Forest management innovations, forage development practices and livestock in the hills of Nepal

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Abstract

Public programmes aimed at regenerating degraded forestland and supporting marginal farmers in the hills of Nepal, through leasehold arrangements and forage and livestock development measures, have emphasised exotic legumes (*e.g. Stylosanthes guianensis*) and grasses such as molasses grass (*Melinis minutiflora*) and napier grass (*Pennisetum purpureum*), along with the promotion of improved buffalo and goats. While introduced forage species were quite successful at low-medium altitudes, evidence suggests that technical packages should incorporate farmers' preferences and focus on the regeneration of local varieties, while considering traditional knowledge. Survey data indicate that the mean number of local goats per participating household increased while the mean number of buffalo per household was constant during the programme. This suggests that both forage and livestock development models need to be simplified in view of resource and marketing constraints and to be designed, implemented and evaluated with the full involvement of farmers.

Introduction

Nepal has suffered from high deforestation rates: 1–2% before the 1980s; and about 0.5% per year in the 1990s (Jha 1997; SAARC 1998/99). The adverse effects of deforestation on poor households, in terms of reduced availability of forage for livestock, dwindling labour supply for agriculture and decreased food security, have been analysed, *inter alia*, by Kumar and Hotchkiss (1988). More recent contributions (Thapa *et al*. 1998) have focused on the progressive intensification of farming practices, in particular the planting of trees and the increasing adoption of stall feeding as a technical change induced by scarcity of forest resources. Planting of trees on farms has been a typical response to declining access to forest resources for over 20 years in certain areas of the hills of Nepal (Kiff *et al*. 2000).

Two paradigms, community forestry and leasehold forestry, have emerged for the conservation and rehabilitation of forest. Community forestry has been supported by numerous international donors since the 1980s. It consists of devolving the management of well stocked national forest to communities of 500–1500 households to prevent over-exploitation of the forest resource. A more recent paradigm, leasehold forestry, has been tested since 1993 to rehabilitate already degraded forest plots and alleviate poverty in the hills of Nepal.[1] Under leasehold forestry, the management of small plots (up to 10 ha) of already degraded national forestland is entrusted to groups of 5–10 small and marginal holders (generally owning no more than 0.5 ha of cultivated land) for 40 years. After 40 years, the lease is considered renewable, although there is no clear provision in law. To date, lessees have not been required to pay rental fees. Groups agree upon and adopt 5-year forest-rehabilitation and management plans, which notably include an immediate ban on grazing. After regrowth has started, leasehold group members have the right to collect forest products (forage, fuel wood, timber,

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tree fruits, etc.) according to the management plan. At the beginning of 2003, about 7400 ha of degraded forestland had been leased to almost 12 000 households, circa 0.6 ha per household (IFAD 2003).

The leasehold programme has been implemented in 10 districts of Nepal. The forage development plan has been carried out in a similar fashion in each district: leasehold groups have been generally formed in winter (September–January) and forage species planted in the ensuing summer/rainy season. Stylo (*Stylosanthes guianensis*) cv. Cook and molasses grass (*Melinis minutiflora*) are the predominant species introduced in all districts, followed by napier grass (*Pennisetum purpureum*). Seed is sown according to the traditional ploughing technique or by broadcasting at all sites, generally without chemical fertilisers and without irrigation. No grazing is allowed and a cut-and-carry system is adopted. Initial harvesting of forages is done after 60–90 days, with subsequent harvests every 60 days. Leasehold plots are assigned to small groups of marginal farmers' households. However, plots are managed individually rather than on a collective basis. Plots are generally divided into sub-plots. A particular household may be responsible for the management (and entitled to collect forest products) of the same sub-plot over a number of years or sub-plots may be reassigned each year through a lottery system.

The contribution of livestock in intensive smallholder subsistence farming in Nepal is important: in satisfying household milk and meat requirements, for draught power, as a source of manure, for cash income and in religious functions. For these reasons, the leasehold programme included forage and livestock development activities, in addition to forest rehabilitation. Forage activities focused on the development of grasslands and shrublands, particularly on the establishment of appropriate exotic grasses, legume species and fodder trees (supplied free of charge to farmers) on both the leasehold plots and private crop land, while attempts were also made to establish fodder trees through the development of fodder tree nurseries. Livestock activities originally included the provision of 'improved' goats and buffalo (although in many instances, local goats were provided). Goats were distributed through a 'passing on the gift' programme with a household receiving does (generally 4) and a buck free of charge and having to pass on the first pair of female progeny to the neediest neighbour. Transport subsidies were provided for buffalo of improved breeds purchased from other districts.

While the focus on intensive livestock development seems, *a priori*, a relevant strategy to reduce poverty in the hills of Nepal, the soundness of the technical packages originally proposed, which relied largely on subsidised exotic forage and livestock species, is open to question. After a brief illustration of the applied methodology, the remainder of this paper will: present the available evidence on the performance and suitability of introduced forage species, with emphasis on the stated preferences of farmers; review evidence on the effects of leasehold forestry on trends in the ownership of both small and large ruminant livestock; and discuss options to simplify and improve the relevance and effectiveness of the technical packages.

Materials and methods

The paper is based on both primary data and the review and analysis of existing documentation and data. Primary data were obtained through: (i) participatory rural appraisal (PRA) tools (Chambers 1981); (ii) a survey of 107 households; (iii) interviews with government extension staff; and (iv) direct observation of about 50 leasehold sites. In addition, statistical analysis was carried out on available household data collected from 78 leasehold households (sites established in 1995) through surveys in 1996 and 1999. Available reports and studies were also reviewed (Shah *et al.* 1998; NARC 2001; Ohler 2001; Singh 2002; IFAD 2003). Field work was conducted by the authors in March 2003, by visiting 10 districts covered by the leasehold programme, although the PRA and survey activities were carried out in only 5 (Chitwan, Dolakha, Kavrepalanchowk, Ramechhap and Tanahun). The 1996 and 1999 surveys had been carried out in the districts of Dhading, Dolakha, Kavrepalanchowk, Makwanpur, Ramechhap and Sindhupalchowk, so data from those and the 2003 survey were not completely comparable. The districts used in the 2003 survey were selected to represent different agro-ecological sections of the leasehold programme area (the district of Gorkha was excluded for security concerns). Accordingly, 2 districts were selected in higher hill areas (approx. 1700–2300 m), 2 in mid-altitude

areas (800–1700 m) and 1 in the lower altitude area (300–800 m). In each district, 3–5 leasehold sites were chosen at random and 5–7 leasehold group members per site (women and men) were randomly selected for interviews. During the interviews, PRA tools, checklists and quantitative questionnaires were administered to respondents. The PRA tools were used to elicit the preferences for forage species and the perceived effects of participation in the leasehold programme. Firstly, leasehold members were asked to rank forage grasses and legumes in terms of dry matter production (biomass), provision of bedding materials, contribution to manure, contribution to milk production and preference of animals. Secondly, discussions were held on changes in access to and management of forage before and after the project, changes in forage self-sufficiency, appropriateness of introduced species and ownership and marketing of livestock. Both the ranking process and the discussions were held in a focus group for a given site, facilitated by the authors and lasting about two hours. After the focus-group discussion, the same farmers completed a short survey questionnaire individually, dealing with status and trends in livestock ownership, in about one hour. In addition, the local leasehold site and the homesteads of the respondents were visited for an additional 2–3 hours.

Site observation and informal interviews with other leasehold members and government extension staff provided further useful information as well as a means of double-checking evidence collected through the previous structured and semi-structured interviews.

Results

Rehabilitation of degraded forest land and forage development

The overall visible effect of converting degraded forest land into leasehold plots was that of forest regeneration and increased plant diversity, as a result of a ban on grazing and improved management, including the introduction of forage species. Reportedly, these changes were obvious within 12–18 months from the assignment of leasehold plots, but careful discussion and consultation with the concerned communities were described as prerequisites to generate leasehold group cohesion and dynamism and to reduce the likelihood of conflicts and encroachment problems (Ohler 2001; Singh 2002). In several instances, through consensus among group members, leasehold plots were further subdivided between groups and managed by individual households either permanently or in shifts through a lottery system.

At elevations up to 2000 m (lower to mid-hill elevation with mostly subtropical climate), farmers were able to collect a significant quantity of local forage species soon after the ban on grazing was applied and even before the introduction of exotic forage species. Examples of dominant local forages at most sites were arthunge (*Heteropogon contortus*) and salimo (*Chrysopogon gryllus*).

In addition to spontaneous regrowth, exotic grasses and legumes, including stylo, molasses grass, napier grass and broom grass/amriso *(Thysanolaena maxima*), were introduced mostly on leasehold plots and sometimes on agricultural land (private farm land). Jointvetch (*Aeschynomene americana*) and oats (*Avena sativa*) were also successfully introduced on the farmland of leasehold farmers, particularly on fallow land after the rice harvest. However, the degree of success varied depending on the nature and fertility of leasehold sites. Introduced species were quite successful in producing more dry matter if grasses and legumes were planted on separate plots, taking into consideration the shading effect of trees. On the other hand, in their efforts to establish exotic varieties, such as stylo, farmers also had to deal with banmara (*Eupatorium adenophorum*), an unpalatable and noxious plant species. Banmara is notorious, mostly in low fertility soils, for dominating/encroaching other species — both local and improved. In one of the Tanahun sites, farmers cleared bushes (where banmara already existed) and introduced improved grasses/legumes, but banmara colonised the cleared area and quickly encroached the introduced species. According to the farmers, banmara flowers earlier than other species and its germinating seeds quickly dominate the soil pool. The only way to eradicate banmara is to clear it before flowering, and farmers have been learning this technique.

At high elevation (>2000 m), attempts to establish introduced pastures and legumes were more problematic, due to the slower pace of forest regeneration and the difficulty of introducing intensive practices and zero-grazing requirements in areas where animals had been freely grazed since time immemorial. Research for high

elevations concentrated on temperate pasture species, including perennial ryegrass (*Lolium perenne*), kote (native, *Medicago falcata*), dhimchhi (native, *Pennisetum facidum*), cocksfoot (*Dactylis glomerata*), Maku lotus (*Lotus pedunculatus*), white clover (*Trifolium repens*) cvv. Huia and Tahora and setaria (*Setaria sphacelata*). Our field observations suggested that a few farmers at high elevation generated some income from selling seed of temperate pasture species, but temperate pasture species were not generally suited to the cut-and-carry system.

Appropriateness of introduced species

The overall impression from the sites visited was that of a remarkable diversity (quality of soils, moisture and microclimate) between leasehold plots, even adjacent ones. Through the household survey, information was collected on farmers' preferences for different introduced grasses and legumes (Table 1). Overall, stylo was the most popular species (45.8%), followed by molasses (19.6%), napier (15.0%) and broom grass (10.3%).

Differences in the mapping of preferences between the visited sites were explained through ranking exercises conducted with farmers' groups. They were due to different perceptions of the significant characteristics of legumes and grasses and to the different 'weighting' of such characteristics. At a site in Ramechhap district, a pair-ranking exercise (Table 2) showed that, overall, molasses grass was the farmers' preferred species, followed in order by broom grass, napier and stylo; clover and oats/vetch were the least popular. From a purely nutritional standpoint and for milk production, stylo was ranked first, while white clover was considered a very suitable legume for the temperate region. However, as the site in question was severely degraded, dry and rocky, farmers preferred the sturdier molasses grass, followed by broom grass, which were easier to establish and capable of producing some green even during the dry season. Finally, as in the same site farmers were primarily raising goats and not milking buffalo, the nutritional value of stylo was not a particular advantage. At another site in Tanahun district, farmers sold surplus milk. Although they appreciated molasses grass

Table 1. Leasehold farmers' preferred (%) introduced forage species from 2003 household survey.

Forage/fodder	Districts					
	Ramechhap (n = 30)	Dolakha (n = 20)	Kavre (n = 13)	Tanahun (n = 21)	Chitwan (n = 23)	Overall (n = 107)
Stylo	53.3	30.0	–	42.9	78.3	45.8
Tall fescue	–	–	7.7	–	–	0.9
Broom grass	–	–	84.6	–	–	10.3
Oats/vetch	–	–	7.7	–	–	0.9
Local spp.	–	–	–	38.1	–	7.5
Molasses grass	40.0	40.0	–	–	4.3	19.6
Napier grass	6.7	30.0	–	19.0	17.4	15.0
Total	100	100	100	100	100	100

Table 2. Pair ranking[1] of different grasses and legumes at Ratomate (Ramechhap) from PRA exercise in March 2003.

	Molasses	Stylo	Broom grass	Napier	Oats/vetch	White clover
Molasses	×	Molasses	Molasses	Molasses	Molasses	Molasses
Stylo	×	×	Broom grass	Napier	Stylo	Stylo
Broom grass	×	×	×	Broom grass	Broom grass	Broom grass
Napier	×	×	×	×	Napier	Napier
Oats/vetch	×	×	×	×	×	Oats/vetch
White clover	×	×	×	×	×	×

[1] The entry in each cell represents the preferred species of the relevant pair. The final ranking (below) reflects the number of times each species was preferred.

Ranking based on total score

Molasses	I	Napier	III	Oats/Vetch	V
Broom grass	II	Stylo	IV	White clover	VI

(I = most preferred to VI = least preferred)

Table 3. Simple ranking[1] of different grasses and legumes by farmers in Polyang Sera (Tanahun) from PRA exercise in March 2003.

Parameters	Grass and legumes species				
	Oats	Napier	Stylo	Molasses	Joint vetch
Contributes more to milk production	II	II	I	III	II
Highly nutritious	II	II	I	III	IV
Produces more dry matter	II	I	II	II	III
Easy to grow/establish and can tolerate multiple cutting	II	I	III	II	IV
Palatable	I	II	I	III	III
Overall ranking	III	II	I	III	IV

[1]I = most preferred to IV = least preferred.

for its high dry matter production, they preferred stylo, due to its contribution to milk production (Table 3).

Some implications for extension packages

The focus group discussions and interviews suggested that farmers' preferences for forage species could vary significantly from one site to another due to differences in soils, slopes, microclimate and marketing opportunities (*e.g.* milk *vs* goat meat). Under these conditions, careful discussion and understanding of farmers' preferences rather than applying semi-rigid schemes would be a key strategy for extension workers. Successful packages would need to be flexibile, and ideally would be site-specific. However, the capacity of extension services to respond to local needs was often inadequate. Our interviews with livestock extension field staff suggested that they had been instructed to offer a limited number of combinations of grasses and legumes, following models developed by the National Agricultural Research Council. Extension field staff were often cognisant of the limitations of these packages but there were also limitations to the responsiveness of district authorities (for example in the provision of seed) in what appeared a centralised line of command. This explained why the inconsistency between supplied varieties of seed and farmers' preferences could persist over time.

Level of forage sufficiency

In general, the availability of animal feed improved for participating households. Most sites were described as barren and degraded when the programme commenced in 1995. When the field observations were made, vegetation had been established, with photographic evidence available for some sites. Farmers reported an adequate supply of bedding material/litter for year-round use in barns and stalls, a commodity which had been difficult to obtain. In addition, critical shortages of feeding materials were restricted to the January–February period. The duration of the average annual feed shortage declined from 3.7 months in 1996 to 2.97 months in 1999 (Table 4). In addition, the estimated average proportion of forage collected from leasehold land more than doubled, from 42.3% in 1996 to 98.7% in 1999.

Table 4. Feed and livestock trends (analysis of available household datasets from 1996 and 1999 surveys).

Parameter/Year	1996 (n = 78)[1]	1999 (n = 78)
No of months of animal feed shortage	3.70	2.97**[2]
s.e.	(1.52)	(0.94)
Estimated percentage of total forage from leasehold land	42.3	98.7**
s.e.	(49.7)	(11.3)
No of cattle units	2.88	2.96
s.e.	(2.87)	(2.05)
No of buffalo	1.38	1.31
s.e.	(1.40)	(1.30)

[1] Number of households involved.
[2] Difference significant at 1% level.

Productivity trends of introduced grasses and legumes

On the relatively 'old' leasehold sites (established in or before 1996/97), the productivity of stylo had been slowly decreasing, partly due to the increase in tree canopy closure, while productivity was maintained on new sites. Stylo is well adapted to tropical climates and is tolerant of low

fertility, drought, acidic soils and poor drainage (Singh *et al*. 1998). However, introducing stylo requires careful management during the early phases, as it establishes much more slowly than grasses. Stylo had been suppressed almost to the 'point of no return' by *Imperata cylindrica* at some sites of Chitwan District. *Imperata cylindrica* spreads readily by rhizomes and seed, and competes very successfully with other species (Singh *et al*. 1998). Stylo was also badly infested with anthracnose (*Colletotrichum gleosporiodes*) at many sites, especially in the relatively old plots in Sindhupalchowk district.

The productivity of molasses grass was also affected by the fertility status of the soil. Although it can grow well in infertile and degraded soils, its productivity declines with low levels of soil moisture; this was particularly the case at leasehold sites on dry slopes in Ramechhap district.

Sustainable production of introduced grasses and legumes was also affected by the patterns of establishment. For example, when molasses grass was mixed with stylo, stylo was mostly suppressed within a few years. On the other hand, when planted on separate areas, the productivity of both species was sustainable. We perceived the adverse effect of increasing tree canopy on the understorey forage species to be a significant problem, while farmers seemed largely unaware of the long-term effects of shade. Not all forages are shade-tolerant, and most will vanish if shade becomes excessive. The effects of shading were visible at more 'mature' sites. However, when farmers had maintained adequate open spaces in plots sown with grasses and legumes, forage species were not affected.

Marginal relevance of introducing fodder trees

Fodder tree species such as *Bauhinia purpurea, Flemingia microphylla*, *Artocarpus lakoocha* and *Leucaena leucocephala* had been provided to participating farmers. However, the impact of introduced fodder trees on leasehold sites was minimal, as most either failed to establish, or their growth was stunted. Initially, saplings were planted in a 50 × 50 × 50 cm pit, along with starter fertiliser [250 g di-ammonium phosphate (DAP) + 150 g sulphur (S) per pit]. At some sites, species such as *Leucaena leucocephala* and *Bauhinia purpurea* attained a height of 2–3 m in 3 years, but the survival rate was only 60% (NARC 2001). The success of planted fodder trees depended on the fertility status of the soil, available space, rainfall and soil moisture content. However, at several sites, farmers already had fodder trees on their private land (about 60–70 trees per household) and therefore did not plant fodder trees on their leasehold sites. In Nepal, farmers have traditionally protected and managed naturally grown or planted trees for fodder and bedding for livestock in and around their homesteads and farms, and plant species with multiple uses (Shrestha 2002). This may explain why some farmers considered that regeneration of natural species would have been a more successful approach than the introduction of fodder trees on leasehold plots.

Livestock situation at household level

Increase in small ruminants. Across all sites, farmers consistently reported an increase in the number of goats, due to increased forage availability. In Kavrepalanchowk district, leasehold groups owned a maximum of 2 goats before accessing the leasehold programme; at the time of the interview, every household had goats, with a maximum of 5–7. In Ramechhap district, before the implementation of the leasehold programme, 60–70% of farmers had only a single goat, while some had none. Almost all farmers now have 2–3 adult goats (the average is 4.9 if castrated and kids are included). Similar trends were found in the districts of Tanahun and Chitwan. The overall mean figure of goats (including castrated and kids) per household of leasehold farmers in the 5 districts was 5.23, compared with the mean for Nepal in 2001/02 of 1.5 goats/household (CBS 2003).

Static numbers of larger ruminants. Trends in large ruminant (cattle and buffalo) populations were quite different from that of goats. Farmers in Ramechhap reported a constant mean of 1–2 local buffalo per household before and after the leasehold programme. The findings from Kavrepalanchowk and Chitwan were similar, while only slight increases were reported in Dolakha and Tanahun. The analysis of 1996 and 1999 household surveys shows a practically unchanged mean of buffalo per household (from 1.38 to 1.31; Table 4). This is comparable with our own computed mean of 1.39 buffalo, although comparisons must be treated with a degree of caution, due to differences in sampling zones.

During interviews with farmers, no indications of major changes in the number of cows

or bullocks emerged following the adoption of leasehold forestry. Household surveys in 1996 and 1999 yielded means of 2.88 and 2.96 cattle per household, respectively (Table 4), while the average for our 2003 survey was 2.51. The same degree of caution must be applied, although the combined evidence does suggest a static or even slightly reduced number of cattle.

Productivity of animal species

Farmers preferred local breeds of goats, which would normally produce twin kids. These breeds have a shorter inter-kidding interval (kidding normally takes place twice in 15–17 months) and, most importantly, they are more resistant to disease than introduced goats. Small farmers would mostly opt for goat keeping, a traditional practice requiring little capital, as feeding materials could be collected easily from the leasehold plots and from trees on their own land, and access to markets was relatively easy. Weekly or bi-weekly local markets for goats are found even in the most remote locations in Nepal.

On the other hand, local breeds of cows have low levels of productivity, usually producing about 1 L/d of milk even during peak lactation. In general, leasehold farmers did not raise improved breeds of cows, indicating their low contribution to direct income generation. As far as buffalo are concerned, leasehold farmers owned improved *Murrah* breeds, or the best of the selected local buffalo, only in areas which traditionally marketed a significant proportion of the milk, *e.g.* in Kavrepalanchowk district, but only to a minor extent in Ramechhap, Dolakha and Tanahun, where few farmers had surplus milk to sell. In other words, access to leasehold plots did not alter the *status quo* for buffalo ownership (in terms of numbers or genetic characteristics) and milk production. The underlying reasons for the low level of buffalo raising were high costs, even when subsidised, and the requirements in terms of labour and management skills, as well as the larger demand (quantity and quality) for feed. The lack of marketing facilities for milk and dairy products acts as an additional constraint.

Discussion

Leasehold forestry has contributed to the regeneration of degraded forests and provided disadvantaged households with access to additional sources of forage for livestock under intensive stall-feeding husbandry systems. This seemed effective at lower to mid-elevations, whereas at higher elevations (>2000 m) intensive leasehold silvipastoral practices appeared less suitable. In the original design, the forage and livestock development packages were heavily reliant on subsidised exotic and high-yielding varieties and breeds. The introduced forage legumes and grasses were readily accepted by small and marginal farmers. However, certain potential problems were not fully anticipated: adaptability to different soil conditions and farmers' needs; the incompatibility of introduced varieties; the risk of suppression by *Imperata cylindrica*; competition from local grasses/weeds; and the effect of increasing shade from the tree canopy.

Field observations suggested that leasehold plots were highly diverse in terms of quality of soils, moisture-holding capacity, microclimate and market access. Therefore, a range of different forages was required, but the technical packages supplied by government extension services were not sufficiently flexible. Moreover, there seemed to be little recognition in the design of technical packages of the potential of native forage species as a well adapted feed source for livestock or for the possible adverse effects of competition by introduced varieties. The provision of fodder trees for leasehold plots was generally unsuccessful and the design overlooked the practice of planting multi-purpose trees on private land. In addition, little attention was paid to the regeneration of native trees or bushes, which many farmers considered a simple and successful approach.

While there is no strong evidence to conclude that the provision of subsidised exotic legumes and grasses should be halted, field visits clearly indicated the need for genuine consultation with farmers and an appreciation of their traditional knowledge and the potential of local grass varieties.

Analogous findings emerged for the livestock development programme. While the original design emphasised the provision of improved goat and buffalo breeds, the clear preference of farmers was for local goats, and there was no evidence of a generalised increase in average buffalo ownership per household. In addition to problems of availability of nutritious forage, large ruminant health management and high investment costs, access to adequate infrastructure and markets was of concern for perishable

products such as milk and its by-products. Local goats seemed to be easier for small and marginal holders to manage than large ruminants, in terms of feed requirements, breeding management and market outlets.

Evidence presented in this paper is, by its nature, limited and more research needs to be conducted. Nonetheless, there are grounds for improving the flexibility of advice provided by forage and livestock extension services. Priority should be given to simpler, less costly solutions. Local goat distribution (the 'passing on the gift' programme) should be emphasised, together with forage development schemes based on spontaneous regeneration of local grasses and hinging on farmers' preferences in terms of forage characteristics and traditional knowledge of forage sources.

Roothaert *et al.* (2003) outline a participatory development approach to improve forage technologies in the upland tropics. The key element of their approach is the active involvement of farmers in all stages of technology development, particularly in the diagnosis and prioritisation of problems as well as the evaluation of the varieties and technologies, although the authors recognise that researchers and development workers have a role to play. Our more limited observations in the hills of Nepal suggest that, if a similar approach had been adopted, some of the rigidities in the extension packages as well as less relevant programme components (*e.g*. the planting of fodder trees on leasehold plots) could have been addressed at an earlier stage. Indeed, the participatory component was absent in the original programme design, although the whole experience provided a wealth of knowledge that could be internalised in future interventions.

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