Transplanting sorghum and millet - a key to risk management

'Transplanting breaks the hunger gap 2-3 weeks earlier…'

'Transplanting increases yields by up to 100%…'

Summary

Why transplanting?

By transplanting sorghum and millet seedlings from pre-season nurseries at the onset of the main rains, farmers are able to minimise risk, by maximising water use efficiency and improving yields under marginal conditions.

What are the main benefits of transplanting?

Agronomic

- Earlier harvests (by 2 – 3 weeks) and the possibility of avoiding terminal drought.
- Often substantially increased grain yields (increase of 0.1 – 1.5 t ha^{-1}) particularly in *Striga* infested fields, together with improved grain size and quality.
- Larger stover harvests in farmers fields.
- Increased flexibility, particularly for poorer farmers who do not own oxen or ploughs. Normally they have to wait their turn after the start of the rains – transplanting seedlings rather than sowing means they are not disadvantaged by this delay.
- Improved germination in the nursery compared to a direct-sown field (also pest/disease control easier and manure application direct to the plant).
- Improved crop stands – reduces the need for replanting and gap filling.
- Reduced weeding requirements, as there is no need for thinning and gap filling, thereby reducing labour during crop growth.

Social

- Hunger gap between seasons reduced.
- Crop harvested when the price is high – farmers can sell grain/seed for a higher price, and avoid buying food at a high price.
- Conserves seed – less seed is required to provide seedlings for transplanting a particular area, compared to that required for an equivalent direct-sown plot.

What are the main pre-requisites of transplanting?

- An area for nursery plots, secure from animals (a 1 m^2 nursery will provide enough seedlings to transplant 200 m^2 field area).
- Labour for transplanting.
- A conveniently situated perennial source of water (farmers watered a 1m^2 nursery with 10 litres /day).
- A series of nurseries planted 10-20 days apart to ensure successful transplanting in variable seasons.

Where can transplanting be applied?

In all sorghum and millet growing arid and semi arid areas of the world where rainfall unpredictability is a problem for subsistence farmers and where climate variability is becoming more extreme resulting in shorter and even more unreliable rainy seasons.

Who benefits from transplanting?

Resource-poor subsistence farmers who experience food insecurity in high-risk environments, particularly in Sub-Saharan Africa.

What next for transplanting?

Dissemination of the technique to all relevant areas through a co-ordinated response, a close collaboration with local farmers and local organisations, including NGOs and NARS, taking full advantage of the experience already gained over the last four years in Zimbabwe and Ghana.

The Context

Rainfall variability and unpredictability characterise arid and semi-arid areas and have a major impact on the livelihood strategies of subsistence communities in such regions. Given the unpredictability of the onset of the wet season(s) and of subsequent individual rainfall events, and the large variability in the total seasonal rainfall, making efficient use of available soil moisture in a given season is crucial to individual and family welfare, and sometimes to survival. Commonly, subsistence farmers in Africa and elsewhere, with little or no access to irrigation water, wait for the beginning of the rains before sowing. However the combination of rainfall unpredictability and the seasonal and annual stochasticity means that, in some instances, the initial sowing may completely or partly fail and/or the crop may not reach maturity before soil moisture is exhausted. Yields are low, often below 1 t ha^{-1}, and generally the crops cannot efficiently exploit the available rainfall as during the early growth period much soil moisture will be lost by evaporation instead of driving transpiration and carbon assimilation.

Climate change models predict an increase in climatic variability, including extreme events, and a decrease in total precipitation but an increase in mean temperature and evaporative demand in many of these arid and semi-arid areas. If such predictions prove accurate the insecurity of these marginal farming systems can only increase with far reaching human consequences.

While sorghum and millet are respectively the fifth and seventh most important cereals, in terms of global production and areas planted, they are quintessentially arid and semi-arid zone crops of critical importance to subsistence farmers of large tracts of Africa and the Indian sub continent. Some 54% of the world's sorghum and 62% of the pearl millet are grown in Sub-Saharan Africa (SSA) (FAO statistical databases), predominantly in areas that experience the 'highest prevalence of food deprivation' (Figure 1) (FAO, 2000)[1].

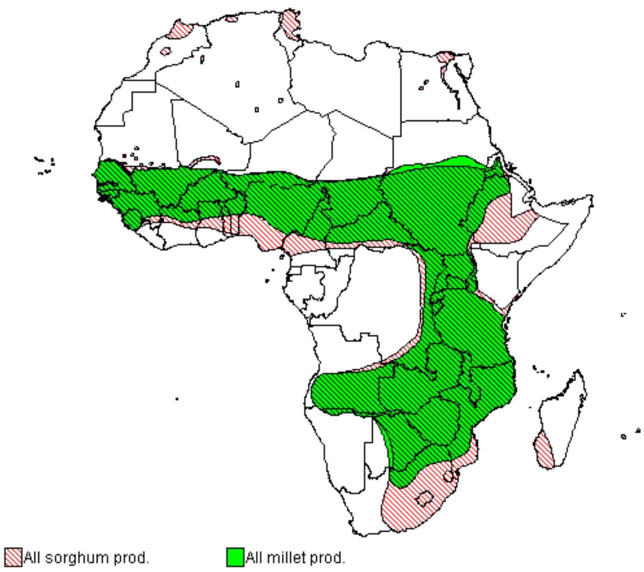


Fig. 1. All sorghum and millet growing areas in Africa. Source GEOWEB system, FAO global information and early warning systems: www.geoweb.fao.org.

The UNDP Hunger Task Force Report (Scherr 2003[2]) estimates that globally there are 800 million hungry people concentrated in SSA and India. Approximately half these food insecure people live in farm households in high-risk environments of low and unreliable rainfall and poor soils. The report emphasises the need for major leaps in sustainable production technology to raise productive potential and reduce risk.

The Response

Transplanting has proved successful in a number of areas around the world. The method is already used extensively around Lake Chad where sorghum nurseries are established during the rainy season and transplanted at the end of the rains into the sandy clay loams and clay soils, which store water during the wet season (Chantereau and Nicou, 1994[3]; Olabanji *et al.*, 1996[4]). In Nigeria transplanting of 'dauro' millet allows double cropping with groundnut and cowpea (Labe *et*

[1] FAO. (2000). State of food insecurity in the World.
[2] SCHERR, S. (2003). *Halving global hunger. The millennium project – hunger task force*. UNDP.

[3] CHANTEREAU, J. AND NICOU, R. (1994). *Sorghum*. The Tropical Agriculture series. MacMillan London pp 4-11.

[4] OLABANJI, O.G., TABO, R., FLOWER, D.J., AJAYI, O., USHIE, F., KAIGAMA, B.K. AND IKWELLE, M.C. (1996). Production and Management: Survey of *Masakwa* sorghum growing areas in Northeastern Nigeria. *International Sorghum and Millet Newsletter* **37**.

al., 1987[5]). Similarly in Vietnam transplanting maize has enabled an additional food crop to be grown in a year, providing 5 tonnes per hectare of maize in addition to the two rice crops normally sown (Uy, 1996[6]). Transplanting therefore offered the prospect of reducing risk and improving yields in marginal areas thereby increasing local food security. However its relevance to subsistence semi-arid rainfed farming needed to be assessed.

Researchers at the Centre for Arid Zone Studies (CAZS), working with local researchers, farmers and extension agents in Ghana and Zimbabwe, have tested this technique for locally-available varieties of sorghum and millet. Over a period of 4 years, in on-station trials, the effect of nursery density, seedling age and trimming the leaves at transplanting on a number of varieties of sorghum and millet have been tested. At the same time over 200 on-farm trials have been undertaken with farmers testing the technique under normal farming conditions. Based on this experience with full farmer participation, a socially acceptable and agronomically robust method has been developed.

In Zimbabwe the on-station trials were conducted at the Save Valley Experiment station, Manicaland Province in southeastern Zimbabawe, and the on-farm trials in the central and northern parts of the Masvingo Province. These areas are characterised by lowlands below 900 m, with rainfall typically below 650mm, and are subject to periodic seasonal droughts and severe dry spells during the rainy season. In Ghana the on-station trials were conducted at Manga Research Station, Bawku West District, and the on-farm trials in Builsa and Bawku West districts of the Upper East Region. These areas, classified as southern Sudan Savannah, are typified by erratic rainfall with periodic seasonal droughts and an annual rainfall average of 900 – 1000 mm.

The Results

As a result of this collective effort it is possible to enumerate the potential benefits of transplanting, and the prerequisites for its successful implementation.

Benefits

Agronomic

- Earlier harvest (Figure. 2)
  - Harvests 2 – 3 weeks earlier for non-photoperiod-sensitive crops.
  - Improved possibility of avoiding terminal drought.
- Higher yields (Figures. 3 – 5)
  - Sometimes similar, but most often substantially increased grain yields, shown by on-station and on-farm trials, particularly in *Striga* infested fields (0.1 – 1.5 t ha^{-1}).
  - Increased stover yields in farmers' fields.
  - Improved grain size and quality.
- Increased flexibility, particularly for poorer farmers who do not own oxen or ploughs. Normally they have to wait their turn after the start of the rains – transplanting seedlings rather than sowing means they are not disadvantaged by this delay.
- Improved germination in the nursery compared to a direct-sown field (pest/disease control easier and manure application direct to the plant).
- Improved crop stands – reduces the need for replanting and gap filling.
- Reduced weeding requirements, thereby reducing labour during crop growth.
- Improved use of soil water because of high Leaf Area Index (LAI) at the time of maximum soil moisture.

Social

- Hunger gap between seasons is reduced.

[5] LABE, D.A, EGHAREVBA, P.N., YAYOCK, J.Y. AND OKIROR, S.O. (1987). Effect of planting methods on the performance of Dauro millet. *Maydica* **32(4)** 287-299.

[6] UY, T.H. (1996). *Transplanting maize on wetland: A technical manual based on a successful case-study in Vietnam*. FAO, Rome.

- Grain harvested when the price is high – farmers can sell grain for a high price, and avoid buying food when it is most expensive.
- Conserves seed – less seed is required to provide seedlings for an equivalent transplanted compared to direct-sown plot.

Pre-requisites

- Area for nursery plots, which is secure from animals (a 1 m^2 nursery will provide enough seedlings to transplant 200 m^2 field area).
- Labour for transplanting.
- A conveniently situated perennial source of water (farmers watered a 1m^2 nursery with 10 litres /day).
- A series of nurseries[7]

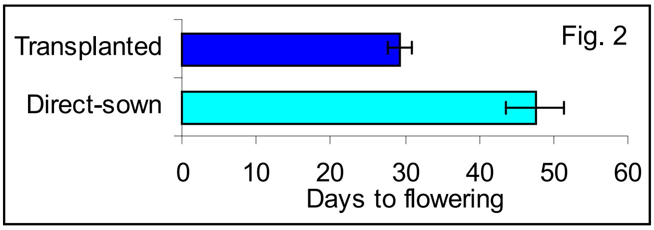


Fig. 2. Days to flowering of direct-sown and transplanted early millet (Manga nara) – on-station trial 2002, Ghana. Standard errors shown.

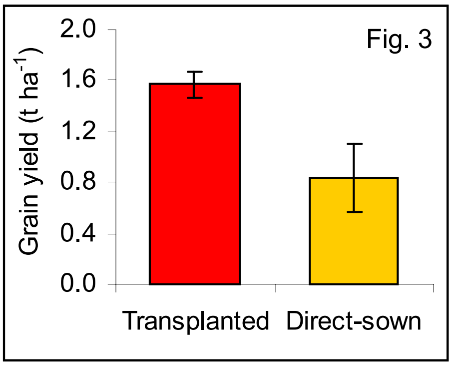
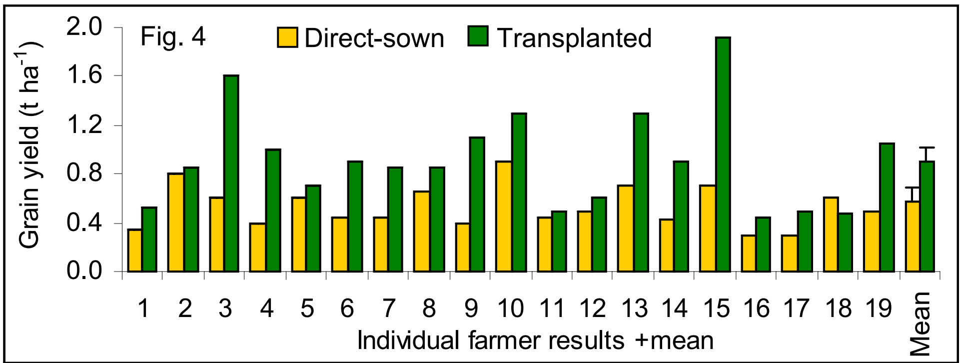


Fig. 3. Grain yield (t ha^{-1}) of direct-sown and transplanted Macia sorghum – on-station trial 2001/02, Zimbabwe. Standard errors shown.



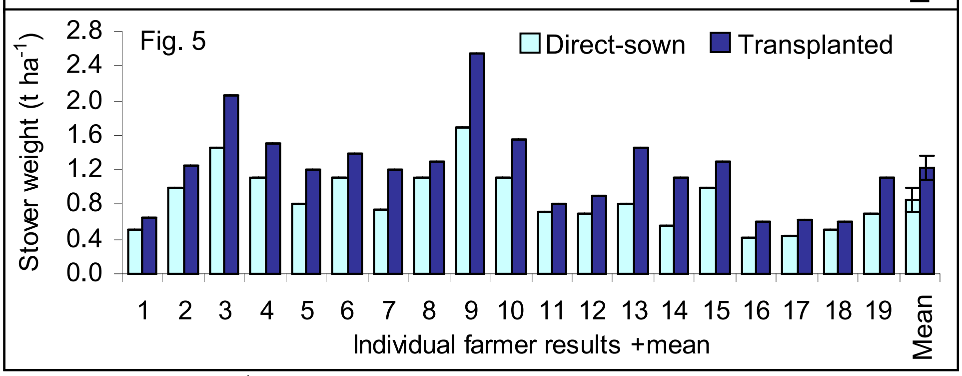


Fig. 4. Grain yield (t ha^{-1}) of direct-sown compared to transplanted late millet for 19 farmers from Navrongo, Ghana 2002. Mean of results and standard errors shown.

Fig. 5. Stover yield (t ha^{-1}) of direct-sown compared to transplanted late millet for 19 farmers from Navrongo, Ghana 2002. Mean of results and standard errors shown.

[7] To maximise the benefits, a series of nurseries must be established that provide seedlings of the correct age at the time of transplanting. The time between the nurseries depends on crop type and can vary from 10 – 20 days. Only some of the nurseries will be transplanted.

The Future

It is clear that transplanting offers a simple, acceptable and effective method of reducing risk and increasing yield in certain semi-arid areas. As a result it potentially has a wide application for improving food security within the context of global climate variability and change by providing the farmer with a new way of manipulating the microenvironment.

Despite efforts to breed for drought and other abiotic stresses, the uncertainty of the onset and duration of the rains continues to be a major constraint across the spectrum from the poorest to the richest farmers. However, for the poorest it may be a critical issue in some years. Transplanting is a means of at least partially managing unpredictability at all levels. The technique also has the advantage of having been successfully modified from existing indigenous practices and being suited to the needs of the poorest of the poor. Subsistence farmers, who are constrained by few resources and little capital, find it risky to invest in new technologies and are often unwilling to allocate scarce cash resources to purchase inputs. Transplanting sorghum and millet is a technology that requires few inputs of the factors that constrain farmers but does provide major benefits, and including improved food security.

During the second year of the trials in Ghana there was evidence of spontaneous dissemination. All but one of the farmers reported during discussion group meetings that several other farmers had viewed their trials and were planning to try the technique themselves during the following season. This represented an increase of more than 250% of farmers trying the technique through farmer-to-farmer dissemination. There can be no better evidence that farmers believe this practice to be beneficial and relevant.

The next stage is develop a strategy to test out the method as widely as possible, to evolve local variants to cope to local circumstances and to disseminate the transplanting method to other farmers who could benefit from using the technique. Figure 1 shows the extent of sorghum and millet growing in Africa, which coincides with rural poverty, this emphasises the extent to which this method could be of assistance to resource poor farmers who live in high-risk environments, particularly in Sub-Saharan Africa. It is possible to start this dissemination process using extensive contacts already established within Eritrea, Ethiopia, Kenya, Uganda, Sudan, as well as existing and new areas of Ghana, who have access to some funds to support initial on-the-ground activities. However to maximise the impact of transplanting and ensure the technique is correctly adapted to local environments as efficiently and effectively as possible, and to enable the incorporation of other relevant areas, a well thought-out co-ordinated response is highly desirable. We are seeking support in order to promote this methodology and to establish a network of local and regional organisations in SSA to achieve this. We wish to ensure that the resource poor subsistence farmers, who, on the basis of the work in Ghana and Zimbabwe will be the beneficiaries, are given the opportunity to judge the relevance of the method to their own circumstances.

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