Yield trends, nutrient use and soil quality development in organic and conventional cropping systems – The 40 years DOK trial experience.

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In the DOK (bio-**D**ynamic, bio-**O**rganic, **K**onventionell) field experiment, located in Therwil south of Basle, Switzerland, organic and conventional cropping systems have been compared since 1978. The cropping systems mainly differ in fertilisation strategy and plant protection. Crop rotation changed slightly at the end of each rotation period but was identical for all systems. This was also true for soil tillage. The experiment comprises two organic systems, bio-organic (O) and bio-dynamic (D) and a conventional systems with mineral fertilisers plus farmyard manure (K) and with mineral fertilisers alone (M). As a control, an unfertilised treatment (N) was included in the design. The D,O and K systems represent mixed farms with livestock housing (milk cows) and arable land receiving farmyard manure and slurry. These systems were split into treatments with two fertilisation levels. Level 2 corresponds to a standard fertiliser input of 1.4 livestock units, which is an average value for organic farms in Switzerland, and level 1, corresponding to 0.7 livestock units or 50% of the fertiliser input of level 2. System K additionally receives mineral fertilisers according to the Swiss national fertilisation guidelines, whereas M receives only mineral fertilisers at level 2. The organic systems (O and D) received 60–65% of the nutrients (NPK) that were applied to the conventional mixed system (K). The crop rotation comprises seven fields. The crops in the present crop rotation period from 2013 to 2019 are 1 clover-grass, 2 clover grass, 3 maize, 4 soybean, 5 winter wheat, 6 potatoes and 7 winter wheat.
Mean yields of the organic systems O and D were lower than conventional systems K and M. Organic potatoes yields were 65 %, wheat 79% and clover-grass 88% of conventional. Except for the unfertilized control (N) yields showed no significant negative trends. However, clover-grass yield tend to decrease in all treatments whereas potatoes and wheat yields tend to increase slightly. The static stability indicated by lower CVs was higher in the conventional treatments for potatoes and clover-grass, but differed only slightly for wheat. However, the dynamic stability indicated by low Shukla values was best for the both organic treatments in wheat. Higher dynamic stability was found in conventional systems for potatoes and clover grass, whereas the organic systems showed a higher dynamic stability in wheat.
Both conventional cropping systems have similar annual P inputs while P inputs in systems O and D are reduced by at least one third. Differences in P outputs between farming systems are less pronounced. Resulting P balances were positive (inputs higher than outputs) for cropping systems M and K, while they were negative for O and D. Potassium balances were equilibrated for organic and conventional systems at fertilisation level 2. However, at fertilisation level 1 balances were negative for both, P and K, and led to a decrease in soil available P and K.
From nitrogen budgets opposing inputs via fertilization, symbiotic fixation, seeds, deposition and soil nitrogen stock change to nitrogen outputs via harvested products resulting balances range from surpluses of about +5 kg to +50 kg N ha^{-1} yr^{-1}. Equilibrated balances, however, indicate soil N mining, while surpluses point to a risk of N losses, and/or N accumulation in the soil. Estimation of soil N stock changes based on yearly total N concentration measurements suggest that soil N stocks in the topsoil decreased under all treatments, except for the biodynamic system on fertilisation level 2. Trends of carbon stock changes were similar to nitrogen stock changes.