8 Technology validation and transfer

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Introduction

Vertisols are agriculturally important in Ethiopia. However, waterlogging is a predominant problem to increased production on these soils. Hence, actual Vertisol productivity is far below potential. Various studies have indicated surface drainage to be a key factor to the release of the agricultural potential of Vertisols (Jutzi et al, 1987; Getachew Asamenew et al, 1988b). Though this fact has also been acknowledged by farmers in the Ethiopian highlands, an efficient traditional technique that can utilise animal traction to harness Vertisols is not commonly known.

As farming in Ethiopia is heavily dependent on animal traction, technologies that are based on this power source were envisaged to be appropriate for better management of Vertisols. Hence, the Joint Vertisol Project (JVP) began research on improved Vertisol technology that included (1) the use of an animal-drawn broadbed maker (REM) to facilitate surface drainage and (2) the use of appropriate seeds, fertiliser and early planting.

As cash income is generally low and credit institutions are not within easy reach of farmers on most highland smallholdings investments are meager. Hence in the development of the BBM, least costliness and simplicity were important considerations.

Technology verification and transfer framework

The objectives of the technology verification and transfer were to:

- verify the economic viability and acceptability of the BBM/Vertisol technology package
- popularise the technology so as to encourage large-scale adoption.

The target areas and farmers

Five principal Vertisol areas with diverse farming systems in the Ethiopian highlands were purposefully selected to verify the BBM/Vertisol technology package and study the transfer of the technology. Altitude, abundance Vertisols and traditional land-shaping methods to control waterlogging were important criteria in the selection of the target area.

Debre Zeit, Ginchi, Inewari, Dogollo and Dejen were the study sites which represented various traditional Vertisol farming systems. Description of the farming systems of these sites has been given in an earlier Chapter in this report.

The technology validation included individually operating farmers and producer cooperatives (PCs). In 1986, on-farm monitoring began with 56 individual farmers (IFs) and three producers' cooperatives at Debre Zeit, Dogollo and Inewari. The addition of Dejen in 1987 increased the technology testing sites to four making a total of 67 IFs and 20 PCs. In 1988 an on-farm verification at Ginchi was conducted jointly by ILCA and IAR. In 1990, a policy declaration by the government gave farmers the right to dismember producers' cooperatives. As a result, most producers' cooperatives were dissolved. Hence, in the fifth year the number of participating individual farmers in the on-farm verification increased to 158 while PC's were reduced to 10 (Table 1). As of 1991 the focus of the technology verification and transfer was on individual farmers.

Table 1. Number of farmers in the on-farm technology verification and transfer studies, 1986 - 1992.

Year	Individual farmers	Producer cooperatives	Total PC members
1986	56	2	200
1987	61	7	1500
1988	67	20	6000
1989	53	25	7200
1990	158	10	2500
1991	240	None	None
1992	340	None	None

Source: Getachew Asamenew and Mohamed-Saleem (1992).

In 1989 Oxfam-America, a non-governmental organization, started to transfer the technology to farmers at Dogollo based on its on-farm research results. The Dogollo site was closed down in the same year because of security reasons. At the time, farmers' participation was excellent. After more than five years of operating a well-focused research and outreach programme in Vertisol areas of the Ethiopian highlands, emphasis was shifted in 1991 towards technology popularisation and transfer at Debre Zeit, Inewari and Ginchi.

Technology verification approach

Research on a farming systems perspective was adopted. It was linked to a two-way information flow between on-station and on-farm research. Technology designed on-station was first verified on-farm while farmers' unsettled queries, obtained through feedback, were redirected to the station to improve the technology for better adaptation. Investigation on appropriate cropping systems, soil fertility and erosion, animal-drawn implements for soil, water and crop management and animal draught power output on-station back-stopped on-farm technology validation. Component research was conducted at ILCA, IAR, AUA and MOA stations. Work on draught power was carried out mainly at the ILCA station in Debre Zeit. Work on crops was carried out mainly at IAR and AUA stations. Trials to develop new cropping systems were undertaken on MOA's Agricultural Development Department (ADD) sites which were also part of JVP's on-farm technology verification sites. There was close collaboration among ILCA, AUA, IAR and MOA on all aspects of Vertisols research. The inter-institutional links were aimed at achieving: (1) mutual information exchange and (2) avoiding duplication and (3) obtaining a critical mass of information in several areas thus generating maximum returns from scarce available resources.

Vertisol technology was first popularised in a community followed by on-farm verification. It was finally transferred to the farming community. Adoption was monitored and further socio-economic constraints were identified.

Monitoring and evaluation of an innovation and its adoption by farmers is the central focus of an on-farm technology verification and transfer. Trials carried out by farmers included cultivation, construction of BBF, planting, weeding, harvesting and threshing. For on-farm technology verification, monitoring was designed on the basis of dialogue with farmers. The farmers were frequently and regularly visited and invited to suggest improvements to the new innovation. Feedback from farmers were important in refining the technology on-farm, where possible, and on experimental stations where not possible otherwise. A teacher-pupil relationship was avoided and an equal partnership was established as the on-farm verification research progressed.

All inputs used and outputs obtained from the verification plots were monitored frequently and carefully by highly experienced resident field staff in the respective research sites. A structured diary was used to record data in the first instance from farmers. The computed data were then transferred to a properly structured format.

To compare the technology in a whole-farm context, the entire cropping pattern was determined and all inputs for the various crops grown on-farm and yields are also accounted for.

Bio-technical feasibility, economic viability and social acceptability are critically important criteria in an evaluation of a technology on-farm. Hence the parameters used in assessing the performance of the Vertisol technology were yield response, economic benefits, risk, and acceptability.

Performance of the BBM

Compared to the traditional land-shaping methods, there was a consistent increase in crop yields and economic returns by using the BBM on Vertisols across the highland sites (Figure 1). Effects of the BBM on Vertisol productivity appear to vary slightly between locations and years. The differences resulted mainly from variation in the traditional Vertisols management practices. This was particularly true of the land-shaping and agroclimatic conditions. Regardless of the land-shaping methods, differences in productivity on Vertisols were, in general, significant across sites and years. Yields of crops in the lower and medium altitude highland Vertisols (Debre Zeit and Ginchi) were higher than in higher altitude highlands at Dogollo, Inewari and Dejen. This was mainly because of differences in rainfall intensity and evapotranspiration which increased the waterlogging intensity in Vertisols. With the use of improved wheat cultivar during the second and third year, the effects of BBM on physical yields, net gain, return to human and oxen labours from crops on Vertisols at Dogollo significantly increased. In the second year, net gain and labour returns from use of the BBM for wheat production was 75% and 43%, respectively, higher than from that produced on ridges and furrows. In the third year, because of BBM use the difference increased to 131% in net gains and to 114% in return to labour.

At Inewari the BBM efficiently replaced the drudgery of manual broadbed and furrow construction thus increasing human welfare. Use of the BBM increased the economic value of draught animals as they were not utilised for seed covering tasks as in other Vertisol areas. Use of the BBM reduced the 55 hr/ha average labour requirement for the manual BBF construction by about 67%. As the manual BBF construction is labour-intensive, farmers indicated labour to be a constraint for this farm activity, thus acknowledging the benefits from use of the BBM. As manually made BBF's can facilitate drainage of excess surface water, crop yields are not significantly different from yields on the broadbed furrows formed with the broadbed maker. BBFs are manually made when Vertisols are moist and pliable. But in years when the rainfall is late, farmers hurry to complete their activity on time and the quality of broadbed furrows constructed suffers resulting in reduced yields. During such periods, use of the BBM helped in increasing crop yields and economic benefits.

Use of the BBM also resulted in increased Vertisol productivity in the medium-altitude highlands of Debre Zeit and Ginchi where crops are traditionally grown on flat plots but no significant variation was observed between years on effects of the BBM on productivity. At Debre Zeit, over a period of five years there was a 32% average net return from wheat production as a result of using the BBM. In the high-altitude highlands of Dejen the effects of BBM on productivity were also positive.

There were variations in total labour input in plots prepared with the BBM across sites and years. Average total labour for wheat production ranged between 466 hr/ha and 681 hr/ha at Debre Zeit and Dogollo, respectively. With the exception of Ginchi, it appeared that total labour use increased with a rise in altitude since higher weed infestation and higher clay content in Vertisols require more weeding and plowing time. However, total labour demand was found to be relatively lower at Ginchi where some farmers use herbicide and hence little weeding was required on wheat fields sown on Vertisols. The net effect of BBM-use was that it generally increased labour productivity across sites and years. For example, at Dogollo in 1986 and 1988 returns to labour from use of the BBM for wheat production increased by 50% and 114%, respectively, compared to the traditional land-shaping method.

The animal traction time required to make one hectare of BBF was on average 50% less than that required for the traditional method of seed covering. The traction time varied between the study locations but very slightly between years because of mainly traction inputs to land preparation. On well-ploughed Vertisols, BBF formation is easier to make and quicker. Although two farmers are needed to handle the BBM, making a broadbed furrow with the broadbed maker took less animal traction time (15.4 hr/ha) than by the traditional method which took 25 hr/ha.

Performance of the Vertisol Technology Package

The previous section has assessed the effect of BBM on Vertisol productivity. But comparison of the two methods is necessary since farmers usually compare the results of the technology with their entire traditional practice. The Vertisol package involves use of the BBM, use of appropriate seed cultivar, application of a given amount of fertiliser and early planting (dry-season sowing). By contrast, traditional practice requires planting of crops late in the season (wet-season sowing), use of usually local seed cultivar (except at Inewari) and application of some fertilisers. Planting on Vertisols is done using traditional land-shaping methods that vary from location to location as explained earlier. Fertiliser is preferably applied to cereal crops such as wheat and teff although pulses are also grown. While it is necessary to assess the opportunity cost of Vertisols under crops grown using the improved technology package, it is clear to see the benefits of using the improved technology compared with traditional cropping practices of Vertisols.

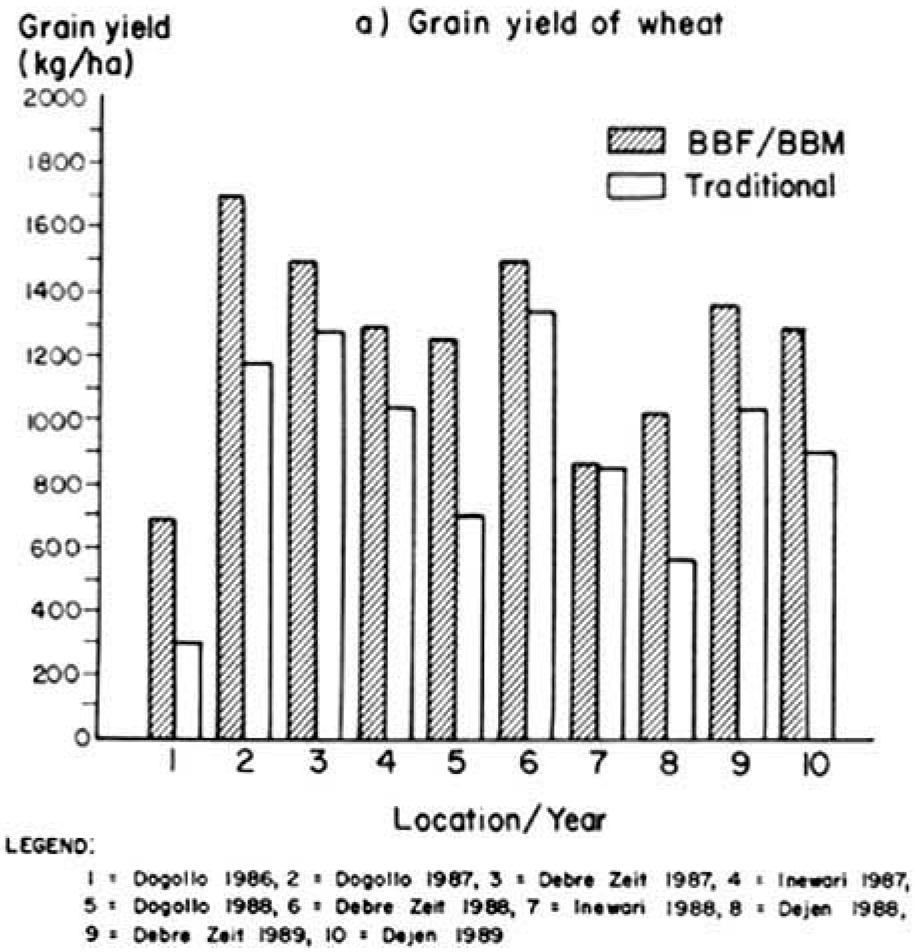
Greater yields of grain and crop residue from using the technology package has made the economic benefits very attractive. Compared to crop yields obtained through traditional methods, yields of wheat (for example) grown with the improved technology were on average more than double (Table 2). Hence the net gain and marginal rate of return (MRR) from wheat were more than double. At Dogollo, with the improved technology wheat yielded even more than four times than wheat grown on Vertisols traditionally. Crop residue harvest was even greater than this.

Field days, feedback and technology popularisation

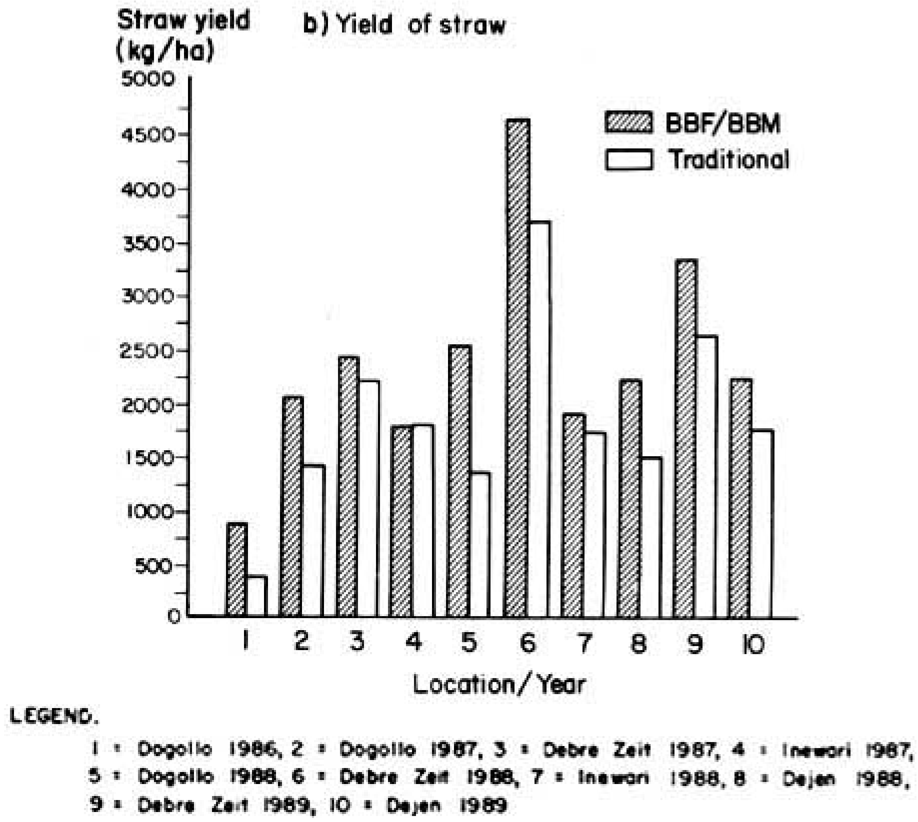
A field day is an important activity of on-farm research because it creates an occasion for farmers to get together and express their opinion about the technology being tested. The Joint Vertisol Project held such field days annually just before harvest. Key/progressive farmers move within the research sites to exchange experiences with farmers from different locations and backgrounds. Invited policy-makers are briefed on the achievements as well as constraints encountered. Participating farmers are given the opportunity to show their verification plots and share their experiences. The research team usually explains about the objectives of the on-farm trials. As much as possible, a teacher-pupil relationship is avoided and all the field-day participants are encouraged to contribute additional knowledge to the innovation. The field days have served as useful fore to collect very constructive feedback and to popularise the technology.

Figure 1. Effect of BBM-formed surface drainage on wheat grain in the Ethiopian highlands.

a) Groin yield of wheat



b) Yield of strong



LEGEND:

1 = Dogollo 1986, 2 = Dogollo 1987, 3 = Debre Zeit 1987, 4 = Inewari 1987,
5 = Dogollo 1988, 6 = Debre Zeit 1988, 7 = Inewari 1988, 8 = Dejen 1988,
9 = Debre Zeit 1989, 10 = Dejen 1989

Table 2. A comparison of economic returns from crops grown with Vertisol technology package and traditional methods in selected Ethiopian highlands.

	Gross margin (EB/ha)	Net gain (EB/ha)	MRR (%) traditional management
Inewari (1988 and 1989):			
Improved management:			
Wheat	789	468	
Traditional management:			
Wheat	537	288	134
Teff	565	241	162
Chickpea	432	239	92
Rough pea	230	16	171
Ginchi (1988 and 1989):			
Improved management:			
Wheat	1214	976	
Traditional management:			
Wheat	536	337	313
Teff	986	725	127
Rough pea	493	333	196
Chickpea	532	355	218

EB = Ethiopian birr. US$1 = EB 2.07 during the study period.
MRR = Marginal rate of return.

Factors that influenced technology adoption

In general participating farmers of the on-farm verification research were impressed in the results obtained from the new technology. Feedback during the initial on-farm verification years, however, indicated that there were some constraints to its wider adoption by the farming community. At the beginning farmers were concerned about the weight of the prototype BBM which they thought was heavy for draught oxen. It was heavy for farmers as well who had to transport it to the fields. As a result, a lighter modified BBM based on the local plough was constructed during the second year. Since two light local ploughs were brought together to form the modified BBM, some farmers felt that the weight would hurt their oxen. They went ahead and tried the new BBM and in time the complaint stopped.

Farmers' most-cited constraint concerned the short supply of technology inputs: BBM parts, fertiliser and appropriate seed. Although MOA had a fertiliser credit scheme for farmers, they felt that the supply was not adequate and that it was usually issued too late to be of any use for early planting. This was because creditworthy farmers were being penalised by being refused receipt of fertiliser on credit if other farmers within their Peasant Association failed to settle their debts.

Since BBM benefits are enhanced when in combination with other technological components, the attitude of farmers towards each component had a great bearing on the adoption of the BBM. For example, as early planting (dry planting) of cereals was a new agronomic practice, farmers initially felt that it could be a loss of investment in seed and fertiliser if the main rain delayed. Eventually, however, after most farmers adopted the technology, and used fertiliser and improved seed, the emphasis shifted to technology transfer of the modified BBM.

If a short dry spell occurred during the main rains, there was pest attack on early planted crops, particularly at lower altitudes. This was another concern expressed. The problem needed chemical control measures.

A major drawback to the spread of improved Vertisol technology was the shortage of extension staff to give advise. Consequently the improved use of animal traction was not given the emphasis it deserved.

To popularise the technology during 1991 and 1992 three modules were used at Ginchi, Debre Zeit and Inewari:

1. Farmer-to-farmer contact: Enthusiastic farmers who participated in the previous on-farm verification research were encouraged to teach and assist other new farmers to use the technology.

2. Encouraging interested individuals among the farming community to promote the technology.

3. Technology inputs were made available to farmers. Observation was made on whether those who had previously used the technology would continue using it.

4. In addition, development agents (DAB) of the MOA were involved and encouraged to train farmers and popularise the technology for wider dissemination.
