Assessing agroforestry adoption in tribal areas of Maharashtra, India

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Summary

In India, the *wadi* agroforestry system promoted by the NGO BAIF Development Research Foundation, has been by any measure outstandingly successful in terms of both rates of adoption, and retention after project cessation, with a significant impact upon the livelihoods of disadvantaged, poor farmers. Between 2001 and 2005, BAIF implemented a large scale *wadi* programme amongst hill tribe peoples in the Western Ghats of Maharashtra, together with accompanying social development actions. This article describes a study undertaken in 2014 to determine why some farmers did and others did not adopt *wadi* agroforestry systems. Sixty four percent of eligible farmers (those with 0.4 ha or more of land) did adopt, rates of retention were high, there was a great increase in tree cover on their farms and evidence that pressure on remaining local forests for fuel wood was decreasing. However, somewhat unexpectedly, none of the commonly used extrinsic variables such as size of farm, age and education, numbers in the household, capital assets, *etc*, were significantly different between adopters and non-adopters (and thus were not useful predictors of adoption). Although not studied in the same detail, it is suspected that less tangible intrinsic (socio-psychological) factors may have been better at explaining farmer behaviour. It is suggested that these factors should be taken into account in future adoption studies.

Introduction

The adoption of externally-facilitated agroforestry practices has been studied extensively by researchers in recent decades. This interest has largely been borne out of recognition that agroforestry development projects have a reputation for achieving limited success, with low and uneven adoption rates, and frequent abandonment occurring soon after cessation of implementing projects (Pattanayak *et al*, 2003). This is despite the fact that there are numerous examples of indigenously developed agroforestry practices in a wide range of agro-ecosystems around the world. In this article, we describe a development programme in India in which agroforestry is a central component and where adoption of a new practice has occurred on a very large scale. Known locally as *wadi* (meaning small orchard in Gujarati), this innovation has been co-developed by a non-governmental organization called BAIF Development Research Foundation (BAIF), working in partnership with Scheduled Tribes (commonly known as tribals or *adivasi*) for over three decades. *Wadi* agroforestry has proven to be very successful and is retained by the majority of participants for many years following initial adoption.

According to Mercer & Miller (1998), one of the common factors which contribute to the low uptake of externally-facilitated agroforestry practices systems is inadequate attention given to socio-economic factors in the development of agroforestry projects. Increased socio-economic research is therefore required in order to better understand the challenges that constrain agroforestry adoption processes (Current *et al*, 1995). Pattanayak *et al* (2003) pooled data from 32 empirical studies to identify the typical determinants of agroforestry adoption. These included: age, gender, education, wealth or social status, household assets (land, labour, livestock and savings) and biophysical factors such as soil quality and slope

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of farmland. Such household and farm characteristics together are referred to as 'extrinsic variables'. These potential explanatory variables were also used in the study described in this article.

The development approach of BAIF

BAIF (www.baif.org.in) is based in Pune, Maharashtra, and was established in 1967 with a mission to promote sustainable livelihoods and improve the quality of life and local environments of tribal people and other disadvantaged groups in rural parts of India. Programmes implemented by BAIF include artificial insemination, cattle and goat husbandry, watershed development, sustainable agriculture and agroforestry. The prototype *wadi* agroforestry model evolved initially in Gujarat in the 1980s and from 1995 was scaled-up under the KfW-NABARD (KfW Bankengruppe - supported) Adivasi Development Programme Gujarat (ADPG). The success of this programme led to its replication in Maharashtra from 2000 under the Adivasi Development Programme Maharashtra (ADPM). Subsequent scaling-up of the *wadi* approach has been supported by various national and international donors, and BAIF reported in 2012 that in excess of 180,000 families in nine states had participated in their *wadi* development programmes. In addition, since 2005, the *wadi* model has been institutionalised by NABARD through its Tribal Development Fund (TDF), which has supported a network of NGOs implementing *wadi* projects and is projected to benefit a further 320,000 families across 21 states of the country.

The *wadi* concept is a holistic approach that takes all aspects of rural life into account. The main objectives of the *wadi* programme are food security and poverty alleviation through development of wastelands. In the context of India, wastelands are defined as land capable of being, but not currently under, cultivation (Chaturvedi *et al*, 2014). As listed below, the *wadi* programme has a number of integrated components:

- Agro-horti-forestry (*wadi*);
- Soil and water conservation;
- Water resource development;
- Agri-business;
- Allied livelihoods; and
- Social mobilisation (farmer groups, cooperatives and federations).

Agro-horti-forestry is the core component of the *wadi* programme. This involves establishment of multipurpose trees around the field boundary - generally reinforcing soil and water conservation measures such as trenches and bunds - along with fruit and/or nut trees in the field, where wide spacing allows continued cultivation of annual crops (see Figures 1 and 2). A typical size is one acre (0.4 ha), but this is quite variable.

In May to July 2014, two of the authors (Pratik Doshi and James Brockington) conducted a study in Maharashtra to explore the determinants of adoption and retention of *wadi* by tribal households who had participated in the ADPM. The ADPM was implemented from 2000 to 2011 by Maharashtra Institute of Transfer of Technology in Rural Areas (MITTRA), a sister organisation operating under the umbrella of BAIF. Implementation was phased in five batches, one each year from 2001 to 2005, with each batch then receiving a further

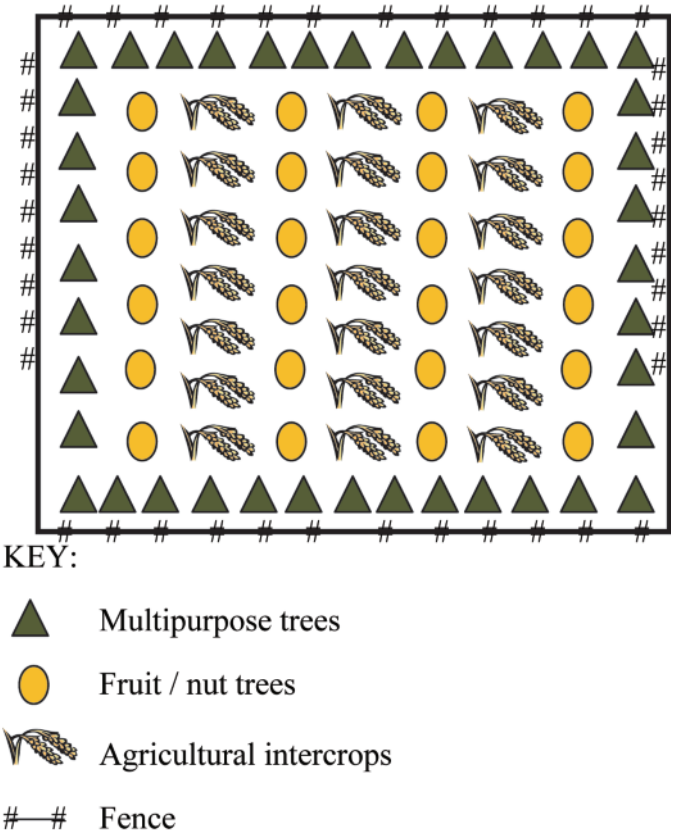

Figure 1. Schematic diagram of *wadi* layout (not to scale)

Figure 2. *Wadi* plot (~10 years old) in dry, pre-monsoon conditions. (Photo: James Brockington)

five years of technical inputs from MITTRA. A total of 13,848 families from Peint and Surgana blocks in Nashik District and Mokhada block in Thane District took part in the ADPM programme.

Methods

This study was carried out in three villages of Peint *taluka* (administrative block), which is approximately 60 km from the city of Nashik in western Maharashtra. Located in the Sahyadri (Western Ghats) range, the topography is hilly and intersected with deep ravines. Much of the dense teak forest that once covered the area has been cleared, leaving a mosaic of remnant forest, agricultural fields, human settlement and wastelands. For the predominantly tribal people who live here, rainfed

agriculture is the primary livelihood strategy. However, despite the region receiving 2,500+ mm of rain in a typical monsoon, lateritic soils and denuded slopes mean that little water is available for crop cultivation outside of the rainy season. In the absence of local employment opportunities, migration is common in the long dry season.

Eighty six farmers were selected for the study using stratified random sampling. Of these, 48 were *wadi* adopters and 38 were non-adopters. A mixed methods approach was employed with quantitative, qualitative and geo-spatial data collected. Households were interviewed using a structured questionnaire to elicit both quantitative data relating to socio-demographics, livelihoods and land-use, and narrative data on the reasons for adoption (or non-adoption) and retention (or abandonment) of the *wadi* innovation. Extrinsic variables were analysed using binary logistic regressions, as is common in such studies, to determine those factors influencing adoption or non-adoption.

The questionnaire was designed using Kobo software and entered directly in the field on to a handheld tablet computer using the Android operating system (Figure 3). This approach was used to eliminate the need to manually transcribe survey forms, thus saving time and improving data quality. Kobo software automatically integrates data from multiple questionnaires into a single database. Agroforestry plots belonging to those households interviewed were also surveyed using a handheld GPS unit to record their geospatial location and extent. An inventory of each plot was conducted to determine numbers and species of trees and agricultural intercrops.

Figure 3. Farmer interview using handheld tablet under mango tree. (Photo: James Brockington)

Results and Discussion

Landholdings in the sample of 48 adopting households ranged from 0.4 to 4.9 ha with a mean area of 1.9 ha (Figure 4). The 38 non-adopting farms were slightly larger, the mean area being 2.04 ha. Mean area per farm of agroforestry of all origins was 0.52 ha. Extensions of the BAIF mediated *wadi* agroforestry were observed in four households out of the 48 adopters, measuring 1.4 ha. Cases where farmers independently established agroforestry plots (*ie* without BAIF support) covered a further 1.8 ha. Figure 4 shows that two households converted all their land to BAIF's *wadi* agroforestry, but on average, agroforestry (all categories) covered 27 percent of adopters' farmland. In land-use change (adoption) studies this is a common finding, where farmers take a cautious approach to uptake of new technologies and typically only convert a small part of their farmland.

At a landscape scale, 64 percent of eligible households (those with 0.4 ha or more of farmland, which was 66 percent of all households) adopted BAIF mediated *wadi* systems. Assuming ours was a representative sample, across the three villages, agroforestry can be estimated to cover approximately 10 percent of farmed land (because we do not have data for the areas of < 0.4 ha non-eligible farms).

At the time of the survey, the mean number of surviving fruit trees per farm was 43 (57 percent survival rate up to 14 years after initial establishment). The majority (52 percent) were cashew (*Anacardium occidentale*), 36 percent were mango (*Mangifera indica*) and 12 percent were amla (*Phyllanthus emblica)*, plus a few tamarinds (*Tamarindus indica*). When extending their plots farmers also included other fruit species such as jackfruit (*Artocarpus heterophyllus*), custard apple (*Annona reticulata*) and guava (*Psidium guajava)*. In addition, there was an average of 157 (range zero to 1,000) surviving multi-purpose and forestry trees around the boundary of each *wadi* plot. Common species included *Acacia* spp, *Bambusa arundinacea*, *Casuarina equisetifolia*, *Dendrocalamus strictus*, *Madhuca indica*, *Pterocarpus indicus*, *Tectona grandis*, and *Terminalia arjuna*.

There were indications that about 70 percent of adopters were obtaining up to 20 percent of their fuelwood and another 20 percent obtained all their fuelwood needs from their *wadi* plots. On the other hand, 90 percent of non-adopters were still extracting all their fuelwood needs from the remnant forest that still remained in the locality. The species of preference for

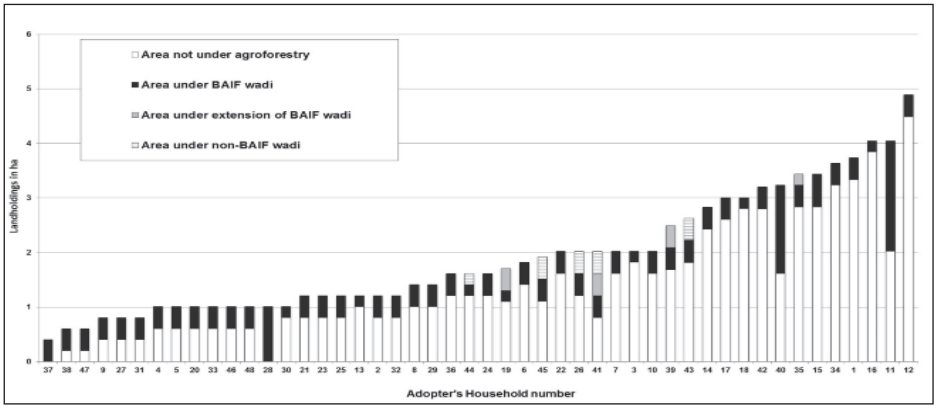

Figure 4. Agroforestry plot area for each of 48 households adopting *'wadi'*

Table 1. Principal reasons for adoption or non-adoption of *wadi* technology*

***Wadi* technology**			
Reasons for adoption	**% of adopters**	**Reasons for non-adoption**	**% of non-adopters**
Expectation of future income from the wadi	75	Land tenure issues	18
BAIF's development approach	35	Household migration	16
Fruit yields can enhance HH consumption	29	Lack of information	16

(* Multiple responses from each farmer were permitted)

fuelwood is *Terminalia arjuna* locally known as *sadada*. This species is also managed by pollarding to provide woody materials for *raab*, a traditional technique of ground preparation prior to the monsoon season involving burning to destroy weeds and weed seeds. Apart from *sadada*, teak (*Tectona grandis*) is also extracted for building purposes (see Figure 5) and for fuelwood.

One of the objectives of the *wadi* programme was to reduce distress migration in tribal communities, which is an imperative for many due to persistent food and financial insecurity but can lead to adverse impacts on social cohesion, family health, education of children, *etc*. Change in migration practice was not used as a variable to explain adoption in this study, but rather was hypothesised to be an important outcome of adoption of *wadi* and the attendant social development. However, there was no significant effect on migration habits as a consequence of the *wadi* programme, although in areas with longer established *wadi* plots in Gujarat, anecdotally there was a much reduced tendency for seasonal migration.

Rather to our surprise, none of the measured 'extrinsic' variables proved significant in predicting why some farmers adopted the *wadi* practice and others did not; this contrasts with our findings in an earlier study of *wadi* adoption conducted in the state of Karnataka (Brockington & Brook, 2014). Clearly there were (unmeasured) factors that did influence the adoption decision. We believe that these must be socio-psychological (or 'intrinsic') in nature, and relate to the aspirations, attitudes, perceptions and knowledge of individual farmers. Meijer *et al*, (2015) argue that uptake of any agricultural innovation (including agroforestry practices) is a complex process and farmer decision-making is influenced by both intrinsic and extrinsic variables. Although we did not attempt to measure intrinsic variables empirically in this study, we did collect narrative statements from farmers about their reasons for and against adoption of the *wadi* practice. Table 1 presents a summary of these.

The majority of the respondents who adopted (75 percent) cited anticipation of future income generated from fruit tree and crop yield as a primary factor in their decision to take up the *wadi* practice. Another common factor reported (35 percent) was BAIF's approach, which involved village planning meetings, exposure visits to other sites with established *wadi* plots, formation of farmer groups, provision of free planting materials and technical guidance. Household consumption of *wadi* produce was also important (29 percent). Other factors identified included: the influence of other villagers, the availability of suitable land for *wadi*, interest in cultivating forestry trees, and opportunities to control livestock.

Eighteen percent of non-adopters responded that there were land tenure issues (generally arising from unresolved inheritances, as most households had secure tenure). Sixteen percent reported that their household was heavily dependent on seasonal migration for employment and did not feel that adoption was possible or desirable given long periods away from the village. Another 16 percent of respondents reported that they had difficulty in getting information about the programme. Other less frequent responses included were health issues, perceived lack of water, poor financial condition, and no interest in planting trees.

Figure 5. Farmer building his house with *Tectona grandis* (teak) extracted from adjacent, remnant forest (probably illicitly). (Photo: James Brockington)

Adopting farmers also reported various challenges in managing their *wadi* plots once established. Common problems included infestation by pests (65 percent) such as rodents, termites, and the tea mosquito bug (probably *Telopelti santonii*) on cashew trees, lack of a water source for irrigation (48 percent), damage caused by livestock (39 percent) and damage to fruit crops caused by adverse weather events (19 percent).

Adoption of *wadi* was producing positive effects on farmers' livelihoods: 48 percent of adopters reported income generation from fruit yields; 35 percent reported household consumption of fruit; 20 percent reported using forestry trees to supply fuelwood and poles for house construction/renovation; and 13 percent reported using forestry trees to supply materials for *raab*.

Conclusions

It was clear that the *wadi* agroforestry practice as extended by BAIF, alongside their other development initiatives, was attractive to the majority of farmers, who retained their agroforestry plots long after the end of the five year post-establishment support period. This is often a crunch point when smallholder farmers abandon new technologies. Our experience of *wadi*-based programmes elsewhere in India (Karnataka, Gujarat) indicated that our observations here are typical. BAIF's own data show that, once established, fewer than 10 percent of farmers abandon *wadi* plots. However, the incidence of subsequent expansion and farmer to farmer diffusion of the technology was low, suggesting that external support was a critical factor in influencing adoption behaviour.

The inability of extrinsic variables to explain why some farmers did and others did not adopt *wadi* was unexpected, given the findings on adoption reported by other researchers. A possible explanation in our case is that the tribal communities are rather homogeneous compared to a typical, highly diverse Indian village, comprising a large proportion of landless households and farms ranging from small sub-economic to quite large tracts furnished with electricity and borewells. Another factor is that the binary logistic regression is a fairly crude instrument which treats adoption as being a simple 'yes' or 'no' decision, whereas reality indicates a much more nuanced response to promoted innovations. In this study there was evidence that intrinsic reasons were important, and our future studies will integrate socio-psychological variables into the analysis of adoption behaviour.

We have not yet been able to fully explain the acceptability of *wadi* to poor smallholder farmers, given the poor uptake of many other natural resource management innovations in India and elsewhere in the tropics. Theory suggests that the simpler a technology is the more likely it is to be adopted, whereas the *wadi* practice is relatively complex (integrating a number of components and the technical knowledge required to manage them in combination) and yet is still widely adopted. BAIF have avoided the temptation to go for an agroforestry approach based around fertility-building, nitrogen-fixing tree species (although they are incorporated along field boundaries to provide fuel wood and fodder for livestock). Instead they have chosen to focus on creating multi-purpose orchards with high future economic value.

The support package that *wadi* project participants receive, including (1) technical guidance over a five year period, (2) free planting and construction materials, (3) financial compensation for the opportunity costs incurred in establishment and aftercare in the first three years (before the fruit trees begin cropping), and (4) marketing assistance through farmer cooperatives and an overarching producer company (Vasundhara Agri-Horti Producers' Company Ltd), is doubtless an important factor in catalysing uptake. Some look askance at what is considered to be a subsidy; but then much of European and North American agriculture is heavily dependent upon subsidies. However one wishes to view the methods employed, there is no question that BAIF's holistic approach to agroforestry and rural development has been an outstanding success across large areas of India, and there is much we can learn from it.

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