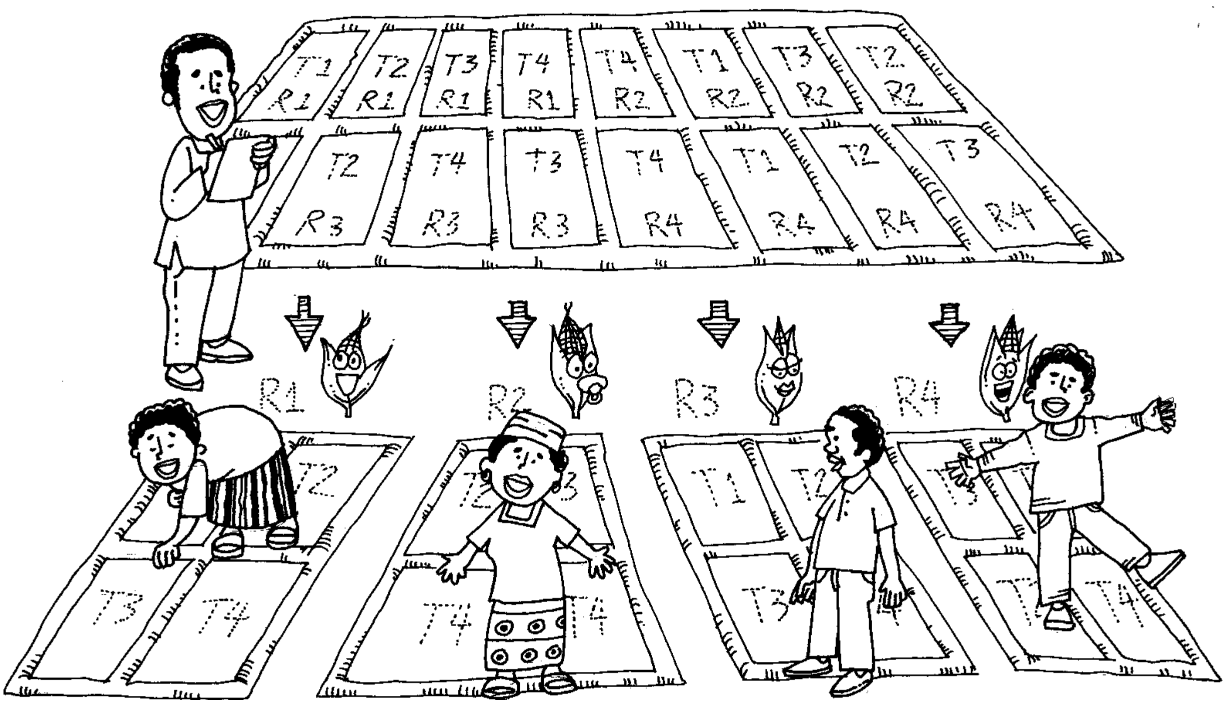
34

Mother-Baby Trial Approach for Developing Soil Water and Fertility Management Technologies



Smallholder farmers in sub-Saharan Africa face severe soil fertility crisis. Surveys in Kenya, Malawi, Zambia and Zimbabwe consistently show high amount of soil nutrient deficiencies, caused by continuous cereal cultivation with limited use of fertility inputs. Fertilizer use is very low, particularly in semi-arid areas. Researchers have hypothesized that currently-available technologies are a poor fit with farmers' resource endowments, investment priorities and risk preferences. In such case, it is believed that Farmer Participatory Research (FPR) is needed to develop technologies that are better suited to smallholder conditions, and hence more easily adopted.

> Many researchers now argue that virtually all research should involve farmer participation (Ashby *et al*. 1987, Chambers *et al*. 1989, Hagman *et al*. 1998). But despite the proliferation of FPR research and methodological tools, **there has been little analysis on what kind of participatory research leads to what outcomes and why some methods are more successful than others.** Alternatively, if certain outcomes are desirable in a given situation, what kind of participatory research should be encouraged?

The mother-baby approach is an on-farm participatory mechanism to introduce and test a range of technology options suited to a heterogeneous community (Snapp 2002). It involves three "levels" – mother trials, baby trials, and farmer experimentation (Figure 1). This trial design serves multiple functions: generating data on performance of alternative technologies, creating the basis for researcher-farmer dialogue to refine the options being tested, and encouraging farmer experimentation even in the absence of researchers. The approach is used to help characterize farmers' risk management strategies, target technology to specific groups (e.g., women farmers), and to provide lessons on how to broaden adoption.

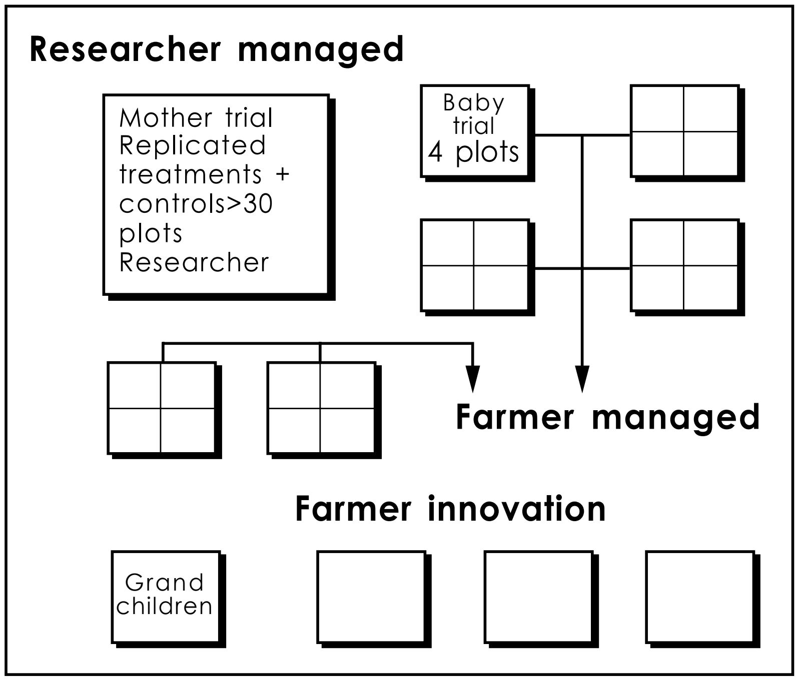


Figure 1. Typical Mother-Baby Trial Layout used in Malawi

Table 1. Levels of the Mother-Baby Trial Approach

Mother trials	Baby trials	Farmer experimentation
❑ researcher designed ❑ researcher managed ❑ completely randomized with 2–4 replications/site ❑ designed to compare "best bet" technologies	❑ located around mother trials ❑ consist of a few treatments chosen from the mother trial ❑ unreplicated ❑ maybe managed by farmers or researchers ❑ allow farmers to see for themselves the performance of treatment at different trial sites ❑ allow for faster larger-scale testing at different locations under different management conditions	❑ farmers select and test technologies of their own choice ❑ they develop their own methods to experiment ❑ modify treatments when needed, share results with other farmers, and identify technologies that offer significant benefits

Mother-Baby Trials

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) field tested the Mother-Baby participatory on-farm approach for developing low-cost soil water and fertility management technologies suited to smallholder farmers in marginal areas. Rather than a single "ideal" technology, the Mother-Baby approach was used to test and promote a "basket" of options, to account for diversity in farming objectives, resource endowments, and tolerances for risk.

> The field project was implemented in collaboration with the national research and extension services, Bunda Agricultural College, Concern Universal, and International Center for maize and wheat improvement (CIMMYT). The trials were extended to Zimbabwe in collaboration with the national program, CIMMYT, TSBF, and the Intermediate Technology Development Group.

Using this approach, researcher-derived "best bet" technologies were evaluated in Malawi for four seasons.

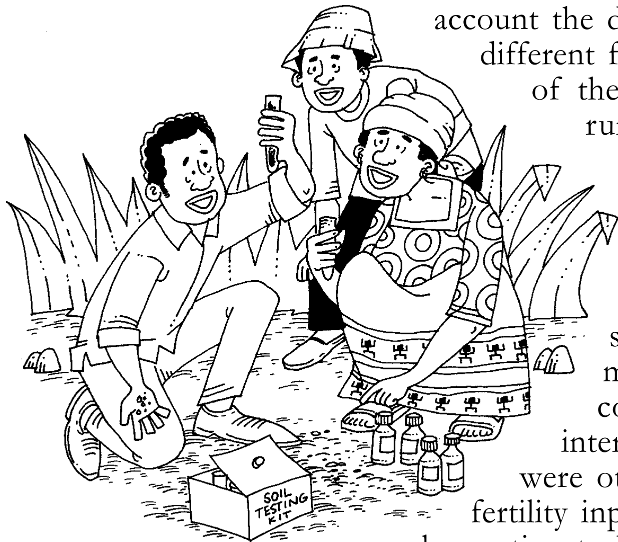
The fieldwork was conducted in six case study areas: three each in Malawi and Zimbabwe, representing a diversity of conditions – in terms of agro-ecology (e.g., rainfall ranging from 400 to 1500 mm), population density, and marketing infrastructure. The soils are mostly sandy or sandy clay, easy to cultivate but inherently infertile, with low organic matter content, and deficient in nitrogen, phosphorus and sulfur.

The average farm holdings in Malawi and Zimbabwe are 2 has and 3.2 has, respectively. Maize is the dominant crop. Maize is often intercropped with a variety of legumes and other crops. Some farmers also grow cash crops – tobacco and cotton in Malawi, sunflower and cotton in Zimbabwe. In the wetter areas farmers produce marketable surpluses of maize and cash crops. In the drier areas, most households fail to produce grain surplus to their requirements, and earn the bulk of their cash income from livestock production and labor migration.

To achieve faster and greater impact, the Mother-Baby trial approach was combined with crop simulation modeling using the Agricultural Production Systems Simulator (APSIM) model. APSIM was used to formulate "best bet" options for on-farm testing. In turn, on-farm testing generated data for validating APSIM and for developing "what if" scenarios. Outcomes and risks were estimated for several important scenarios, and risk-return tradeoffs calculated for alternative soil water and fertility management options. This allowed temporal comparisons of risks and returns from these technologies. The results were then used as a basis for discussion among stakeholders – farmers, extensionists, and private sector input suppliers – about scaling up.

Application of Mother-Baby Trials in the Field

Baseline crop management surveys were implemented to set research priorities and benchmark adoption rates for technologies targeted by the project. Researchers designed "best bet" soil fertility technology options, taking into



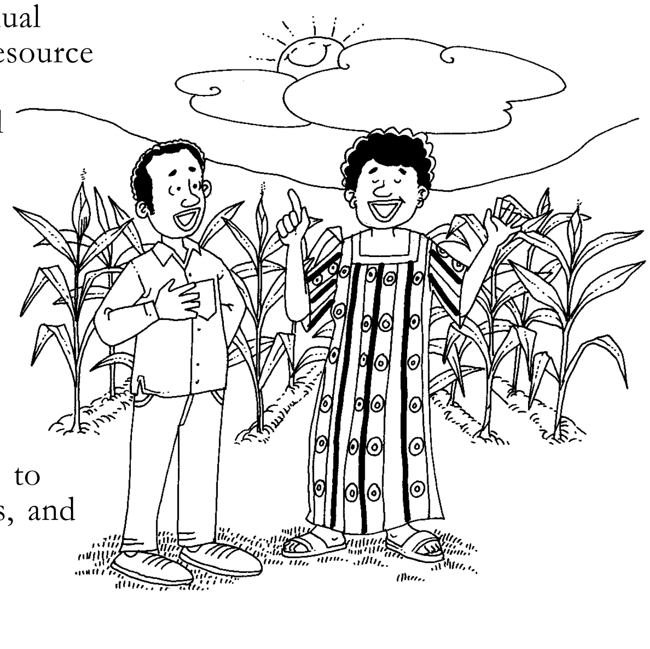
account the different needs and resources of different farmers. This was based on findings of the baseline surveys and participatory rural appraisals.

Originally, the best-bets focused on small quantities of chemical fertilizer. These were expanded during experimentation to include small quantities of cattle and goat manure, manure-nitrogen fertilizer combinations, and maize-legume intercrops and rotations. Also tested were other technologies that complement fertility inputs, such as weeding, water harvesting techniques (modified-tied ridges, dead level contours, infiltration pits), and seed priming.

At the start of the project, researchers, extension and NGO staff, and farmers were trained in FPR methods, as well as simulation modeling. Over 600 trials were planted: 10 Mother trials and 455 Baby trials in Malawi (over 4 seasons), and 27 Mother and 117 Baby trials in Zimbabwe over 2 seasons. Trials were monitored by field enumerators, who visited host farmers periodically over the season, and recorded detailed observations on a standardized format. Soil samples were also collected and tested to monitor changes in soil fertility.

Field days were held at all six study areas. Host and non-host farmers visited trials as a group and compared them with their own experiences (baby trials and farmer experiments). Comparisons were made using farmer-derived criteria as well as standard ranking methods (matrix, pairwise and absolute rankings), and provided a better understanding of farmers' preferences and priorities.

Farmers were surveyed at the end of the season to collect data on farmers' individual rankings of the technologies, resource endowments, knowledge and understanding of trials and trial results, changes (if any) in farmer practice, and farm production. These data were used for assessing the risk-return tradeoffs of investments in the best-bet technologies relative to other investment options available to farmers. Researchers and extension agents were surveyed to assess changes in their practices, and record their perceptions of the Mother-Baby approach.



Outcomes of Applying Mother-Baby Trials

Based on the FPR conducted on the Mother-Baby trial design, the following results were ascertained.

- **The Mother-Baby trial is a good communication and learning tool and generates swift results**.
  Farmer participation results in the generation of a broader range of technologies that are scientifically sound, practical, and adoptable, with significant potential for improving farming methods, yields, and household food security. The approach helps researchers establish a good understanding and mutual trust with farmers. Farmers give feedback on technologies that they find most useful (with very honest assessments), and even advise researchers how to improve their methods. Extension agents benefit from a better understanding of the criteria farmers use when making adoption decisions.

- **Spontaneous adoption began during experimentation**.
  Farmers are encouraged to experiment, and gain the confidence to apply the new technologies not only on trial plots but on their main fields. Group experimentation, evaluation and decision-making result in faster learning compared to individual experimentation and assessment. Although households farm as individual families, technology adoption is often a group decision.

- **There is differential uptake of technologies, and gender is an important factor**.
  Male-headed households tend to adopt technologies that are labor intensive and land extensive (e.g., cereal-legume rotations and green manures). *De facto* female-headed households favor technologies that are cash-intensive and labor saving (e.g., hybrid seed and inorganic fertilizers). *De jure* female-headed households adopt technologies that are cash and labor saving (e.g., cereal-legume intercrops, and dead level contours that are constructed during the off-season).

- **The process by which farmers participate is important in identifying the most suitable technologies and disseminating them quickly.**
  If participation in trials (choice of host farmers) is based purely on who volunteers, this results in sampling bias and factor biasing of the technology options. The trials will mostly benefit farmers who can afford to buy hybrid seeds and fertilizers; and have livestock, implements and carts to transport manure. In contrast, specifically targeting resource-poor households during selection of host farmers results in a broader set of technologies.

Conclusions

Five main lessons have emerged from these trials.

- A substantial amount of high quality data can be collected on-farm using a Mother-Baby approach. The quality of data is often comparable to that from an on-station trial.

- The suitability of technologies to different households is empirically observable and can be used to predict adoption potential and target these technologies accurately in new areas.

- The approach encourages farmers to experiment, and they rapidly gain the experience and confidence to use the technologies in their main fields.

- Farmers conduct adaptive research that can be used for moving from process research at the plot level to analysis at the whole-farm, landscape and watershed levels in order to define adoption boundaries and scale out technologies.

- The Mother-Baby approach leads to joint researcher-extension learning, feedback, and changes in practice by both groups. This helps improve the efficiency of research and extension, improves accountability, and produces greater impact.

Recommendations

The Mother-Baby trial approach, initially tested for fertility management technologies, has now been adapted for variety evaluation as well. CIMMYT's Southern African Drought and Low Soil Fertility Project uses the approach to test maize varieties under researcher-managed (mother) and farmer-managed (baby) conditions. The Mother-Baby design is particularly useful for technologies that are easily copied and can be spread through spontaneous farmer-to-farmer exchange but are currently limited by sociological and cultural factors such as witchcraft and grant systems of exchange.

Three recommendations are made for further adaptation.

- Adapt the Mother-Baby trial approach for better targeting of best bet technologies. There is a need to move from plot level to whole-farm, landscape, and watershed scales of analyses; and link crop simulation, household survey data, mathematical optimization methods, and GIS to define adoption domains. The Mother-Baby methodology needs to be adapted to analyze the average treatment effects of technologies when there is self-selection among host farmers and plots and substantial heterogeneity.

- Adapt the Mother-Baby trial design for group-based adaptive work for making the transition from research to dissemination through Farmer Field Schools (FFS). The FFS experiment plots can be designed as the Mother trial and farmers' individual trial plots as Babies.

- Adapt the Mother-Baby trial approach for shifting the focus of extension from moving individual components (e.g., soil conservation, tillage, soil fertility management) to integration of several components. The Mother-Baby trial approach needs to be adapted to develop ways of presenting to farmers the interaction between different technology components in order to accelerate adoption.

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