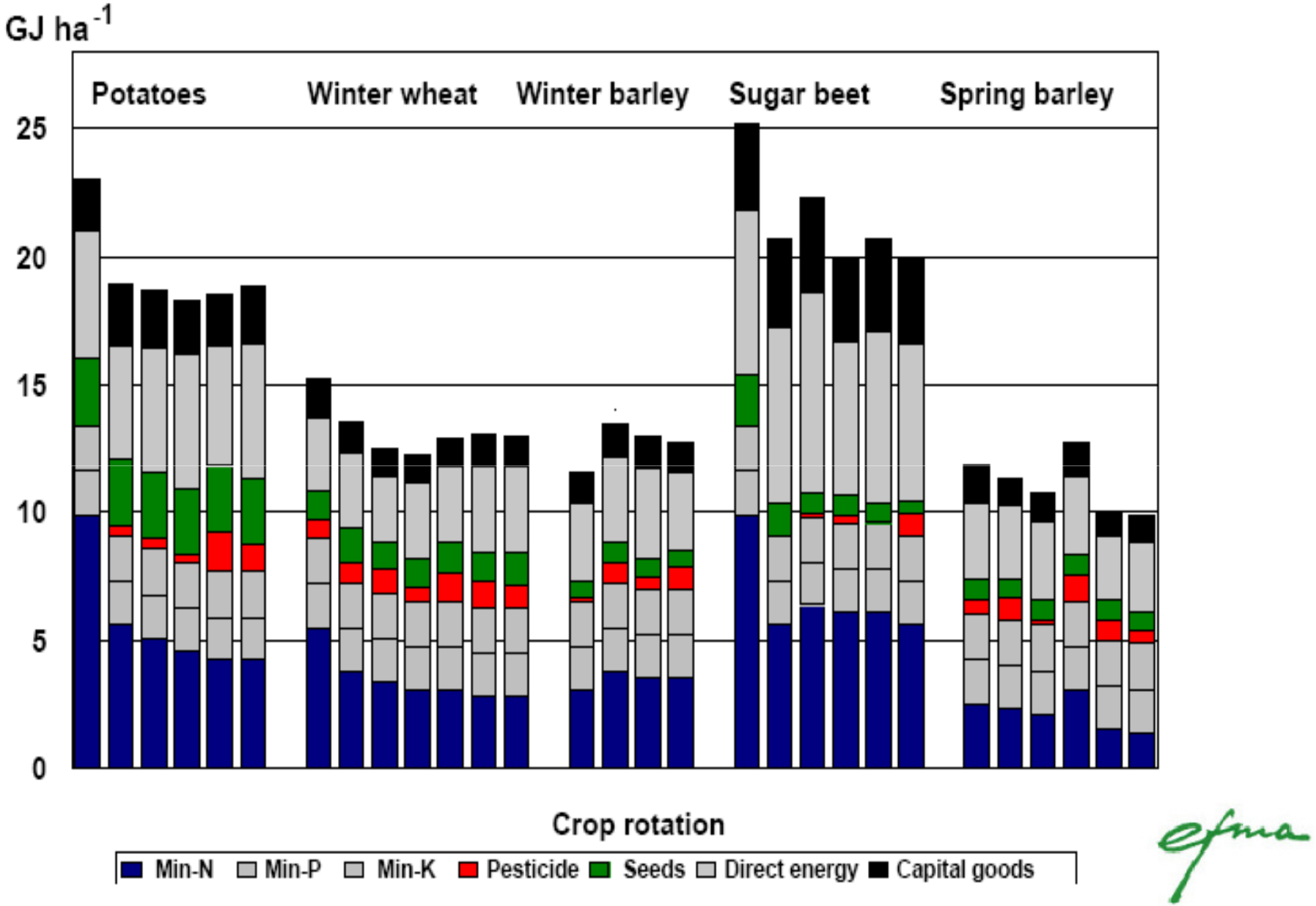

Fig. 5: Energy input (GJ ha^{-1}) in Leipzig-Seehausen

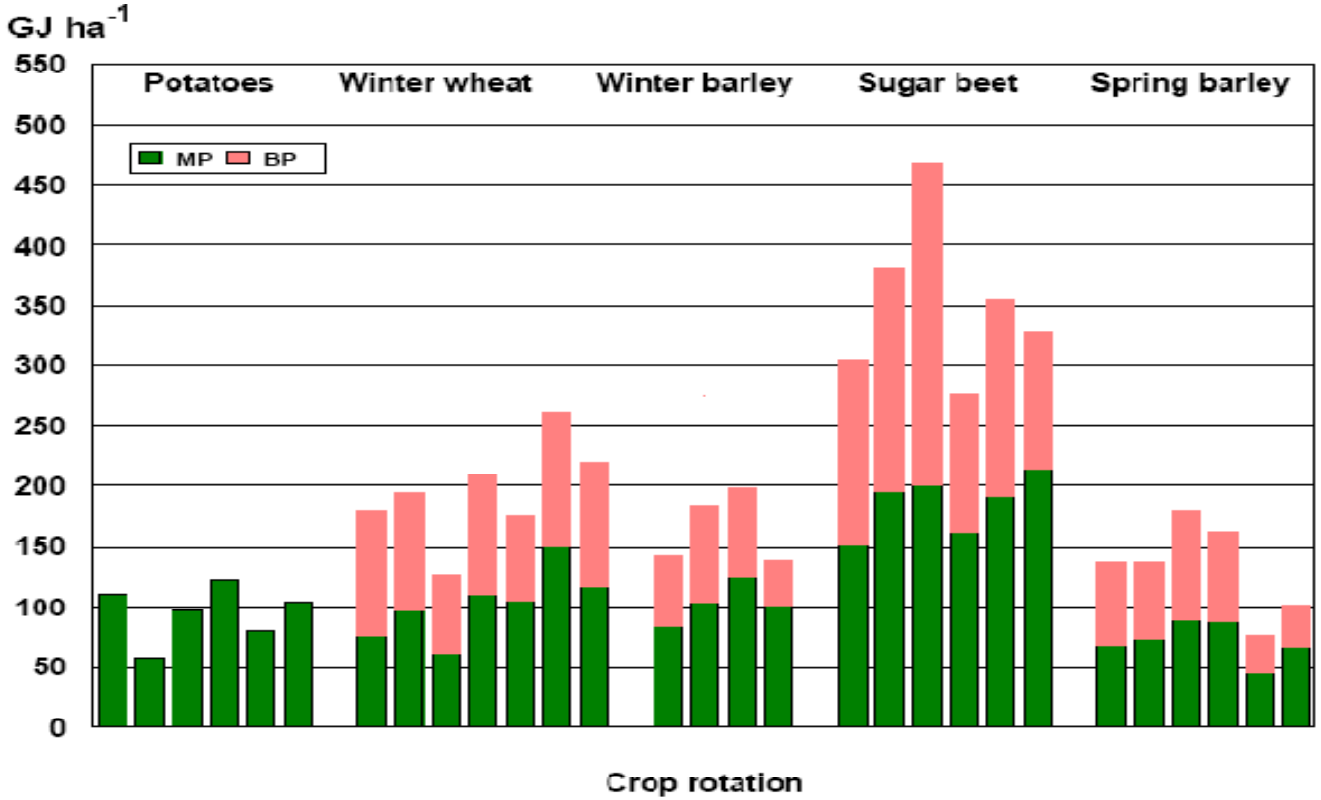

Fig. 9: Development of the energy output (GJ ha^{-1}) in the field experiment F1-70 in Leipzig-Seehausen (MP: main product; BP: byproduct)

See Küsters J. 1999. Life cycle Approach to nutrient and energy efficiency in European Agriculture. Proceedings of the International Fertiliser Society No. 438, and
Hülsbergen K-J and Kalk W-D. 2001 Energy Balances in Different Agricultural Systems - Can they be Improved? The International Fertiliser Society - Proceeding 476
Updated in later Efma/Martin Luther university paper
Citation, search - Biermann, S., Rathke, G.W., Hülsbergen, K.J. and Diepenbrock, W. (1999): Energy recovery by crops in dependence on the input of mineral fertilizer. Martin-Luther-Universität Halle-Wittenberg, Germany, EFMA, Brussels, Belgium.

REQUIREMENT TO ADD VALUE AND DEVELOP COPRODUCTS

1. DIESEL CONSUMPTION (SOIL CULTIVATION) AND NITROGEN INPUTS ARE A LARGE PART OF THE ENERGY INPUT (PREVIOUS FIGURES)
2. AGRONOMY MAKES IT CLEAR ROTATION, N MANAGEMENT (ORGANIC AND MINERAL) AND REDUCTION OF SOIL CULIVATION (FROM NO-TILL TO PLOUGH), IF/WHEN POSSIBLE SHOULD BE UTILISED
3. N IS NOT FREE IF IT COMES FROM MANURE, FEED TO CARCASS CONVERSION HAS 5% EFFICIENCY AND REQUIRES 13 KG OF FEED FOR EACK KG OF CARCASS (SMIL ET AL)
4. FARMERS AIM TO OPTIMISE ROTATION, N APPLICATION AND MINIMISE SOIL CULTIVATE, YOU DON'T PLOUGH FOR FUN!
5. MINERAL NITROGEN IS PRODUCED UTILISING 30 MJ FOR EACH KG OF AMMONIA, THE THEORETICAL MINIMUM REQUIRED TO FIX N IS 23 MJ/KG. 23% OF THE N HUMANS CONSUME IS FIXED INDUSTRIALLY (SMIL 1999)

OPTIMAL N APPLICATIONS RESULT IN LOWER ENERGY INTENSITY AND MAXIMAL YIELD FOR THE SYSTEM

1. NOTE: SOIL CULTIVATION AND HERBICIDE MANAGEMENT IS CRITICAL TO ENERGY INPUT – HERBICIDE RESISTANT CROPS MAY ENABLE THE UTILISATION OF NO- AND MIN-TILL RESULTING IN EFFICIENT SOIL CARBON CAPTURE AND ENVIRONMENTAL BENEFITS

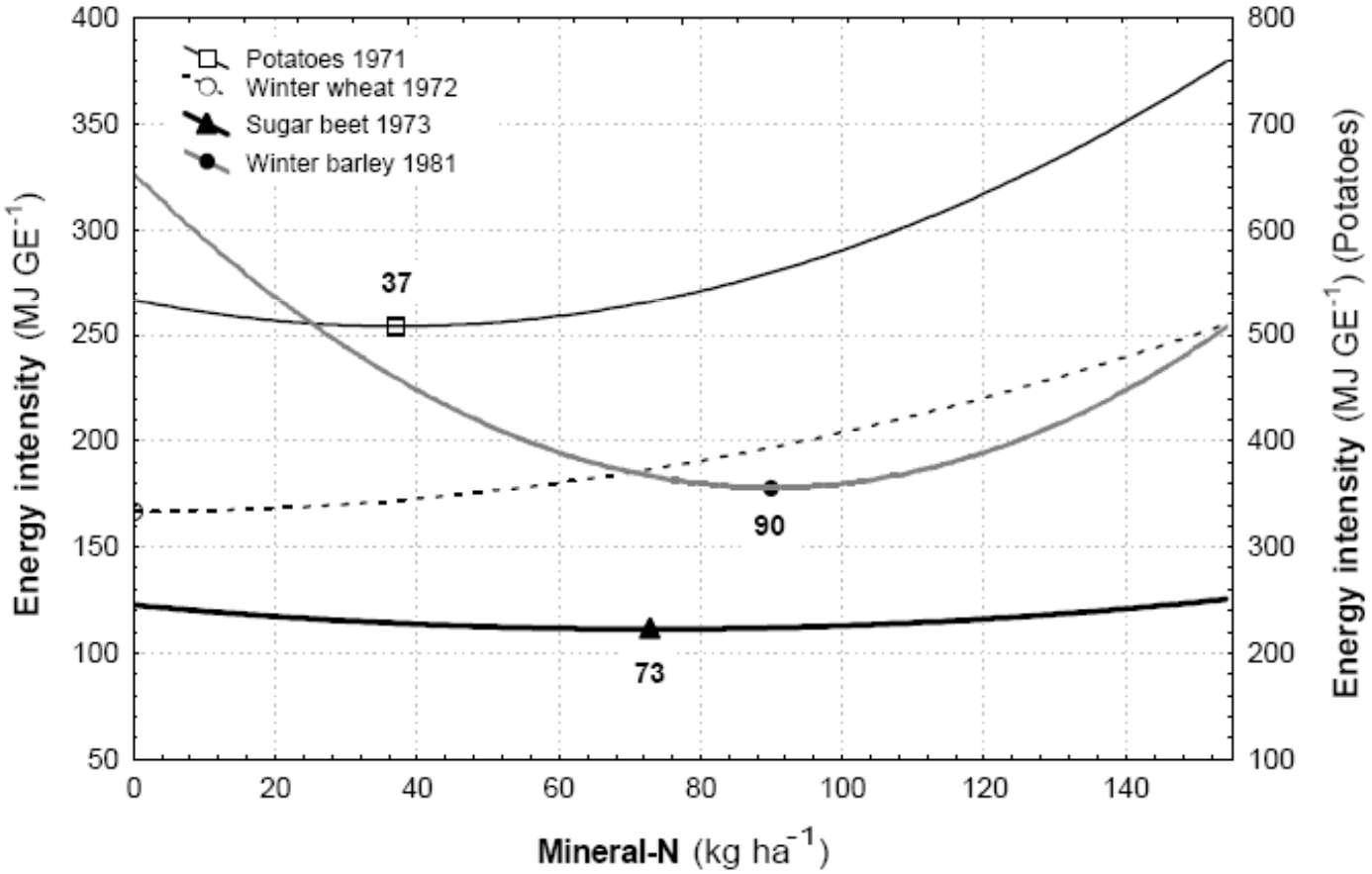

Fig. 16: Energy intensity (MJ GE^{-1}) in Leipzig-Seehausen 1971-1981

QuickBird, Toledo, Spain, 2 February, 2002, Pan-sharpened

CURRENT WORK

1. CURRENTLY DEVELOPING GIS AND REMOTE SENSING APPLICATIONS AND UNMANNED AERIAL VEHICLES TO IDENTIFY OPTIMAL AGRONOMIC OUTCOMES AND CROP STRESS- WATCH THIS SPACE (SEE ATTACHED GRAIN CHAIN ABSTRACT) WITH ROBOTICS AT SHEFFIELD HALLAM
2. DESCRIBED BIOFUEL-FOOD SYSTEMS ENERGY ANALYSES (LCAs)- SEE ATTACHED NATURE COMMENTARY WITH TREWAVAS (UNIVERSITY OF EDINBURGH)
3. PROJECT FLOW- MAPPED REGIONAL FOOD AND AGRICULTURAL PRODUCT SUPPLY CHAINS WITH THE REGIONAL FOOD GROUP- WATCH THIS SPACE
4. See http://spie.org/x32288.xml?ArticleID=x32288 Pablo J. Zarco-Tejada, J. A. J. Berni, L. Suárez, and E. Fereres