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- Translating science into policy and practice



Does labour invested in sustainable intensification practices give sufficient yield returns?

The increasing demands for nutritious food, feed, fibre and fuel of a growing world population with changing consumption patterns cannot be satisfied through increasing the arable land area. Sustainable intensification of crop production is needed, as in producing more without environmental harm but with positive effects on natural resources, profits and social capital. However, smallholder farming systems in e.g. sub-Saharan Africa (SSA) face many barriers to increased crop productivity, one being labour shortages during key periods that strongly influence yields. For example, insufficient labour often leads to late planting and a mismatch with the growing season, and to poor weed control leading to high competition for nutrients, water and light and thus to low yields.

Meeting global food demands

The need to increase food production to meet global food demand has produced a range of options for sustainable intensification of crop production on smallholder farms. However, uptake of these practices has often been lacking or practices have been abandoned once external incentives have ceased. We suggest that labour limitations on the farms and/or low labour productivity of some of the practices can lessen their suitability and explain their low adoption rate. Here, we reviewed publications

Key findings

- Options considered for intensification on smallholder farms fell into four categories: (a) low labour demand but high yield returns, (b) high labour demand and yield returns, (c) low labour demand and yield returns, and (d) high labour demand but low yield returns.
- Herbicide use and ridging (which provided mechanised weeding) gave increased yield returns to labour. Technologies that relied too much on manual labour did not give the same yield returns to labour.
- Practices for sustainable intensification can be beneficial if farmers are able to invest in mechanisation and/or herbicide use to reduce labour input and conserve soil moisture. However, it should be combined with improved crop varieties, nutrient inputs and pest control.

studying the relation between yield effects and labour demand for a range of practices proposed for sustainable intensification of maize production on smallholder farms.



Figure 1. Some of the reviewed practices. A: The ridge alternative. B: No-till relay intercropping. C: Planting basins. D: Intercropping.

Effectiveness of practices in increasing yield and labour productivity

Twenty-four of the reviewed publications reported yield effects in maize and labour inputs for tillage systems that increase water availability in soil, such as ridging, planting basins and no-till compared with flat tillage. Cropping systems that may decrease diseases and pests and increase soil fertility through biological nitrogen fixation (BNF), are for example legume intercropping (as opposed to solecropping) and rotations (as opposed to mono-cropping). Publications mostly presented data on labour for land preparation, for weeding and/or total labour during

the cropping cycle and these are presented in this brief.

The effect of the interventions on yield or labour input is expressed as a ratio between that of the intervention and that in the widely used (baseline) practice (figure 2 and 3). The change in labour productivity is presented as the ratio between the changes in yield and invested labour. The red line (figure 2) indicates no change compared with the baseline. A value below 1 indicates decreased labour productivity; a value 0.5 means e.g. yield could be halved at the same labour use or yield was the same but labour doubled. A value above 1 indicates increased labour productivity; a value 2 means e.g.

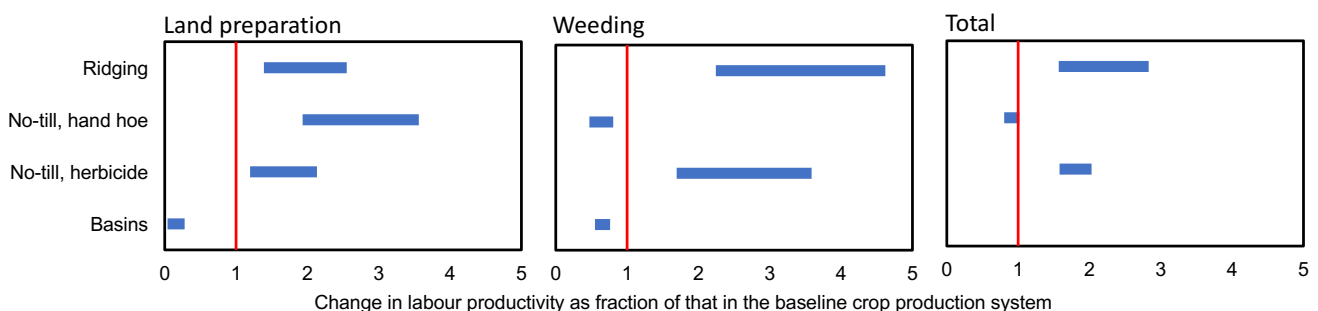


Figure 2. Confidence intervals (95%) for the relation between changes in yield and labour use for ridging, no-till and planting basins, expressed as fraction of the baseline practice (flat tillage).

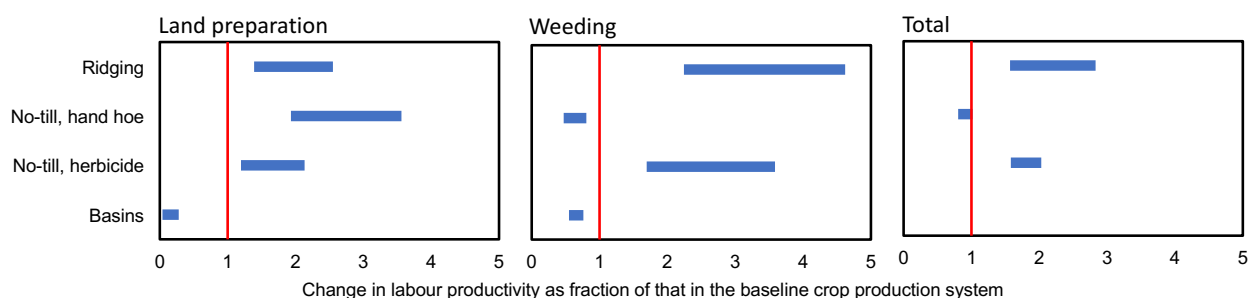


Figure 3. Confidence intervals (95%) for the relation between yield change and change in labour use for rotation and intercropping, expressed as fraction of the baseline practice (mono/sole-crop).

yield could be doubled at the same labour use or yield was the same but labour was halved. Intervals crossing the no-change line show no significant effect of the practice compared with the baseline.

Ridging

Ridging along the contour (figure 1A) has the potential to trap water and increase infiltration and may also provide mechanised weeding. Ridging systems consistently increased yields and saved labour leading to significantly increased labour productivity; yield per unit labour input on average doubled or tripled depending on the task for which labour was recorded (land preparation, weeding or in total for the growing season). A combination of mechanised weed control and increased water availability to the crops are factors behind the positive outcome in these studies that were carried out in relatively dry areas. Availability to machinery that allows ridging needs to be further enhanced, e.g. through tool development and market chains for e.g. two-wheel tractors and their maintenance developed.

Planting basins

Planting basins (figure 1B) allow water to accumulate and infiltrate close to the plant and is often combined with fertilisation and/or soil amendment in the basins. The manually dug planting basins increased labour demand greatly for land preparation and also to some degree for weeding, but did not increase yields correspondingly. Labour productivity was thus low. Studies carried out in even drier areas have shown increased yields in basins compared with flat tillage. If basins can be retained over the years especially in soil of good structure, labour demand during the succeeding years can be expected to decrease. Targeting planting basins to the relevant agro-ecological settings will however be important for a positive outcome.

No-till

No-till (figure 1C) leaves residues on soil surface which decreases evaporation and thus increases soil water, and increases soil organic matter, at least in the surface soil. No-till systems decreased labour needs for land preparation but increased labour needs for weeding unless herbicides were used. Yields were reported to increase as well as decrease. The total labour productivity was thus on average similar to the baseline when the same manual weeding was performed. Labour productivity was higher when herbicides were used, but the labour savings were linked to costs for herbicides, decreasing the net profit and requiring that farmers have access to the necessary funds or credits to purchase agricultural inputs under sufficiently favourable terms. Nevertheless, no-till may be attractive where labour availability and/or draught (animal) power is limiting, in particular at the onset of the growing season and water is limiting. Environmental cost were not assessed in the studies.

Rotations

Rotations refers to the growing of different crops in sequence and can provide a pest and disease break and varying amounts of fixed N. Rotations with legumes tended to give higher labour productivity than the mono-cropped maize (Fig. 3). The attractiveness of this system depends on the farmers' ability to invest in an initial growing season with the alternate legume crop. This means potentially lower or no immediate benefit to the household to reap the yield benefits of the cereal the following season.

Intercropping

Intercropping (figure 1D) is the growing of two or more crops on the same unit of land at the same time, and can provide complementarity of crops in

resource use as well as pest reduction and BNF. The labour productivity in manually weeded intercropped systems did not differ significantly from the sole-cropped baseline (figure 4), and yields were reported to increase as well as decrease. However, the maize component carried all the labour for land preparation and weeding, thus exaggerating labour use for the maize crop. The simultaneously produced companion crops of many kinds would contribute to the overall system productivity which suggests the system therefore has a somewhat higher labour productivity than could be accounted for. Labour productivity was higher when herbicides were used but implied other costs, as seen for the no-till practice with herbicides.

Overall results

The large variation in labour productivity within each practice pointed to the effects of the subtle interactions between agroecology conditions such as weather events, management decisions and pest occurrence. The most suitable practices for a farmer will also strongly depend on the farmer's ability to invest, and on the relative scarcity of labour vs other limiting factors such as arable land and access to input and output markets.



Delayed or poor weeding has a major impact on yield. Left part of this field was left un-weeded due to time constraints.

Conclusion and the way forward

- Practices that deliberately include crop rotation, herbicide use and mechanisation reduce labour inputs, increase yield and profitability of smallholder agriculture. However, options need to be tailored to the agro-ecological and socioeconomic contexts of farmers. Hence, solutions should be evaluated locally to satisfy farmers' differing production goals and investment capacity.
- Sustainable intensification of crop production hinges on more efficient use of resources including farm labour. Availability of draught power (e.g. animals or tractors) and tools for mechanisation need to be increased through tool development and supply chains to reach the most remote farmer. Herbicides, whilst efficient in reducing labour demand, carry alternative costs in terms of outlays and environmental and health effects. Extension support to lessen the latter through appropriate handling and use is vital.

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