

Organic farming upscaling and food security : a review of modelling foresight studies

Introduction

Organic agriculture (OA) is receiving broader attention as a more sustainable type of agriculture but concerns have been raised regarding its low productivity in the event of its deployment. **We reviewed modelling studies of large-scale implementation of organic agriculture with a particular focus on the capacity of agricultural systems to provide sufficient food for domestic populations.**

The review set comprises a total of 23 studies, from subnational to global scale evaluating an OA expansion level from 44 to 100% (18 simulated full conversion).

Modelling modalities

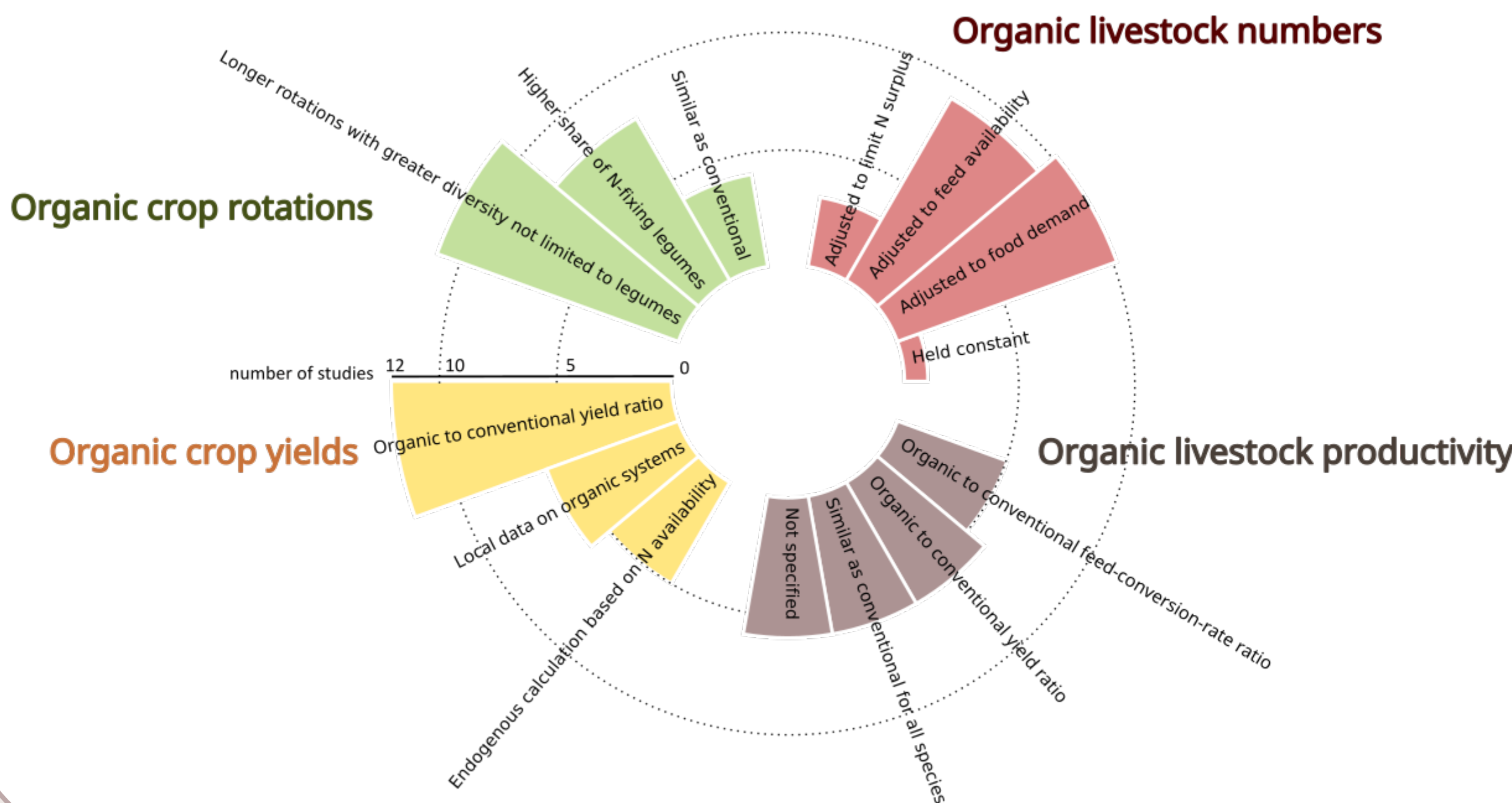


Figure 1. Modelling principles behind key parameters across the review set.

a) Changes in crop rotations compared to the conventional reference
b) Rules for adjusting livestock numbers
c) Method to estimate organic crop yields and d) method to estimated organic livestock productivity.

Simulated productivity of organic crops and livestock

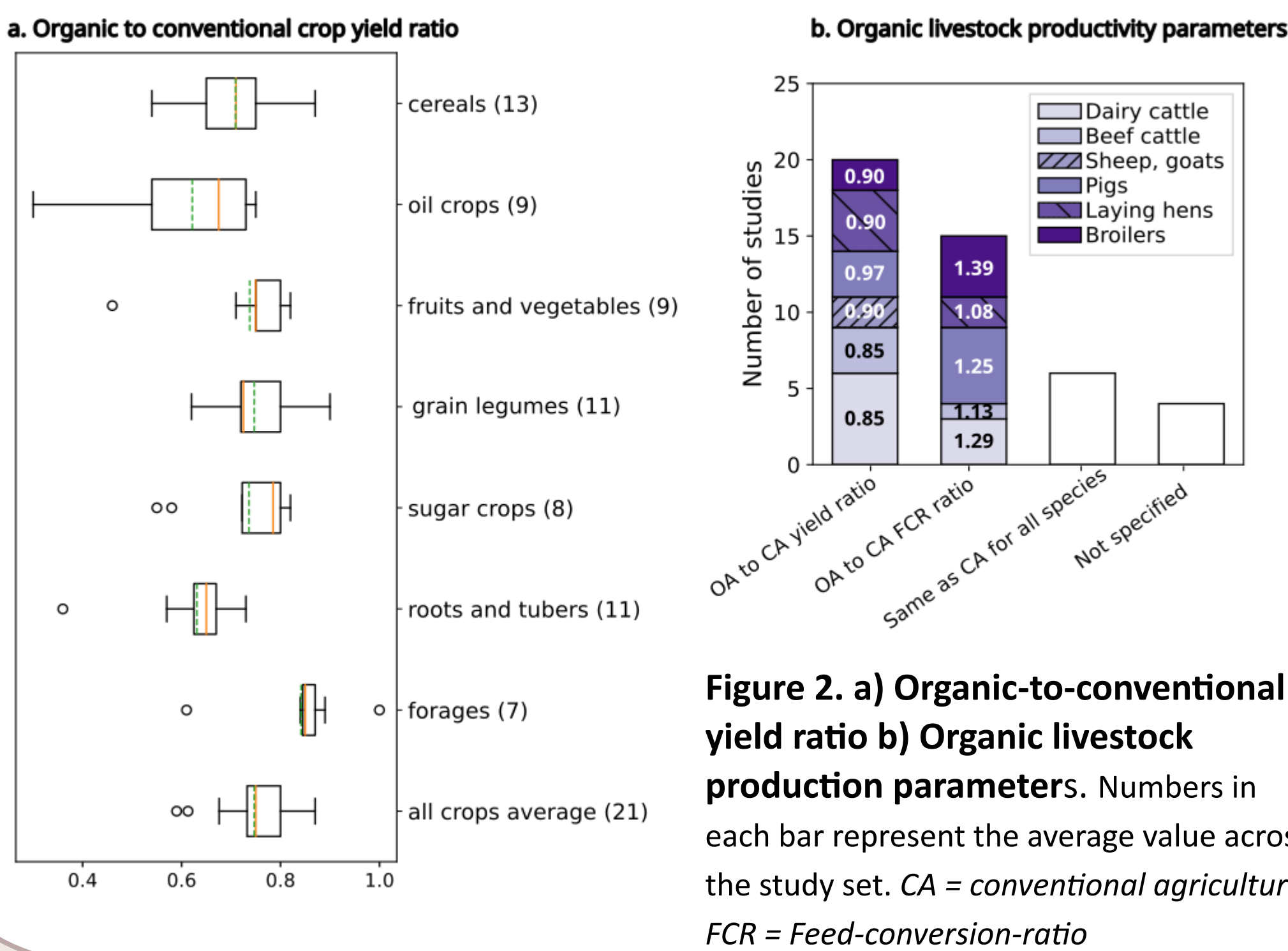


Figure 2. a) Organic-to-conventional yield ratio b) Organic livestock production parameters. Numbers in each bar represent the average value across the study set. CA = conventional agriculture
FCR = Feed-conversion-ratio

Organic yields were 0.75 those of conventional crops, which is in line with the average yield ratio reported in meta-analyses.

80% of the review set used exogenous data on organic yields in their models (fig. 1). The lowest values were reported by studies that endogeneously simulated crop yields according to nitrogen (N) availability. A likely explanation is that these studies captured the effect of a stronger competition for organic N resources in the event of OA development.

N is the productive factor that has received the most attention. **Consideration of productive factors is still largely lacking in OA simulations.**

Our results indicate a lack of data on organic livestock productivity as only 13 studies have considered the varying productivity of animals under organic management. Yield ratio ranged from 0.85-0.97 and Feed-Conversion-Ratio (FCR) ratio ranged 1.08-1.39

Food production and land-use

Studies results indicate that food production decreases by 30.2% in OA simulations (range -59; +20%). Discarding studies that did not evaluate a full conversion to OA led to an average production gap of 31.7%.

The livestock decline was more pronounced for monogastrics. Ruminant population decreased by 13% on average whereas monogastric dropped by -51% LU. This results from ruminants advantage of limiting food-feed competition and transferring nutrients from permanent grasslands to croplands.

Food production was strongly dependant on the assumptions about agricultural land dynamics. The decrease of total food production was -22.4% in studies allowing for total agricultural area expansion vs -41.2% in those who did not.

Results should be interpreted with caution given the limited sample size and data availability

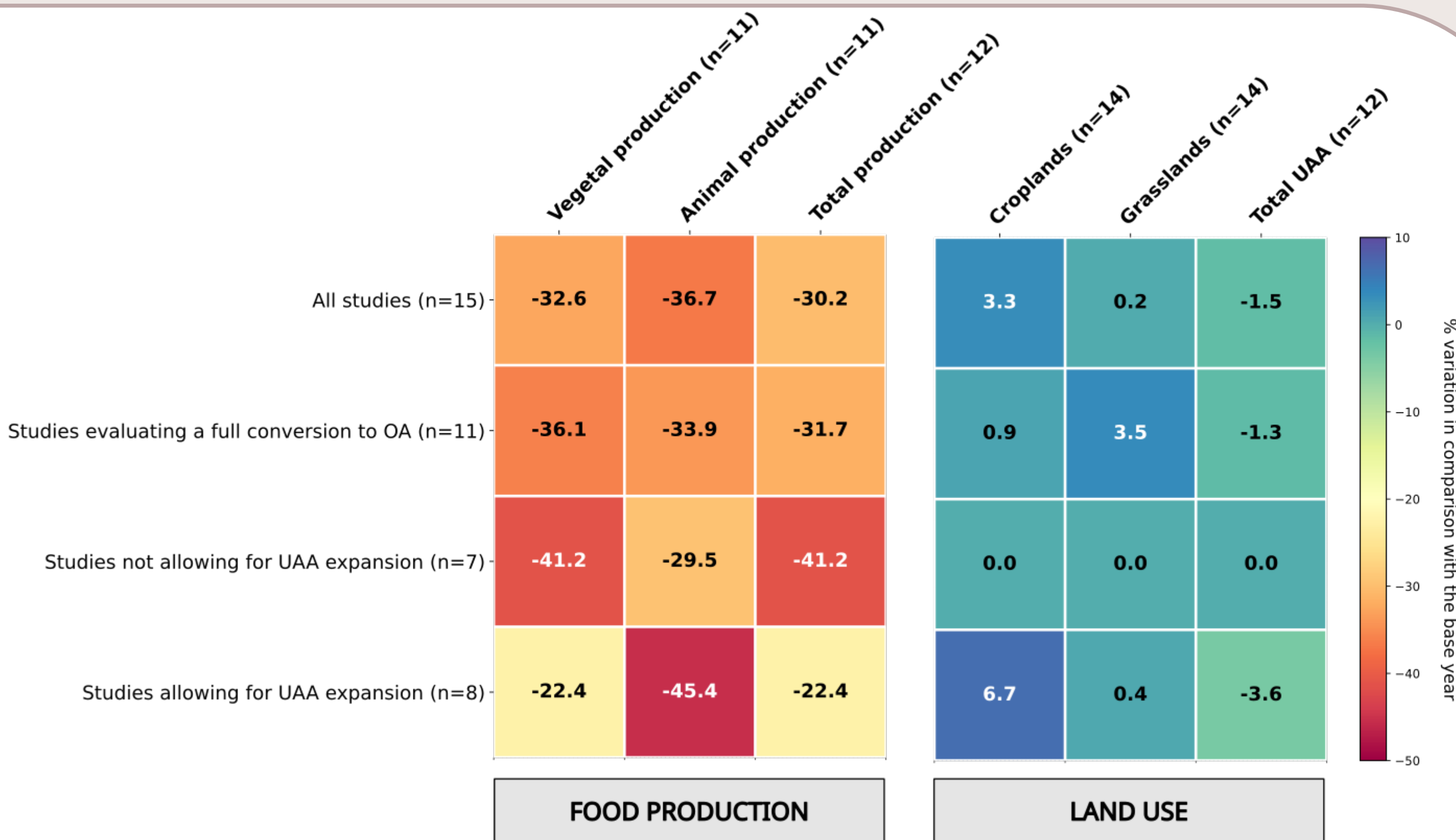


Figure 3 - Variation in food production and land use compared to the initial level. Note that the number of studies reporting total variations does not equal the number of studies reporting variations for individual parameters. UAA : utilized agricultural area

Domestic food-self-sufficiency : dietary changes matter !

Three quarters of studies found evidences of food-self-sufficiency under large development of organic agriculture.

Dietary changes, in particular the decrease of animal foods consumption is a keystone for enabling organic farming development.

Balanced diets (reduced protein and calories intake as well as reduced intake of animal products in overconsuming populations) led to lower pressure on land and partly compensated for the low productivity of OA.

Vegetarian and vegan diets were the least land demanding diets. However, the decrease of manure availability is likely to have adverse effects on yields which could offset the land sparing-effect of reducing animal husbandry.

The review set largely focused on food availability whereas consideration of other pillars of food security (access, utilization, stability) is lacking.

Take home message

Findings of this review suggest that there is a road for sustainable large scale development of OA.

Knowledge gaps, data scarcity and modelling constraints remain and strongly nuance the results.

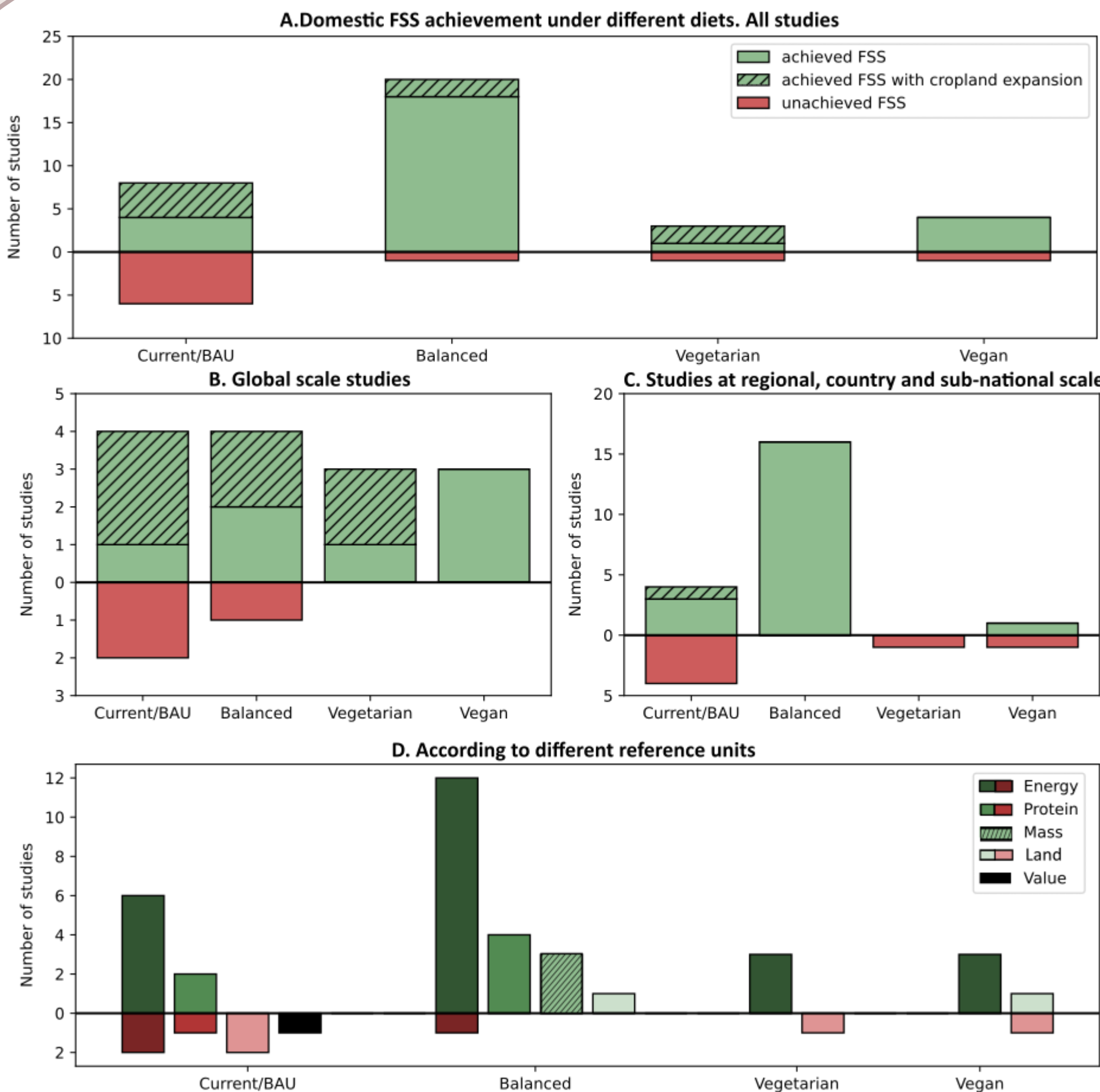


Figure 4 - Domestic food-self sufficiency (FSS) under different simulated diets. Y axis represent the number of studies that found evidences of achieved/not achieved FSS. Current/BAU = current or trending dietary patterns. Balanced = meat including diet in line with nutritional recommendations