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Evaluation of the cost-beneficial improvement of first mile access on small-scale farming and agricultural marketing

Final Report

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Tables and Figures

Abstract

TRL Limited and the International Forum for Rural Transport and Development (IFRTD) were commissioned by the DFID funded Research for Community Access Partnership (ReCAP) to deliver this project which evaluates the cost-beneficial improvement of first mile access on small-scale farming and agricultural marketing. The project is concerned with improvement of 'First Mile' access and the transport services associated with transferring harvest produce on the initial stages of movement from the farm to established road access.

The project has completed data collection and analysis, and following two country workshops in Kenya and Tanzania under Phase 3, a consolidated set of recommendations was produced in the Phase 3 report. Following the completion of Phase 3, a Cost Benefit Analysis has been undertaken on one of the trial sites in Tanzania, located in the pineapple growing area of Madeke. This analysis was based on the principle that motorable roads could be brought closer to farms, in order to reduce the most expensive aspect of transport on the First Mile roads, and exploiting the cheaper and more efficient transportation by trucks.

These results were presented at a regional stakeholder workshop in Arusha, Tanzania in November 2018, at which the key stakeholders from Kenya and Tanzania were present. The main theme of the workshop was to present the Cost Benefit Analysis, and to discuss the recommendations and how they could be practically implemented, as well as identifying how the results of the research could be disseminated at all levels. Consensus was found on all of these issues, and is contained in the details of this report.

Key words

First Mile, Transport services improvements; Transport services indicators; Rural mobility; Rural road outcomes; Rural road impacts; Rural road preservation; Rural road provision, Cost Benefit Analysis

Acronyms, Units and Currencies

4WD	Four-Wheeled Drive
AfCAP	Africa Community Access Partnership
AsCAP	Asia Community Access Partnership
AWAN	Africa Women in Agribusiness Enterprise
CBA	Cost Benefit Analysis
DCO	District Community Officer
DFID	Department for International Development
e.g.	for example
EU	European Union
FGD	Focus Group Discussion
GIS	Geographical Information System
GPS	Global Positioning System
HDM-4	Highway Development and Management Model
IFRTD	International Forum for Rural Transport and Development
IMPARTS	Interactions: Maintenance and Provision of Access for Rural Transport Services
IRF	International Roads Federation
IRI	International Roughness Index
IRR	Internal Rate of Return
JTLU	Journal of Transport and Land Use
KII	Key Informant Interview
LGTF	Local Government Task Force
LVRR	Low-Volume Rural Road
MDA	Ministries, Departments and Agencies
NIT	National Institute of Transport (Tanzania)
NPV	Net Present Value
PIARC	Permanent International Association of Road Congresses
PMU	Project Management Unit
PO-RALG	President's Office - Regional Administration and Local Government
RAI	Rural Access Index
ReCAP	Research for Community Access Partnership
RTS	Rural Transport Services
RTSi	Rural Transport Services Indicator
SARF	South African Roads Federation
SSATP	Sub-Saharan Africa Transport Policy Program
TARA	Tanzania Roads Association
TARURA	Tanzania Rural and Urban Roads Agency
ToR	Terms of Reference
TRL	Transport Research Laboratory
UK	United Kingdom (of Great Britain and Northern Ireland)
UKAid	United Kingdom Aid
USA	United States of America

GBP	Great Britain Pound (UK pound sterling)
£	Great Britain Pound (UK pound sterling)
kg	kilogram
km	kilometre
KSh	Kenya Shilling (approx. 125 KSh = £1)
m	metre
s^2	per second squared
TSh	Tanzania Shilling (approx. 3,000 TSh = £1)
US$	United States Dollar (approx. 1.27 US$ = £1)

Executive Summary

TRL Limited and the International Forum for Rural Transport and Development (IFRTD) are delivering this project on the evaluation of the cost-beneficial improvement of first mile access on small-scale farming and agricultural marketing, on behalf of DFID for the Research for Community Access Partnership (ReCAP). The project is concerned with the improvement of the initial transport segment and the transport services associated with transferring harvest produce from the farm to established road access in Kenya and Tanzania.

A large amount of data was collected and analysed under Phase 3. Results were disaggregated to highlight gender and socio-economic issues. A discussion section was included in the Phase 3 report which identifies the main findings from the research and how they are relevant to the main themes of this research. Some tentative recommendations were identified for discussion at the regional workshop in November 2018.

This report sets out the key activities undertaken during Phase 4, including the Cost Benefit Analysis, the final regional workshop and the main scientific paper for publication in a relevant journal. An assessment of the workshop can be seen in the Annexes to this report.

The main findings of the project are:

- Initial transport costs and crop losses account for reductions in the region of 30 to 40% of net incomes of potatoes and pineapples in Tanzania. While for French beans in Kenya, the associated reduction in net incomes is around 10 to 15%.
- A key factor affecting farmers' incomes is the degree of competition amongst buyers, especially in Kenya. Farmers in Meru received approximately half the price for their French beans than those in Machakos. The buyer in Meru also discouraged the formation of a farmers' association.
- Initial high transport costs of head/backloading and other low capacity forms of transport are many times more expensive, expressed per tonne-km, than by trucks. Overall the analysis demonstrates the importance of reducing first mile transport costs and the associated crop losses to a minimum.
- The Cost Benefit Analysis showed a good return on investment of 47% IRR to improve access roads and bring them within an average of 0.5 km of the farm, from the previous average of 1.0 km. This was a specific sample taken from one area, with a number of assumptions, but gives a snapshot that suggests upgrading is economically viable under certain circumstances.

The report also includes sections on the implications of the research and further research that could be beneficial in further understanding the dynamics of First Mile transport and how it affects farmers. The potential implications include the main expected outputs of the research, including the effect on transport costs on the First Mile, relationships between transport and incomes, gender perspectives and the potential costs and benefits of improving First Mile roads. Areas have been identified where further research will enhance the understanding of farmers livelihoods as a result of road condition, such as integrated planning of infrastructure and transport services, looking at the secondary transport segment, community involvement in road maintenance and understanding some of the less obvious results of the data collected. The regional workshop was held as part of a ReCAP Transport Services event, and was linked with the PIARC conference in Arusha in November 2018.

The project had a scientific paper on road condition data collection accepted and presented at the SARF conference in Durban in October 2018, and it also had a further paper on First Mile access accepted and presented at the PIARC conference in Arusha in November 2018. These two events provided a good opportunity to disseminate the results of the project and build awareness of the issues related to First Mile access. A scientific paper for publication in a relevant journal is under preparation and will be completed for submission to the Journal of Transport Land Use by the end of the project.

This research will add value to the body of evidence on First Mile access through investigation of a large sample of the small-scale farming population, taking account of the differences in transport costs and access constraints for well-connected and remote rural farmers located in the same market catchment, growing the same crops. It also assesses the potential for low-cost engineering measures to be used in the primary transport segment as part of community driven development projects going forward.

1 Background

1.1 Project Overview

The issue of 'First Mile' research was previously explored by IFRTD in two pilot studies covering the transport and marketing of onions in Kenya (Njenga et. al. 2014), and tomatoes in Tanzania (Njenga et al. 2015). The concept of 'First Mile' looks at the potential exploitable benefits of smallholder farming productivity and the impact that improved access to rural markets can have for local small-scale economies. The aim of this research is to extend the evidence base for the benefits associated with access improvements to small-scale farmers, and the potential impact that those benefits have on food security and poverty reduction on a much wider scale.

The expected output of the project is to provide guidance on the cost-beneficial improvement of all-season access on a range of levels from policy makers down to villages and small scale farmers. In terms of impact the recommendations are expected to lead to improved access to markets for small scale female and male farmers with reduced overheads and improved timeliness; contributions to poverty reduction and food security. Uptake will be focused at the local level, whilst informing and encouraging uptake for central policy-makers and regional planners.

This report is a culmination of the activities during Phases 1 to 4 (**Error! Reference source not found.**), during which time the Project Team has worked with counterparts from Ministries, Departments and Agencies (MDA) in both countries. The aim of this key report is to identify and discuss the implications of the research and identify how it may be carried forward into practical application. The report also outlines a range of outputs and knowledge dissemination initiatives designed to promote uptake at the farm, village, district and central levels.

Table 1: Project Phases

Project Phase	Start Date	Finish Date	Description
Phase 1	May 2017	June 2017	Inception, develop programme and identify key issues
Phase 2	July 2017	August 2017	Literature review, identify principal challenges, define research methods and select trial sites
Phase 3	September 2017	August 2018	Targeted data collection, summarise implications of research, identify practical applications
Phase 4	September 2018	January 2019	Draft range of actions and potential knowledge dissemination at all levels

The findings and analysis of the research can be found in the Phase 3 Report. Additional analysis has been provided as a Cost Benefit Analysis (CBA) and can be seen in Section 3 of this report. This report is designed to inform stakeholders on the outcomes of the project, the potential implications of the research and how it can be carried forward into practical application. Feedback from the regional stakeholder workshop is shown in Section 4 and a summary of the workshop is included in Annex 1, including the workshop assessment summary.

Phase 4 of the Project has also included preparation of a scientific paper based on the research outputs, which will be finalised and submitted for acceptance by an internationally recognised, peer-reviewed journal by the end of the project. Abstracts from the technical papers produced can be found in Section 9.

1.2 Research Objective

The main objective of this project is to provide guidance on cost-beneficial improvement of all-season access at a range of levels from policymakers down to villages and small-scale farmers. The expected

impact is improved access to markets for small-scale female and male farmers with reduced overheads and improved timeliness, with meaningful contributions to poverty reduction and food security.

The research was designed to culminate in:

- Identification of the specific elements of the transport system that can be improved in order to unlock growth in the smallholder value chain sector.
- Better advice to road planners on the best location for access improvements.
- Quantification of the economic benefits of better initial access.
- A framework to provide advice to farmers and the authorities on the best pattern of transport in different circumstances.
- Better understanding of the role of different forms of transport in the small-scale agricultural environment, and the gender dimensions therein, and the needs to regulate them.

This research has been undertaken with the basic principles of capacity building, knowledge transfer, uptake and embedment in mind.

1.3 First Mile and the Provision-Preservation-Services Continuum

ReCAP projects are set within the provision – preservation – services continuum of the ReCAP 'Way Forward Strategy', as discussed in the context of this project in the Phase 3 Report. The findings from this project show the importance of considering the whole continuum in terms of the roads that are constructed and how they are maintained, against how they are used and what transport services are able to use them.

Many of the recommendations provided in Section 4 show that the interaction between infrastructure provision and maintenance is inextricably linked to the transport services that ultimately service the roads. The First Mile is an often neglected part of the road network, as roads organisations concentrate on the strategic part of the network that takes the higher traffic. However, the research shows that the provision – preservation – services continuum is vitally important to First Mile roads, which would benefit greatly from a more coordinated and less siloed approach.

2 Summary of Key Research Findings

This section sets out the key research findings, as detailed in the Phase 3 report, available on the ReCAP website at: http://www.research4cap.org/Library/Hineetal-TRLIFRTD-2018-EvaluationCostBeneficialImprovementFirstMile-Phase3-AfCAP-RAF2109A-181108.pdf .

Data was collected using an array of different survey instruments, including:

- Farmer's household questionnaire
- Transport operator's questionnaire
- Farmer/seller market data questionnaire
- General market data questionnaire
- Focus group discussions
- Key informant checklist – Agriculture
- Key informant checklist - Infrastructure

These questionnaires and checklists can be found in the Phase 3 report, as shown above. The number of responses can be seen in Table 2.

Table 2: Survey sample size

Survey instrument	Kenya		Tanzania		Total
	Meru	Machakos	Matola	Madeke	
Farmer's Questionnaire	126	129	132	139	526
Transporter's Questionnaire	35	35	90	26	186
Market, seller/farmer produce data	4		10		14
Collection point/market general data	5		4		9
Key informant interviews	6		3		9
Focus Group Discussions	2		5		5

Road condition data was collected using a developed methodology, which comprised a combination of:

- Driving along the road to obtain an overview of the overall condition of the surface and visible drainage, normally side drains and turnouts.
- Walking along sections of the road/track and taking detailed notes of surface condition, as well as drainage condition and issues.
- Taking GPS coordinates of bottleneck spots and any issues that would affect the transport of crops.
- Review of videos recorded during the field exercise. Videos also record the speed travelled, which can be used to estimate condition.
- Where the speed of travel permitted, estimates of road roughness were measured using the smart mobile phone application 'RoadLab Pro'.
- Since the minimum speed for RoadLab Pro to operate is not easily attainable on most of the farm roads/tracks, portable accelerometers were used to measure the vertical accelerations experienced on these roads/tracks at comfortable travel speeds (usually less than 15 km/h).

The key findings are as follows:

2.1 Analysis of Transport Charges

An analysis was undertaken to explore how transport charges varied with distance. A wide scatter in the data was found for all main modes: headloading, motorcycles, animal carts and truck transport. Short distance movements were focused on, while long distance movement of potatoes in Tanzania was also considered for comparison. A regression analysis was undertaken for each short distance, transport mode, whereby the transport charges per kg were regressed against distance. For the 17 sets of data (10 for Kenya and 7 for Tanzania) significant relationships, whereby charges per kg increased with distance, were found for 13 sets. However, for four of the Kenyan data sets a reverse relationship (where charges decreased with distance) was found. This can possibly be explained by a hidden correlation between load and distance, distorting the results. From the regression coefficients, it was possible to model the transport charges for each of the different modes for varying distances (0.5 km, 1 km, 1.5 km, and 2 km). The results of the modelling show that a substantial part of the apparent difference in the charges of different first mile transport, between the different modes, might be explained by differences in transport distance.

It is well recognised that the best measure of transport costs is a weight distance charge, i.e. the charge per tonne/km, or per kg/km. Using this measure a substantial variation in transport charges between different modes and surveys was found. One complication in the analysis relates to head/backloading because many farmers employ labour to both harvest the crop and carry the produce to the first collection point, particularly in Meru. Overall, the analysis suggests that the opportunities to substantially reduce transport charges by changing modes (through better transport links and load consolidation) for short distance trips, may be more limited than previously thought. For Tanzania, the maximum potential saving for a one

kilometre trip would be 46% of the current price. However, for Kenya the potential saving appears much higher at over 70%, but the local circumstances in each situation will inevitably reduce this. Probably, the most effective method of reducing transport costs would be by picking up farm produce at the farm and transporting directly to market, avoiding double handling at the collection point altogether. The marginal increase in costs for a few extra kilometres, for the truck involved, are likely to be minimal.

2.2 Relationship between Initial Transport and Incomes

There are a range of ways in which initial transport might affect farmers' incomes. Possible ways include:

- Through crop spoilage in getting produce to market
- Through paying for crop transport costs and thus directly reducing the net incomes
- Through increasing the costs of farm inputs (including labour) and thus reducing net incomes
- Through reducing the efficiency of farming production and of the marketing of produce, thus indirectly reducing net incomes.

A separate regression analysis was also undertaken, to see whether net farming incomes, per acre might be predicted from a range of variables, including transport costs and crop spoilage. A complication with this is that farmers in Meru often combine, and pay for, harvesting with first transport, and hence the first transport costs may be underestimated. Also, there was no clear relationship between net incomes and the percentage of crop spoiled. An analysis of Machakos data did find a significant negative relationship between crop spoilage and net incomes, however there was a perverse, positive relationship, between transport costs and net farm incomes. For Tanzania, for both pineapples and potatoes, net incomes were found to be negatively associated with first transport costs and crop losses. The independent variable of the regression was net income per acre, and other explanatory variables were crop acres, crop yield, crop sale price, transport costs and first transport crop losses.

In order to estimate the impact of transport costs and crop losses on incomes, the mean values of the independent variables were multiplied by the regression coefficients. The results were then compared with the mean values of the net income per acre for the two crops. For potatoes, initial transport costs are associated with an average reduction of net incomes by 35%, while crop losses are associated with an average reduction of 2%. Similarly, for pineapples, it was found that initial transport costs are associated with an average reduction of 22% in net incomes, while crop losses account for a further average reduction of 7%. Overall the different analyses suggest that initial transport costs and crop losses account for reductions in the region of 30 to 40 % of net incomes of potatoes and pineapples in Tanzania. While for French beans in Kenya, the associated reduction in net incomes is around 10 to 15%.

2.3 Gender Findings

A range of gender related data were collected in the different surveys. Key data collected from the farmers' surveys is presented in Table 3.

Table 3: Gender breakdown of key farmer's data

	Machakos		Meru		Matola		Madeke	
	men	women	men	women	men	women	men	women
Number	76	52	79	47	96	43	89	43
Main crop, acres	1.2	1.2	0.43	0.36	2.2	1.2	5.2	2.7
Yield kg/acres	1,410	1,132	3,651	3,511	4,594	3,080	12,141	19,163
Net income US$	400	315	179	159	720	340	5,315	3,343
Distance to collection point, km	1.57	1.03	1.48	1.40	1.32	0.99	0.36	0.41
Ownership of mean of transport %	63%	48%	27%	6%	47%	23%	45%	19%
Cost of first transport US cents/kg	1.3	1.4	0.86	1.11	0.95	0.92	1.48	1.39

In total, 35% of farmers interviewed in both countries were female. In three of the four locations, the area farmed by men was significantly larger than that farmed by women. For Machakos the crop areas were the same. Yields per acre were lower for women in three locations, however for Madeke pineapple farming women achieved 58% higher yields. Overall, in each location women's net incomes were substantially less than for men.

Women's farms tended to be closer to the collection point than for men (the exception was Madeke). However, despite this the cost of first transport was higher for women in Machakos and Meru. Women owned substantially fewer means of transport than men did, although there was a significant variation between different locations. An analysis of gender breakdown of transporter survey data for Kenya showed that a majority of head/backloading transporters interviewed were women. Women undertake this unskilled work in addition to performing general farming duties. Only one woman was interviewed in relation to operating an animal cart. In Tanzania no women transporters, or head/backloaders, were encountered.

3 Cost Benefit Analysis

In order to identify the merits of improving first mile access, an analysis of the costs and benefits of improving the road network was undertaken for one of the study areas. In this case the cost of road construction and maintenance were compared with the expected increase in the net incomes of the farmers. To help compare the difference in time profile of the cost and benefits a 'Financial Cost Benefit Analysis' framework was used. The Madeke area was selected because the pineapple crop is perishable and presents a good representation of the type of issues encountered along the First Mile.

3.1 Example for Interventions in Madeke, Tanzania

An evaluation of a package of infrastructure interventions to support pineapple farmers in the Madeke area of Tanzania was undertaken. The Madeke area was selected as a good representation for the project because the crop is highly perishable (more so than the potatoes grown in Matola) and is grown in areas with low accessibility. Access to farms is limited, especially in the wet season, and there is significant potential for road improvement. Although Kenya was also part of this study, Kenya was not selected for cost benefit analysis as it was not possible to obtain appropriate costs and unit rates for road construction and rehabilitation. In addition, the main Kenyan crop of French beans is less vulnerable, so would not have been such an appropriate example.

Unit rate cost information for road construction and maintenance activities can be sensitive and it can be difficult for government agencies to release financial data because of the potential effect it would have on procurement of contractors for such activities. For Tanzania it was possible to find cost ranges, which were then verified by local sources and an average value was used, so the team are confident that the Tanzania unit rates are reasonably accurate.

The analysis is inevitably tentative because of the uncertainty in predicting how farmers and the transport and marketing system will respond to the changes. In Madeke the first mile transport of pineapples is overwhelmingly undertaken by head/backloading to the first collection point. The rationale used in the analysis involves bringing the collection points closer to the farms by improving the surface of the access roads to make them passable all-year round (to all-season standard) by conventional vehicles, allowing for short breaks due to inclement weather, and thus reducing the initial transport burden. In the analysis of the survey data, and also in discussions with farmers, it was found that there was a strong disconnect between the effort involved in head/backloading produce to the first collection point and the transport charges paid. Due to these distortions, a pure 'transport cost savings approach' was not undertaken as a way of analysing the benefits of improving first mile accessibility. More reliance was given to an analysis of how farmers' incomes might change.

3.2 Key Information Relating to the Area

The Madeke pineapple growing area is approximately 40 sq km in area in overall size, and is a designated organic growing area. In this respect there are fewer inputs to the farming process that need to be transported to the farms, such as fertiliser, pesticide, etc. It has a secondary road of 12 km and a total of 16 km of access roads, but of the latter only about 5 km are accessible all-year as all-season roads. It has been estimated that pineapples are grown on 20 sq km (i.e. approximately half of the land area), which is devoted only to pineapple growing. On the basis of the yields found in the surveys, about 76,000 tonnes of pineapples are produced each year, which is about one third of Tanzania's total production. Pineapples are harvested throughout the year but are sold exclusively in the local market, not for export. Some are sold in local markets and some in the main cities.

In order to identify the differences relating to accessibility, the farmers' survey data was analysed in terms of the distance to the collection points. This is shown in Table 4.

Table 4: Data collected from Farmers' surveys, based on distance to collection point

	Less than 0.5 km to collection point	More than 0.5 km to collection point
Number of farmers surveyed	95	36
Average distance to collection point	0.15 km	0.97 km
Total distance of farms to collection point	14.38 km	34.85 km
Average transport charge for head/backloading	33.2 TSh/kg	35.1 TSh/kg
Average revenue per kg of pineapples	232 TSh/kg	194 TSh/kg
Reported non-transport farming costs/kg	54.2 TSh/kg	58.2 TSh/kg
Average crop losses	12.7%	10.7%
Average farm size	4.1 acres	5.66 acres
Average net income per farm	13.2 m TSh	10.1 m TSh
Average net income per acre	3.2 m TSh	2.29 m TSh

The Table shows that for most farms (73% of total surveyed) are located close to the collection point, with an average distance of 0.15 km, while the remaining 27% are located an average distance of 1 km from the collection point. Despite the six fold difference in average distance, the head/backloading transport charges were increased by only 6%. While at the same time the selling price of pineapples was 16% less and the net incomes per acre were 28% less for the farms that were far from the collection points. The more distantly related farms had larger farm sizes and fewer crop losses, but despite this, overall net income levels per farm were 23% less than for the farms close to collection points. Although the reported absolute crop losses are less, for the more remote farms it is likely that the lower selling prices are also the result of lower quality produce at collection point, resulting from the increased handling and transport. The more remotely located farms also had higher costs of production per kg.

Overall Table 4 shows that remotely located farms are at a considerable disadvantage. These results confirm the previous regression analysis in the Phase 3 Report which showed that farm incomes are negatively correlated with first mile transport costs. The regression details are given in

Table 5. Here the independent variable of the regression was net income per acre, and other explanatory variables were crop acres, crop yield, crop sale price, initial transport costs and first transport cross losses. A similar regression analysis was carried out on the Matola potato growing area, with very similar results.

The regression shows that net incomes are negatively correlated with initial transport costs and first transport crop losses.

Table 5: Regression details explaining net income per acre for Madeke pineapples

Y= net income per acre	Madeke Pineapples	
Observations	129	
Regression R squared value:	0.673	
Regression F value	50.58	
	Coefficient	T value
Intercept	-1052645	-2.0
Acres	3079.9	0.12
Initial transport costs (TSh/kg)	-16980	-1.8
Yield (kg/acre)	166.16	15.1
Gross produce price (TSh/kg)	7570.5	4.42
First transport crop losses (%)	-1498885	-1.44

If the mean values of the regression data are multiplied by the regression coefficients then it can be calculated that, on average, initial transport costs are associated with an average reduction of net incomes per acre of 22%, compared with a calculated result, where initial transport costs are zero. Similarly it may be calculated that first transport crop losses account for a further average reduction of 7% in net incomes.

The reason for lower farm net incomes for remote farms is almost certainly the result of a number of factors in addition to poor access, including a reduced ability to negotiate good prices, poorer quality produce being offered for sale and poorer management of farm labour. However, other factors such as more difficult farm terrain where there are steep areas may also play a part.

The Focus Group interviews confirmed that it was the custom for head/backloading charges not to substantially increase with distance, despite the increased effort. One possible explanation of the small difference in transport charges is that the same farm workers did both harvesting and transport, and that while nominally they may be paid similarly for transport (between a near and remotely located farm), the remotely located farms had to pay more for harvesting and other farm activities. This is confirmed from the data in Table 4 where it can be seen that the non-transport farming costs are 7% higher per kg of harvested produce. This would have a knock-on effect of reducing net farm incomes for the remotely located farms.

3.3 An Example Set of Interventions

In Table 6 a set of road maintenance interventions are suggested that would enhance accessibility in the area. The interventions are designed to provide year-round basic access, particularly on the 16 km of access roads. Interventions have also been suggested for the main gravel road and an improvement to the more difficult footpaths.

Table 6 Suggested Interventions

Interventions	Length (m)	Intevention Rate (TSh/m)	Amount (TSh)
Treatment of Bottlenecks 100 m * 6 spots (slippery spots on Main Gravel to Madeke - Njombe)	600	138,000	82,800,000
Levelling of Steep Sections	2,500	16,480	41,200,000
Widening of access roads	16,000	8,240	131,840,000
Re shaping/re-grading of access roads	16,000	23,080	369,280,000
Bottlenecks (weak soils spots on access roads)	3,500	92,000	322,000,000
Shaping and providing side drainage	16,000	9,000	144,000,000
Watercrossings	4	3,600,000	14,400,000
Culverts (2 for 5 access roads)	10	4,515,000	45,150,000
Grass Cutting on sides	16,000	340	5,440,000
Footpaths within farms to access roads	7,000	340	2,380,000
TOTAL			**1,158,490,000**

The assessment is designed to provide evidence to support the relocation of the collection points on the seasonally impassable access roads to bring them nearer to the more remotely located farms. This is represented by the 27% of farms in the survey where the collection point was further than 0.5 km from the farm. For these farms it is anticipated that the average distance to the collection point will reduce from 1 km to 0.5 km. For a collection point to work effectively it needs to be on a road with good all-year round (all-season) access that the farmers, transporters and wholesalers have confidence in. Transporters will not risk using access roads that are vulnerable to rainfall and where they could get stuck, but they will tend to develop transport services on all-season roads where accessibility is reliable.

The decision to base the analysis on a revised distance from farm to accessible road of 0.5 km was based on the fact that this would be a reasonable intervention for the local road organisation to make, and would be significant enough in reducing head/backloading charges to make a difference to farmers' livelihoods.

3.4 An Elasticity between Transport Charge and Net Income

One way of relating changes in transport to income is to derive an elasticity.[1] This can be expressed as the proportionate change in net incomes per acre divided by a proportionate change in transport charges, i.e.

The elasticity of net income per acre to transport charge:

= (-0.284/1) / (0.057/1)

= -4.98

Hence a 1% decline in transport charges is associated with a 5% increase in farm incomes. However, it should be noted that other factors besides transport costs, such as differences in terrain, may also play a part in reduced incomes of the more remote farmers. Therefore, erring on the side of caution, it is suggested that an elasticity of -2.5% is used for predictive purposes.

[1] Elasticity is a measure of a variable's sensitivity to a change in another variable. Elasticity refers the degree to which consumers or producers change their demand or the amount supplied in response to price or income changes (www.investopedia.com/terms/e/elasticity.asp).

If the average distance of the collection points is brought 0.5 km closer to the more remote farms (represented by the 27% in the survey) then the overall manpower burden for transporting pineapples (expressed in terms of tonne-km) from the farms will reduce by 35%, but following the existing marketing arrangements, overall transport for head/backloading charges will fall by only 2.2%, or TSh 0.73 per kg. However, at the same time it is expected that there will be a small increase in freight charges as the truck has to travel the extra distance to pick up the more remote loads. Assuming an extra 2 km for these trips, based on data collected from long distance transport movements of pineapples, overall truck freight charges would increase by TSh 0.16 per kg. So combined transport costs would fall by TSh 0.57 (TSh 0.73-0.16) or 1.7%. An overall fall in transport charges of 1.7% combined with an elasticity of -2.5% would, assuming a robust causal relationship, be associated with an overall rise in net farm incomes of 4.25%.

3.5 Cost Benefit Calculation

The Madeke pineapple growing area is 20 sq km, which is equivalent to 5 acres. The survey reported an annual yield of 15.45 tonnes per acre, which equates to a gross yield of 76,364 tonnes per year. The reported revenue was TSh 231 per kg. This gives an overall income for the area of TSh 17,640 M. The ratio of net to gross income was reported to be 0.828, which gives a net income for the area of TSh 14,606 M.

If it is assumed that overall incomes rise by 4.25%, (as proposed in the elasticity analysis above) this would be equivalent to a rise in net incomes, in the current year, of TSh 620.7 M. In the calculation it is assumed that overall incomes will rise by 2% per year as the rise in incomes encourages further pineapple growing and more land to be devoted to pineapple farming. It is also assumed that if the interventions take place in 2019, then in 2020 only half the full benefits are assumed to occur (assuming a time lag), with the main full benefits from 2021 onwards. A 15 year planning time horizon was used in the analysis.

The full programme of investment in roads of TSh 1158.5 M occurs in 2019. After this, annual maintenance of TSh 15 M is assumed with a larger maintenance effort of TSh 129 M in 2024 and 2029 (note that due to the many possible combination of interventions that could be implemented, it is not practical to convert the cost of rehabilitation, routine, or periodic maintenance to a per km figure). The cost benefit stream is shown in Table 7. An Internal Rate of Return (IRR) of 47% is calculated, with a Net Present Value (NPV) of TSh 3,070 M, discounted at 12%. The discounted cost benefit ratio is 2.65.

Table 7: The Cost-Benefit calculation of the Madeke programme of interventions

Year No.	Year	Investment Maintenance	TSh M. Change in net incomes	Net Benefit Stream
1	2019	1,159		-1,159
2	2020	15	323	308
3	2021	15	659	644
4	2022	15	672	657
5	2023	15	685	670
6	2024	125	699	574
7	2025	15	713	698
8	2026	15	727	712
9	2027	15	742	727
10	2028	15	757	742
11	2029	125	772	647
12	2030	15	787	772
13	2031	15	803	788
14	2032	15	819	804
15	2033	15	835	820
			IRR	47%
			NPV, 12% discount rate	3,070
			Discounted Benefit Cost ratio	2.65

3.6 Conclusions

An analysis of the farm survey data suggests that 27% of farms in Madeke pineapple area have to transport their produce by more than half a kilometre to a collection point. These farms suffer from much lower revenues and net incomes compared to the majority of the farms that lie within 0.5 km of their collection points. The reason for the longer distances to collection points is due to poor access and road conditions, where roads are not open all year round to traffic. In order to address this, a programme of road interventions has been suggested that would enable the collection points to be located closer to the farms.

In order to predict a response from better accessibility, an elasticity between net incomes and transport costs to collection point was derived. Using predicted changes in transport costs and a cautiously adjusted value of the elasticity, predicted changes in net incomes were calculated as a response to the road improvements. Based on an analysis of construction and maintenance costs and gains to farmers, an IRR of 47% and a discounted cost benefit ratio[2] of 2.65 for the interventions were calculated. The analysis indicates that the interventions in this case would be very worthwhile in helping to raise farmers' incomes. However, it is important to point out that while the CBA results of the Madeke case may suggest that other first mile interventions elsewhere may be justified, each case needs to be considered on its merits.

4 Feedback from Regional Workshop

The regional project workshop was held in Arusha, Tanzania to present the final outcomes and proposed way forward for the first mile research. Participant details and results of the workshop feedback are detailed in Annexes 2 and 3. A total of 21 country participants attended, six from Kenya and fifteen from Tanzania, as well as three of the IFRTD local team and two TRL team members. There was a good spread of expertise generally, although the engineering counterparts from Kenya were unable to attend due to unavoidable commitments. Eight additional participants, who were in Arusha for the ReCAP Interactions: Maintenance-Provision of Access for Rural Transport Services (IMPARTS) regional project workshop, attended as observers.

The workshop commenced with an introduction from the Team Leader, with everyone introducing themselves and stating their designation, background and interest in the project. The Team Leader then provided some background to the research and explained the objectives of the workshop.

Shedrack Willilo (IFRTD) then summarised the principles of the research, objectives, the data collection process and the results of the road condition surveys.

John Hine (TRL) presented the findings and analysis from Phase 3 data collection, which was largely similar to his presentation at the previous country workshops. He then presented the results of the recent Cost Benefit Analysis. Clarifications were made and discussions held on this subject.

The Team Leader then presented the deliverables to be completed by the end of the project, which included this final report and a scientific paper. He then presented the recommendations, which would be the main subject of the workshop. The recommendations were developed during Phase 3 and were expanded following the country workshops in Kenya and Tanzania in October 2018.

The workshop tasks were then presented as follows:

Group work – Task 1
Comment on and agree 'implementable' recommendations – how can they be carried forward into practical application?

Group work – Task 2
Identify knowledge dissemination initiatives designed to promote uptake at the farm, village, district and central levels of government.

[2] A cost benefit ratio is an indicator used to summarise the overall value for money of an intervention, in this case it is the Net Present Value of the investment divided by the investment's initial cost.

The participants were split into three groups. These groups represented a range of disciplines and were mixed according to gender and country. Under Task 1, Group 1 was asked to consider recommendations 1 to 4, Group 2 was asked to consider 5 to 8 and Group 3 considered 9 to 11. All Groups were asked to consider Task 2 (see Annex 2 for a list of stakeholders in each group).

The groups convened for approximately 1 hour and 20 minutes, before they returned and presented their thoughts in plenary. At this stage questions of clarity and discussions on the key issues were facilitated and the results listed in Annex 1.

As a result of these discussions, the recommendations made previously in Phase 3 have been revised and are detailed in Section 5 of this report. A consensus was found on most issues and the feedback has resulted in stronger and more robust recommendations that are more focused on practical application.

Before leaving the workshop all participants were asked to complete a feedback form, the results of which are listed in Annex 2.

5 Revised Recommendations

5.1 Extend All-season Motorable Roads Closer to Farms

The results of the research show clearly that the most cost effective means of transport on the first mile is truck, typically a 2-axle truck in most areas. This is of course provided that economies of scale and distance can be exploited, and that produce can be delivered to a final market without extra intermediate handling. Table 8 gives examples of transport charges (per kg km) in Tanzania, for different modes of transport collected from farmers' and transporters' surveys.

Table 8: Transport charges for different modes of transport in Tanzania

Mode	Crop	Survey	Distance	Charge
			km	TSh/kg/km
Truck	pineapples	transporters	195	0.58
Saloon car	pineapples	transporters	108	1.72
Motorcycle	pineapples	transporters	31.5	6.70
Motorcycle	pineapples	farmers	1.25	41.10
Headloading	pineapples	farmers	0.36	469.00
Truck	potatoes	transporters	585	0.19
Animal cart	potatoes	transporters	2.5	8.92
Motorcycle	potatoes	transporters	1.7	12.81
Ox cart	potatoes	farmers	1.9	19.70
Donkey cart	potatoes	farmers	1.8	40.30
Motorcycle	potatoes	farmers	1.4	43.70
Headloading	potatoes	farmers	0.6	156.90

Table 8 shows that the cost of truck transport (per kg/km) is a tiny fraction of headloading. Similarly, freight transit by truck is at least ten times lower than motorcycle freight transit fares. However motorcycle transport can in turn be much cheaper than by headloading, depending on the circumstances and distances involved.

This demonstrates that the cost of transport could be dramatically reduced if larger vehicles were to be used. This would in turn lead to an increase in income for farmers. However, trucks can only be used if the access roads are suitable, i.e. if they are wide enough, if they are not too steep and if the surface is suitable and robust enough for heavy vehicles. There would also need to be an effective maintenance regime in place and operational so that reliable access could be guaranteed in all except the most exceptional circumstances. The access roads observed on this project in Kenya and Tanzania were certainly not fit for the required agricultural purposes.

The Cost Benefit Analysis of the Madeke example suggests that it would be very worthwhile to improve road access in that area. However each case needs to be considered on its merits. To upgrade all access roads to the required performance level for every farm would undoubtedly be prohibitively expensive, even with the potential benefits it could bring to farmers. Each road would need to be justified in terms of the costs it would incur against the benefits it would bring. In this context it would be sensible to explore alternative options to full upgrading. These options would involve assessing the most appropriate alternative transport services to move the produce from farm to collection centre, and what level of access they would require from an engineering perspective.

Where it is not feasible to construct a road suitable for truck movements (either because of the terrain, or shortage of demand) then a motorcycle track might be a suitable alternative option. Currently in Liberia there is a programme to construct a network of motorcycle tracks that also include simple bridges and culverts for water crossings that both pedestrians and motorcycles can use.

An all-season road depends to some extent on what services are intended to use it. The definition of all-season as used by the Rural Access Index (RAI) is “a road that is motorable all year round by the prevailing means of rural transport (often a pick-up or a truck which does not have four-wheel-drive), with some predictable interruptions of short duration during inclement weather (e.g., heavy rainfall) allowed” (Roberts et al, 2006). In many cases it is possible to construct a good quality gravel road that would provide all-season access, but earth roads are very unlikely to provide this level of access. Paved roads would be a possible option if low-cost seals were used, taking into account the whole-life costs of the road in order to justify its construction. There would also be justification for localised paved areas on steep sections to render the road motorable even in periods of high rainfall, by using cobblestones or stone soling.

To make this recommendation implementable it could be possible to involve the local community in the provision and maintenance of the road. If farmers can be empowered to lobby for improved access and can get access to decision makers, this would allow them to apply pressure for improved first mile infrastructure. As the continued maintenance of the road is essential to gain the confidence of transporters, the involvement of communities or farmers’ associations in maintenance provision could also be encouraged, which could be facilitated by on-site training and technical support. Also using alternative technologies to help with this initiative would be beneficial, for example tractor based maintenance[3] as this type of equipment may well be available locally (limited tractors are available in the areas studied, but are not owned by the farmers interviewed).

5.2 Stimulate Transport Services by Improved Infrastructure

Roads organisations centrally and locally should be encouraged to work with local communities to ensure that roads are designed, constructed and maintained in a way so as to encourage and stimulate appropriate transport services.

The existing roads in the study areas have shortcomings, for example in Meru they were constructed with a steep gradient and no drainage, so they were washed out very quickly, as seen in Figure 1. In Madeke the roads were of earthen surface and trench type construction, so they become impassable even with low rainfall. These factors critically restrict the transport services that are able to use them.

[3] See the ReCAP project report ‘Introduction of tractor based rural road maintenance approaches in Zambia’ (ZAM2059B) for further details on tractor based maintenance (Petts, Gongera and Goma, 2017).

Figure 1: Steep roads with no drainage in Meru, Kenya

In such situations road planners and designers should consult with the communities that will be using the road and plan/design the road appropriately. A rural land use plan could be developed so that the expansion of economic activities and agricultural yields can be planned, along with the transport services that use the first mile and access roads. Ensuring all-season access was suggested as a measure to ensure that transport services stimulation is implementable, with the aim of giving confidence to transporters to access farms and allowing farmers to invest more due to the lower risk of spoiled crops.

This research has highlighted the advantages of bringing the roads as close as possible to the farms in order to facilitate truck access and minimise costs to the farmer. Although improved roads do not guarantee improved transport services, this would set the foundations for transporters to travel closer to the farms. It was also suggested that a compensation scheme be introduced for suppliers to set up rural transport services. Although this is more common for bus services, mainly in developed countries, it could be worth exploring.

5.3 Community Participation in Road Rehabilitation/Maintenance

Following on from suggestions made in 4.1, there was interest expressed during the interactions with local communities to become involved in the provision and maintenance of the road infrastructure to farms. In fact this has already happened in some isolated cases in the study areas, such as in Machakos, where motorcycle transporters (boda-bodas) cooperated and repaired a broken box culvert. However, local communities are reluctant to get too involved without technical training, and could well need permission to work on the roads from the local engineering department. This is a subject that warrants further investigation as a potentially cost effective and sustainable way to ensure appropriate access.

Several countries in Africa have a history of using the lengthworker system of maintenance, where members of the local community are employed to carry out routine maintenance of roads, designed to maintain them to a certain standard and prevent damage. This usually involves tasks such as clearing drains and culverts, removing debris and filling small depressions and potholes with locally available material. For this to be effective the roads need to be constructed to an appropriate standard, geometrically and geologically, so for example roads with excessive gradients and earthen surfaces are in effect unmaintainable using the lengthworker system.

If a community system were to be used for road maintenance, it could be appropriately managed through a farmers' association or similar organisation. It could perhaps require each farmer to commit a certain amount of time to road maintenance per month. Maintenance works can be organised through the associations just prior to the harvest season and after a rainy season. Farmers could use simple farm tools for the works and ox-carts to transport materials. Maintenance groups could be established at village level and because they are already part of a community they would be able to support each other.

In terms of resources for community participation, a manual for simple spot improvement/ track engineering and maintenance could be circulated to local technicians. As such documents exist, for instance the 'Spot improvement manual for basic access', produced for Tanzania's President's Office - Regional Administration and Local Government (PO-RALG) (Done, 2006), they should be reviewed and used if appropriate, or revised to suit the particular situations prevalent in the areas where they are to be used.

This should be reinforced by training sessions – predominantly practical in nature. There are other maintenance manuals that could be used, for example the PIARC International Road Maintenance Handbooks (PIARC, Vols 1 – 4, 1994-2006), which use a lot of graphics to impart the maintenance tasks and how they should be carried out, or the Ethiopian Low Volume Roads Manual, Part G on Road Maintenance, which uses some of the same illustrations. A supplement was also produced for 'The Organic Farmer' magazine in Kenya (Beusch, 2008), which shows pictorial advice on maintaining rural farm roads and is illustrated in Annex 4. There are also existing maintenance manuals or handbooks for low volume roads in other countries that could be adapted to suit the local situation.

5.4 Establish a Framework for Community Involvement in Road Rehabilitation and Maintenance

A further community driven development initiative of community involvement in road maintenance, and in particular spot improvement of rural roads to keep them motorable, is proposed in the 'Spot improvement manual for basic access' (Done, 2006). Spot improvement is very important for maintaining all-year-round access to farms, and this is an approach that needs to be fostered. This manual proposes models of community involvement and the distinctive roles that community members could adopt. It also includes simple drawings that show how maintenance should be carried out, as well as tools to assist in the management of road maintenance by local communities.

A framework to assist farmers in obtaining engineering technicians to advise and supervise farmers in carrying out simple track/road maintenance activities should be put in place. This should be at sub-county or sub-district level so that the technicians are within easy reach of the farmers. It may be necessary to establish a legal and policy framework to recognise community participation in road works. This would provide communities with some protection and justification to work on the road. There are existing examples of similar involvement, for example Kenya has a special fund[4] whereby 30% can be allocated to special groups such as youths, women and people with disabilities, with a structure at community level. This gives the community a sense of ownership, although it is not well enforced at present.

In Tanzania, TARURA is limited to only working on classified roads, so first mile roads are generally beyond their remit to maintain. However, TARURA is a new organisation and is undergoing a review of its rural network and its classification. It recognises that it needs to work more with rural communities and hopefully this research will be able to facilitate that approach.

Road construction and realignment will inevitably require land acquisition. Farmers should consider making land available to facilitate re-alignment of track sections to minimise steep gradients, but this would be made easier if a framework was in place that could facilitate the process. This could be achieved as a part exchange whereby the farmer is compensated with an equal area of land on the old road alignment to turn into farm space. Alternatively the community or farmers' association may be able to work out a compromise, but compensation in cash is unlikely.

An institutional framework would need to be developed for community involvement. In most places this exists, but is rarely implemented. The framework needs to specify resources, support, capacity building and funding before it will be successful.

5.5 Encourage Local Government Involvement

Whilst it is recognised that local government funds for road construction and maintenance are limited, it is essential that the local government engineers have some input into the process and provide some funding for at least the essential work to make roads motorable. Cooperation with the local communities can be considered in order to reduce costs, but the communities will not be able to maintain the roads without any resources or training.

Local governments should also consider providing capital investments for the construction of simple water-crossing structures in every farming community to improve all-year-round access. Once the structure is

[4] http://www.ngeckenya.org/news/1042/vulnerable-groups-to-benefit-from-30-percent-gok-procurement-plans

provided, the farming community can then be trained to carry out simple routine maintenance through the farmers' associations.

It is recommended that committees are set up at local level to facilitate road maintenance. This could be established through existing structures or organisations within the community. These committees could then assist in the provision and delivery of training to relevant people in the community, with the training consisting of administration and communications, as well as technical subjects. It could be possible for the local government to set up a special fund to support infrastructure in rural areas.

5.6 Encourage District Based Coordinators under District Engineer

It may be possible to encourage the counties /districts to help provide a technician, with funding, to assist with small scale community construction activities. This was achieved in Tanzania under the Rural Travel and Transport Program (RTTP) (or Village Travel and Transport Programme, VTTP) of the SSATP, based in the World Bank. This initiative has however lost momentum in recent years. When it was operating the technician had access to funds to buy materials, but labour was generally provided on a voluntary basis by the local communities. This would not be possible in Kenya because KeRRA is already responsible for such activities.

Government programmes could be used to identify and establish coordinators. If an appropriate policy was in place funds could be moved to invest in programmes to support district based coordinators. Cooperation with the responsible roads organisation would be necessary.

5.7 Strengthen/Introduce Farmers' Cooperatives/Associations

From focus group discussions and other data it is clear that the areas where farmers do not have any type of association or group, they receive a lower price for their crops. This is particularly true in Meru, Kenya, where farmers wanted to form an association, but were discouraged from doing so by the sole buyer, which is a large organisation and procures all of the crops produced in the area. The buyer also supplies seed and fertiliser directly to the farmers on a credit basis, which strengthens their hold on the marketing process. There are other reasons that Meru farmers receive a lower price for their crop, but it does seem that their relatively weak marketing position contributes significantly to the lower price.

Forming a farmers' association would strengthen the farmers' position and could allow them to negotiate better prices for their produce. In addition there could be benefits in lobbying for improved road access with the local county engineers department, rather than approaching them as individuals. The farmers in Meru expressed a keen interest to become involved in infrastructure provision to their farms as they realise the benefits that motorable access roads would bring. At present they are paying a premium for headloading and backloading their produce to the collection point, but there would be a significant saving if trucks or even pickups could ply the access roads that are at present washed out and unmotorable.

A farmers' association could also become involved in maintaining the access roads, as this is an area where local engineers are unlikely to have any significant funding. Community involvement in road maintenance is not a new concept and there are many models that can be learned from, but forming an association to take on this task would make it more feasible. It would be necessary for the association to liaise closely with the local engineers department, initially to consult over the work necessary to rehabilitate the roads, but also to participate in training on how the roads need to be maintained. Ideally the local engineers department would provide assistance in terms of training, resources (tools and materials) and supervision.

Extension workers or District Community Officers (DCOs) could be used to develop farmers' associations and cooperatives. They would also be able to advise on market access for farmers, which would need to go along with the development of organisations, such as better communications for market access via mobile phones, etc. Collective farm storage would also be easier to arrange with a farmers' organisation, especially where highly perishable crops are involved.

5.8 Encourage Farmers to Liaise, Coordinate and Amalgamate Loads

As suggested above, a farmers' association would benefit the farmers in many areas. In addition to the marketing issues discussed above, an association could facilitate farmers to liaise with each other in terms of organising transport of crops in the most cost effective way. At present most farmers arrange their own transport, using various modes. There would be increases in efficiency if farmers could liaise and amalgamate loads, effectively sharing the transport services that are available. If some loads are only partially full, this results in inefficiency for the farmers and ultimately reduces their income. This again could be facilitated by DCOs or extension workers.

5.9 Increase Competition amongst Buyers and Transporters

Marketing of a crop is best managed by instilling competition amongst buyers. If the farmers allow a sole buyer to control the market, it is inevitable that they will receive a lower price for the crop as the buyer knows the farmers have no other options to sell. This appears to be happening in Meru in Kenya, where a single buyer purchases all of the crops available each harvest. Market forces dictate that a sole buyer will tend to maximise their profits by offering as low a price as possible. It was also learned that the buyer in Meru agrees one price at the collection point, then pays a lower price to the farmer about two weeks later, when the crop has been transported to the main market. The farmers are given no explanation as to why this happens and feel powerless to challenge such practices. Competition amongst buyers would go a long way towards providing better prices for the farmers in Meru and other locations.

In this case the development of associations or cooperatives would benefit the farmers, and they may need assistance in resisting the buyers to establish such organisations. When farmers organise themselves in this way they also find it easier to provide support to each other in times of hardship, such as when crops fail. Cooperatives would be able to negotiate on the farmers' behalf, and could also help to arrange transport that could be shared amongst farmers to maximise economies of scale. The first step would be to raise awareness of the benefits of cooperatives, how they can help farmers and how they could be formed/managed. Cooperative leaders may need some form of training to effectively manage the organisation. It may also be possible for local government to provide some resources to the cooperative or association, or to arrange joint projects whereby the government provides resources and the cooperative provides labour in kind. In many countries rules over the establishment of such bodies already exist, so the framework could well be in place already. For example in Kenya there has been government regulation and support for cooperatives since independence, and they are still strong today.

5.10 Gender and Social Issues

Men are more prominent as farmers and transport operators in most of the areas researched. In all areas men produced higher yields per acre, except for pineapples in Tanzania where the productivity of women farmers was found to be higher. It is recommended that the community as a whole try to share the burden of production and transportation, with better access to credit and more funding options made available to women. At present, credit is available from Government, NGOs, etc. but there was feedback from the workshops that women struggle to access such credit and that it is more expensive for them. It would be beneficial to find a way to make credit more affordable to women. The M-Pesa system has been used in Kenya since 2006, and facilitates access to funds for many rural inhabitants (Lonie, 2010) and has been promoted as empowering rural women, although this notion has been challenged (Ndiaye, 2014). It has been suggested in feedback from the workshops that women have difficulty in irrigating their crops, so female friendly irrigation equipment could also be introduced.

Youths should also be considered along with vulnerable groups (which could include men) for assistance to maintain their farming livelihoods. Women and vulnerable groups have less bargaining power and get less income for their crops, as opposed to men. In some places special funds are available from government to women and vulnerable groups to participate in farming. This could be made more widespread and extended to transporters, as from the whole study only one female transporter was recorded. There is scope for women to become more prominent in the role of transporting, as attitudes change and

opportunities arise. Any solution to the gender and vulnerable groups issue must involve the whole community.

The first step in empowering women is to educate the men. A small first step would be to ensure that women farmers are paid directly, rather than the husband or head of household. This already happens in some areas. In addition women should be given equal access to land, modern farm procedures and technologies, which could help to alleviate their burden.

5.11 Add Value at the Farm

In the second Tanzania country workshop there was a suggestion that value could be added at the farm by taking on some simple processing tasks of the produce. In the Madeke area of Tanzania, which predominantly produces pineapples, the government had set up a processing facility to dry pineapples for packaging within the pineapple growing area. Ultimately this did not succeed for various reasons, but it would have been a practical solution to the issue of crop spoilage associated with the remoteness and long distances for transporting the pineapples, the poor road conditions and the vulnerability of the crop. Transport costs would ultimately be cheaper because the processed produce being transported is smaller in volume and lighter in weight.

One suggestion was to use waste fruit that is not suitable to sell in the market, to produce juice for sale locally. In this case the main export of whole fruit would continue, but waste would be minimised through juice production. The fruit could be graded, with the highest grade going for export as fresh fruit, and the lower grade being processed into fruit juice. Clearly this would involve outside investment and training / capacity building in the local community, but the benefits are potentially substantial.

There may also be potential for technologies such as solar power to facilitate processing at the farm level. The processing may need improved services such as water, electricity, etc. before value can be added. In the example of Madeke pineapple farming, where the pineapples are grown as organic produce, the waste could be processed as organic fertiliser.

6 Outputs and Knowledge Dissemination Initiatives

6.1 Awareness Raising, Dissemination and Guidance

There is a requirement in the ToR to outline a comprehensive range of outputs and knowledge dissemination initiatives designed to promote uptake at the farm and village level, as well as central and district levels. The following recommendations were discussed and agreed at the country and regional level workshops.

6.1.1 Farm level:

- Produce leaflets to raise awareness on regulations, these could be picture based to include illiterate farmers
- Training at the farm level through farmers' associations or cooperatives
- Local programmes for awareness raising, possibly coincided with existing local events where the farmers are already gathered
- Use cooperative officers and extension workers to raise awareness and implement training, help to interpret rules and regulations
- Introduce modern farm procedures, through extension workers or cooperatives

6.1.2 Village level:

- Holding village/community meetings or village council meetings to raise awareness
- Use cooperative officers and extension workers to raise awareness and implement training, whilst helping to interpret rules and regulations

6.1.3 District/County level:

- Use district or county meetings to raise awareness
- Use radio programmes to raise awareness and inform
- Use cooperative officers and extension workers to implement training

6.1.4 Central level

- Printed brochures could be appropriate at this level
- Radio programmes could also be useful to sensitise the general public on first mile issues
- Government tends to work in silos, but cooperation should be fostered between Ministries and departments
- Typical initiatives would be to use seminars, conferences and workshops to sensitise decision makers and policy makers centrally. These could be specifically arranged events, or piggy-backing onto previously arranged events.

6.2 General:

In general it was agreed that initiatives should start at the grass roots and work up. Resources are always scarce so it is necessary to have the initiative to design a mechanism for cooperation. Although some recommendations are implementable, they may not be sustainable in the long term. This aspect should be critically evaluated before dissemination programmes are initiated.

7 Implications of the Research

There are many potential implications of this research. The findings shown in the Phase 3 Report uncovered the following key aspects of first mile access, and these were further refined and finalised during the regional stakeholder workshop in Arusha in November 2018.

7.1 How transport can unlock growth

The Cost Benefit Analysis showed that there is a potentially significant benefit to the farmer of reducing the transport charges to the collection point. This can be achieved by improving the road condition on the first mile segment of access roads. To date, many first mile roads are not classified or are afforded low priority, which means that very little money is spent on providing fit for purpose access or appropriate maintenance. If this message can be delivered to policy makers and roads organisations then the potential implications are significant.

The First Mile is an often neglected part of the rural road network, and is often not even mapped or recognised through formal classification. This research and the dissemination activities have the potential to sensitise stakeholders to the importance of this link to farmers, as well as to the economy as a whole. Once this is recognised then the implications on policy and the potential resources that could be committed to improving First Mile roads have potentially significant implications for farmers, transporters and rural communities as a whole.

7.2 Better advice to road planners

7.2.1 Consultation

The research has highlighted the need for road planners to consult fully with farmers, transporters and locally based technicians to identify the dynamics of each particular area and design a network that meets their needs, in terms of efficiently and cost effectively transporting produce to the market.

This consultative process would be able to facilitate the process of identifying what physical infrastructure would be required and where it would be most effectively located to meet the demands of smallholder

farmers. This would include the location of collection/storage facilities, whether they would need cooling facilities, the nature of the onward journey from the collection point, etc. In terms of road provision, the whole life costs of the road should be taken into account and the likely levels of maintenance that would be applied, possibly with different scenarios, i.e. no maintenance, community maintenance, full maintenance.

7.2.2 Rural Road Condition Measurement

It is also important for road managers and planners to know the condition of roads and how they deteriorate, in order to effectively plan road maintenance. The use of accelerometers to measure road condition, and to monitor the movement and deterioration / damage of crops during transit, shows some promise. Where roads are in poor condition and traffic speeds are very low, accelerometers can provide an objective measurement of the movement in the X, Y and Z directions of the vehicle. This is a low cost and simple way to measure roughness, where the use of sophisticated equipment would be too risky in terms of damage, and where the traffic speed is too slow for smartphone monitoring. Research would need to be carried out to correlate the results with the IRI. In a similar way, accelerometers can also be placed within the crops to determine the dynamics of crop damage during transit. There is potential for further research (see Section 8.8) and knowledge generation to inform farmers and transporters of the best way to transport crops so as to minimise damage during transit.

7.3 Quantification of the economic benefits of better initial access

7.3.1 Transport Costs

The findings show that a substantial part of the apparent disparity in the charges of various first mile transport, between the modes, might be explained by differences in transport distance. For example, it is well recognised that the best measure of transport costs is a weight distance charge. Using this measure a substantial variation in transport charges between different modes and surveys was found. For example, the mean headloading charge for Madeke in Tanzania is 668.9 TSh per kg/km, which is 54 times as expensive as the donkey cart charge in Matola at 12.25 TSh per kg/km. However, if a 2 km trip was made by both modes then the modelling suggests that the Madeke pineapple head/backloading charge would be just 38.5 TSh/kg compared with 22.2 TSh/kg for the donkey cart in Matola, i.e. just 1.6 times as expensive.

Overall, the analysis suggests that the opportunities to substantially reduce transport charges by changing modes (through better transport links and load consolidation) for short distance trips, may be more limited than previously thought. Probably, the most effective method of reducing transport costs would be by picking up farm produce at the farm and transporting directly to market, avoiding double handling at the collection point altogether. The marginal increase in costs for a few extra kilometres, for the truck involved, are likely to be minimal.

This finding adds weight to the argument that all-season motorable roads should be extended closer to farms, in order to cut down on the most expensive modes of transport, and maximise the use of trucks which are the cheapest mode. Even though motorcycles are more expensive, they are able to operate on narrower trails with lower standard construction. However, the main advantage of truck access would be that the collection points could be located closer to farms, and the trucks could take higher volumes of produce directly to the market or end point, which is not the case with motorcycles. With the majority of economic activity being agricultural in much of Africa, this could have significant potential implications for the sector.

7.3.2 Relationship between First Mile Transport and Incomes

In order to estimate the impact of transport costs and crop losses on incomes, the mean values of the independent variables were multiplied by the regression coefficients. The results were then compared with the mean values of the net income per acre for the two crops. This showed that for potatoes, initial transport costs are associated with an average reduction of net incomes by 35%, while crop losses are associated with an average reduction of 2%. Similarly, for pineapples, it was found that initial transport costs are associated with an average reduction of 22% in net incomes, while crop losses account for a further average reduction of 7%.

Overall the different analyses suggest that initial transport costs and crop losses account for reductions in the region of 30 to 40 % of net incomes of potatoes and pineapples in Tanzania. While for French beans in Kenya, the associated reduction in net incomes is around 10 to 15%. This allows a greater understanding of the dynamics surrounding transport and incomes and will inform policy makers and planners of the most effective infrastructure and transport services solutions for farm to collection point access.

7.4 Framework for advice to farmers and authorities for improved transport patterns

A number of issues and suggestions have been highlighted during this research, which are important for farmers and authorities to maximise the pattern of transport in rural areas. For example, the costs of different modes of transport have been investigated, so the most appropriate can be compared to define how loads could be amalgamated. In terms of the physical infrastructure it would be possible to determine the most efficient routes, given the costs per kg / km and what level of maintenance would be required to maintain roads at a relevant condition for the transport services that use them. More sophisticated research could be funded to consider simulations using different modes, quantities and load amalgamation strategies to provide a range of costed solutions to see what is likely to work best in different scenarios.

7.5 A better understanding of transport and the agricultural environment

7.5.1 Community Involvement in Roads

This research has shown that there is interest from local communities and farmers to take on a more active role in the provision and preservation of rural roads, specifically First Mile roads. There were extensive discussions on this subject in both the country and regional workshops and the consensus was that it is desirable for local involvement, and therefore ownership, of rural roads. There may be some political and practical barriers to overcome, but it was the opinion of the stakeholders that these were not insurmountable.

It was agreed that a framework for community involvement would be beneficial, as it would enable a formal programme of training, capacity building, etc. If implemented, this could lead to better quality and more regularly maintained First Mile roads, which will increase accessibility and hopefully stimulate more regular transport services closer to farms. The implications of this would be to reduce transport costs for farmers and to ultimately improve their livelihoods and associated income levels.

7.5.2 Farmers' Associations / Cooperatives

It is clear from the research that where the farmers have formed associations, they receive a better price for their crops. Although there are many other factors that influence this, it does seem that farmers' associations are significant in empowering farmers to have more influence over buyers and transporters. Other benefits include encouraging farmers to share transport and consolidate loads, which again reduces transport costs. There are well established regulations and structures for farmers' associations in most countries, so it should not be too onerous to develop a guideline for farmers and the benefits of forming associations.

The potential implications are that farmers would have more power over the growing, transport and marketing of their crops. There are examples evident in the research that show areas with strong associations where farmers are getting good prices and have lower transport costs (Machakos), against areas with no associations where farmers have lower incomes and are unable to afford motorised transport (Meru). The implications of a strong farmers' association are clear, they provide farmers with more strength and power to negotiate better deals in transport and marketing. The resulting outcomes would be that if farmers are able to secure higher prices for their produce and lower transport costs, this would have a positive effect on their livelihoods.

7.5.3 Gender and Socio-Economic Perspectives

In total, 35% of farmers interviewed in both countries were female. In three of the four locations, the areas farmed by men were significantly larger than those farmed by women. For Machakos the crop areas were

the same. Yields per acre were lower for women in three locations; however for Madeke pineapple farming women achieved 58% higher yields. Overall, in each location women's net incomes were substantially less than for men. Women's farms tended to be closer to the collection point than for men, but despite this the cost of first transport was higher for women in Machakos and Meru. Women owned substantially fewer means of transport than men, although there was a significant variation between different locations.

Although these findings are not particularly surprising, they do provide evidence as to the reasons why women, youths and vulnerable groups are disadvantaged, although being located closer to a collection point should not be a disadvantage. This data can be used to plan for more equitable and inclusive engagement of women in smallholder farming, as well as in local transport from the farm to collection point, and beyond. The potential implications are that positive measures can be made to balance the situation, based on evidence from this research, and ultimately women and vulnerable groups could benefit through improved incomes and livelihoods.

8 Further Research

A number of potential areas for further research are noted here:

8.1 Effective Arrangement and Management of Community Maintenance

This was a key outcome of the research, but is different in every country due to the rules, regulations and laws around who is allowed to work on government assets. It should be possible to carry out a review of examples from a representative sample of countries and produce a generic guide to arranging community maintenance. The 'Spot improvement manual for basic access', produced for PO-RALG (Done, 2006) proposes models of community involvement and the distinctive roles that community members could adopt. It also includes simple drawings that show how maintenance should be carried out, as well as several tools to assist in the management of road maintenance by local communities. The supplement produced for 'The Organic Farmer' magazine in Kenya (Beusch, 2008), would also be relevant. The resources required for this approach would be beyond the capacity of farmers included in this research, but would be possible with local road authority involvement. The PIARC International Road Maintenance Handbooks are also good examples of practical guides that could be used on site (PIARC, 1994 – 2006). It should be possible to build on these documents and others to produce a generic model for community involvement in road maintenance.

8.2 Secondary Transport Segment

This research has focused on the First Mile, which is considered as the primary movement from farm to first collection point or local market. The research has however, noted the importance of the secondary transport segment from collection point to storage facility or primary market. The quality of these secondary transport segments varied quite significantly between sites, and between countries. In Tanzania there were long sections of fair to poor gravel road from the collection centres to the nearest paved road or market, whereas in Kenya there were paved roads or short sections of good gravel road relatively close to the collection centres. It was also noted in Kenya that many main roads have speed bumps or 'sleeping policemen', which are frequent and often quite steep, so there is a possibility that such road features could affect the crop in a negative way through bruising and damage.

The secondary transport segment gravel roads in Tanzania are vulnerable to heavy rain. During the wet season, wet and boggy spots quickly appear and the surface becomes slippery and ruts easily. The particularly bad areas can cause large trucks to become stuck for long periods, and in the worst-case scenario the road could become blocked for some hours. In any case, the transport of crops becomes difficult and unreliable, leading to damaged crops and crops that become spoiled because they cannot be transported to the market on time.

To better understand the dynamics of how the secondary transport segment affects the quality and price of perishable crops it would be beneficial to carry out further research in this area, although arguably this could be beyond the scope of the ReCAP remit of low volume rural roads.

8.3 Investigate Successful Examples of Maintenance to First Mile roads

If some examples of rehabilitation or upgrading of First Mile type roads could be found, it would be a useful exercise to assess the success or otherwise of the intervention in terms of how it affected the price that farmers received for their produce and ultimately whether a difference can be seen in their livelihoods. This could be a key input into the decision to improve rural roads to a standard whereby trucks or other four-wheeled vehicles can access closer to farms. If enough data is available an analysis of the before and after benefits could be carried out.

8.4 Add value at the Farm

A desk study could be undertaken to identify the types of interventions that would be appropriate for adding value at the farm, through diversification for various types of crops. This type of intervention has been implemented across the world, with one of the most recent examples being in the UK where a dairy farm has started to make ice cream on the farm premises because it provides more income than just selling milk.

It should be noted that on the field trip to Madeke an old pineapple drying factory was observed. It was set up by the government but was never fully commissioned so is now used solely as a storage shed. It could be that a farmers' cooperative would be more successful than the government at an innovative scheme such as this, but it is nevertheless a good example of what could be achieved in terms of adding value at the farm gate.

8.5 Competition

On the Meru site, limited buyers were a problem. Basically one buyer served all of the farms and the farmers received a significantly lower price for their crop than in Machakos in Kenya. Although this was not the only reason for the lower price, it was thought to be a significant factor. It would be possible to research this issue in more depth and to define what the constraints are to getting more buyers to serve an area. For example, is it just monopolistic practices, or are there other factors that influence this, such as a very small supply? Is the secondary road a problem for the buyers? Although this is not a low volume roads or transport issue, it does have a bearing on farmers' incomes and needs to be factored in when considering First Mile issues.

8.6 Crop Deterioration and First Mile Transport

The Inception Report for the project identified a range of research that has been undertaken on post-harvest crop deterioration, and the field research also collected data on this. This work needs to be built upon, using experimental trials, involving different methods of collection, packing and transport, to identify the ways of minimising crop deterioration in the most cost-efficient manner. It is well known that once produce is harvested, its quality can only deteriorate and therefore it is imperative to ensure proper harvesting, handling and transport practices are followed to ensure that quality of the produce is maintained so far as is possible. The development of educational material clearly indicating proper produce harvesting, handling and transport practice would be a possible outcome of any research.

8.7 Condition Measurement by Accelerometer

In Phase 3 the data collection of rural road conditions was carried out using a range of technologies, and because of the very slow speeds possible on many of the roads accelerometers were found to be appropriate. Accelerometers can also be used within the loads to measure crop damage, as has been trialled previously (Pretorius, 2012), which would lead to a better understanding of the mechanism of damage to crops in vehicles that travel over roads in poor condition. There is potential to develop a scale by which these types of accelerometer can be linked to the IRI roughness scale, which would facilitate monitoring of roughness and potential for crop damage in particular vehicles.

9 Technical Papers

The Journal of Transport and Land Use (JTLU) has been selected as an appropriate internationally recognised publication for submission of a peer-reviewed scientific paper, based on the research outputs of this First Mile project, and the article has been produced in a relevant format for the journal. Formal acceptance of the paper is still pending, but the abstract is shown below.

9.1 JTLU Abstract

The "First Mile" is a reference to the primary segment of transport that links farmers to the nearest produce collection or consolidation point, or local market. Research has been carried out in Kenya and Tanzania under UKAid funding through the Research for Community Access Partnership (ReCAP), where means of transport on the first mile vary from human porterage, animal carts, bicycles and motorcycles, to tractors, pick-ups and small trucks. These modes of transport and the condition of the road can have a significant influence on the quality of crops being transported by the time they reach their destination.

This research was designed to better understand the dynamics of transport on the first mile and the effect it has on farmer's livelihoods and ultimately on poverty, by exploring this aspect of the transport chain and making recommendations for practical application and policy consideration. This paper sets out the main findings of the study, and shows the key issues that affect farmers' livelihoods with respect to accessibility. A cost benefit analysis was carried out based on the principle of reducing the distance from farm to collection point by improving the road surface to accept motorised vehicles in all seasons.

9.2 Durban Abstract:

The project also had one scientific paper accepted at the SARF/IRF/PIARC 'Africa Regional Conference' in Durban in October 2018. This paper was presented by Robin Workman.

The efficiency of rural transport is important for improving financial and time costs in the delivery of produce and for reducing post-harvest losses. Many crops lose value as they are transported over rough roads and suffer time delays in getting to the market. The pattern of transport varies between seasons with many roads becoming impassable, which results in slower transport and increased costs. There is growing recognition that rural infrastructure needs to be planned together with transport services to minimise transport costs, reduce crop wastage and gain the maximum advantage for farmers.

TRL is undertaking research in Tanzania and Kenya on moving harvest along the primary transport segment, or 'First Mile', from farm to established road access. This project is concerned with the cost-beneficial improvement of access, by assessing the condition of these primary road segments to determine the effect on crop damage and wastage. The condition assessment is being carried out using a variety of high-tech methods, in addition to traditional visual surveys being assessed from DashCam videos of the road. A quantitative assessment of road roughness was measured using three methods, maximum comfortable achievable vehicle speed, smartphone apps and accelerometers. Accelerometers were placed in both passenger and goods vehicles; in amongst the produce when vehicles are loaded. The accelerometer data was analysed, along with socio-economic data, to gain a greater understanding of First Mile access problems that will result in recommendations for improvement.

9.3 Arusha Abstract:

An additional paper was also presented at the PIARC 'International Seminar on Transport in the Fourth Revolution: A Complex and Dynamical World' conference in Arusha in November 2018. This exposure provided a good opportunity to disseminate the results of the project and build awareness of the issues related to First Mile access. This paper was presented jointly by Grace Muhia and Fridah Mugo.

> This paper is based on research undertaken in Kenya and Tanzania between 2017 and 2018, to investigate the issue of 'First Mile' transport for small holder farmers. The study was funded by the UK's Department for International Development (DFID) under the Research for Community Access Partnership (ReCAP). The "First Mile" is the initial segment of transport from farm to the first market or a collection point. In Kenya the study was conducted in Meru and Machakos where French Beans for export are grown. In Tanzania the study was carried out in Matola and Madeke where potatoes and pineapples are the main crops. Data was collected using semi-structured interviews with farmers, transporters, and focus groups. The condition of local access roads was also assessed.
>
> In all the study locations, it was found out that a key challenge for agricultural marketing is that farms are too remote and the road condition is too poor for transport services to access. In all cases, ownership of motor vehicles is negligible. Human porterage, animal transport and motorcycles are the most common means of transport. Head and back loading is the most expensive means of transport per ton/km, with animal transport being the least expensive.
>
> The study also found that the area farmed by men was significantly larger than that farmed by women. Women's farms tended to be closer to the collection point than for men. However, their first mile transport costs were higher on the account of owning fewer means of transport.
>
> Recommendations from the study include the need for local governments to work with local communities to ensure all weather access to areas of high agricultural productivity. Women who predominantly work on the farms need to be supported to gain from the benefits that improved transport infrastructure and accessibility can bring to agricultural value chains. The study also underscores the need to leverage innovations in Communication Information Technologies as a tool to link producers to markets and as well as improving the efficiency of produce consolidation and transport.

10 Conclusions

The following presents a summary of the conclusions from the research and is based on the original objectives of the research:

10.1 Unlocking growth in the smallholder value chain sector

Following the research and analysis the main aspects of the transport system that could be improved and would lead to growth in the sector were the road infrastructure itself, the transport services and how communities can become more involved in the system. In terms of road infrastructure there is a case for extending all-season roads closer to farms in order to reduce the high cost of transport from farm to collection point. There is scope to plan roads so that more appropriate transport services are able to use them, and there is interest from communities to become involved in road rehabilitation and maintenance. If these key improvements can be secured they will contribute towards unlocking growth in the smallholder value chain sector.

All of the recommendations made have some potential for unlocking growth. This research and the dissemination activities have the potential to sensitise stakeholders to the importance of this link to farmers, as well as to the economy as a whole. Once this is recognised then the implications on policy and the potential resources that could be committed to improving First Mile roads have potentially significant implications for farmers, transporters and rural communities as a whole.

10.2 Better advice to road planners on the best location for access improvements

The research identifies road planning as a key activity to be improved in order to improve access. Many roads that could be termed as First Mile roads are not designed to be appropriate for the type of vehicles that would most effectively use them; in fact many are not properly designed at all. This was evident in some areas where gradients were too steep and drainage was minimal, leading to rapid damage and inaccessibility. Planners should consult with local communities, transporters and local technical departments to more appropriately plan rural roads. A rural land use plan could be developed so that the expansion of economic activities and agricultural yields can be planned, along with the transport services that use the first mile and access roads. Ensuring all-season access was suggested as a measure to ensure that transport services stimulation is implementable, with the aim of giving confidence to transporters to access farms and allowing farmers to invest more due to the lower risk of spoiled crops.

It is recommended that committees are set up at local level to facilitate road maintenance. This could be established through existing structures or organisations within the community. These committees could then assist in the provision and delivery of training to relevant people in the community, with the training consisting of administration and communications, as well as technical subjects. It could be possible for the local government to set up a special fund to support infrastructure in rural areas.

10.3 Quantification of the economic benefits of better initial access

A cost benefit analysis was undertaken that justified extending all-season rural roads to be closer to farms and thus reducing the costs associated with the initial transport segment. The results of this were overwhelmingly positive, although it should be noted that it was carried out in one specific area, and the dynamics of different crops and different situations in different countries will give different results. Nevertheless, this does provide evidence to back up the extension of all-season roads to be closer to farms.

Although the analysis suggests that the opportunities to substantially reduce transport charges by changing modes for short distance trips may be limited, the most effective method of reducing transport costs would be by picking up farm produce at the farm and transporting it directly to market, avoiding double handling at the collection point altogether. The marginal increase in costs for a few extra kilometres, for the truck involved, are likely to be minimal.

This reinforces the argument that all-season motorable roads should be extended closer to farms, to minimise the most expensive modes of transport and maximise the use of the cheapest modes. The main advantage of truck access would be that the collection points could be located closer to farms and the trucks could take the produce directly to the market. Excluding South Africa, agriculture in Sub-Saharan Africa employs 62% of the population and generates 27% of the GDP of these countries (Livingston et al, 2011). According to FAO (2012), agricultural growth involving smallholders, especially women, is most effective in generating employment for the poor and reducing extreme poverty and hunger. The World Development Report 2008 was dedicated to agriculture. The report underscored the fact that in SSA, agriculture contributes significantly to economic growth, and, because the poor are concentrated in rural areas, it is an important tool in poverty reduction.

10.4 A framework to provide advice to farmers and authorities

There are a number of important features of this research that provide guidance on how farmers and authorities can gain advice on transport patterns. There is a clear benefit of using heavy vehicles to transport produce from as close to the farm as possible. The time taken to transport crops, especially those that are vulnerable to heat, is crucial, so the provision of cooling facilities at the collection point can have a bearing on the transport used. This research compared the different types of transport used in the particular trial locations, which are fairly typical for Kenya and Tanzania. The information on cost per kg / km is useful in determining the efficacy of each transport mode and developing a pattern of transport that will serve all of the stakeholders most efficiently.

Based on feedback from the country and regional workshops, a framework to assist farmers in obtaining engineering technicians to advise and supervise farmers in carrying out simple track/road maintenance

activities should be put in place. This should be at sub-county or sub-district level so that the technicians are within easy reach of the farmers. It may be necessary to establish a legal and policy framework to recognise community participation in road works. This would provide communities with some protection and justification to work on the road. The framework also needs to specify resources, support, capacity building and funding before it will be successful.

Road construction and realignment will inevitably require land acquisition. A framework to make land available for re-alignment of track sections to minimise steep gradients would facilitate this process. This could be achieved as a part exchange whereby the farmer is compensated with an equal area of land on the old road alignment to turn into farm space.

10.5 Better understanding of the role of transport and gender dimensions

The research did disaggregate data on a gender basis, which showed that women are significantly disadvantaged in the smallholder value chain sector. Overall, in each location women's net incomes were substantially less than for men, women owned substantially fewer means of transport and although their farms tended to be closer to the collection point the cost of first transport was higher. There is a need to plan for more equitable and inclusive engagement of women in smallholder farming, as well as in local transport from the farm to collection point, and beyond. It is anticipated that farms, and agriculture as a whole, would benefit from more female input, especially if women are given responsibility in more significant roles.

Women and vulnerable groups have less bargaining power and get less income for their crops. In some places special funds are available from government to women and vulnerable groups to participate in farming, so this could be made more widespread and extended to transporters. There is scope for women to become more prominent in the role of transporting, as attitudes change and opportunities arise, but any solution to the gender and vulnerable groups issue must involve the whole community.

The first step in empowering women is to educate men. Small changes that can be implemented quickly are that women farmers are paid directly, rather than the husband or head of household, and women should be given equal access to land, modern farm procedures and technologies, which could help to alleviate their burden.

10.6 Knowledge Dissemination Initiatives

Knowledge dissemination activities were discussed in detail at the country workshops and the regional workshop. The feedback has been consolidated to provide the following recommendations:

10.6.1 Farm level

At the farm level it was recommended to produce leaflets to raise awareness on regulations, these could be picture based to include illiterate farmers. Training at the farm level through farmers' associations or cooperatives was also proposed, as well as undertaking local programmes for awareness raising, possibly coincided with existing local events where the farmers are already gathered. Using cooperative officers and extension workers to raise awareness and implement training, and helping to interpret rules and regulations, is also an important consideration. Modern farm procedures could be introduced through extension workers or cooperatives.

10.6.2 Village level

Holding village/community meetings or village council meetings to raise awareness is an established way to raise awareness at the village level. Also cooperative officers and extension workers could be used to raise awareness and implement training, whilst helping to interpret rules and regulations.

10.6.3 District/County level

At this level it would be feasible to use district or county meetings to raise awareness, as well as using radio programmes to raise awareness and inform people, which is a popular form of media in rural areas. Again using cooperative officers and extension workers to implement training would be helpful.

10.6.4 Central level

At the central level the medium of communication is more formal, so printed brochures could be appropriate, as well as radio programmes which could also be useful to sensitise the general public on first mile issues. Government tends to work in silos, but cooperation should be fostered between Ministries and Departments. Typical initiatives would be to use seminars, conferences and workshops to sensitise decision makers and policy makers centrally. These could be specifically arranged events, or piggy-backing onto previously arranged events.

10.6.5 General

In general it was agreed that initiatives should start at the grass roots and work up. Resources are always scarce so it is necessary to have the initiative to design a mechanism for cooperation. Although some recommendations are implementable, they may not be sustainable in the long term. This aspect should be critically evaluated before dissemination programmes are undertaken.

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Annex 1 Workshop Report

First Mile Presentations

There were four presentations made to present the outcomes of the project, set the scene and prepare the groups for the tasks ahead. The presentations made were:

1. Robin Workman: Introduction and purpose of the workshop
2. Shedrack Willilo: Background on the First Mile, data collection and road condition
3. John Hine: Analysis of results, Cost Benefit Analysis
4. Robin Workman: Recommendations, workshop tasks, group formation

The participants were then split into three working groups and given specific tasks. Each group was asked to consider three or four of the recommendations from the perspective of whether they were implementable in a wider context, and how they can be carried forward into practical application.

All groups were asked to identify some knowledge dissemination initiatives that could be designed to promote uptake of the recommendations at farm, village, district/county and central levels.

Group work

Participants were split into 3 groups, with an even split of Kenyans and Tanzanians, and sector experts.

Group 1: Recommendations 1, 2, 3 and 4

Shedrack Willilo
Steve Miano
Sylvia Muthoni
Zainab Mshana
Arrif Mohamed
Filemon Namwinga
Bruno Kinyaga
Joseline Kagombora

Group 2: Recommendations 5, 6, 7 and 8

Grace Muhia
Dennis Onkundi
Kelvin Ritho
Elikana Kagoma
Frank Mwangoka
Ahmed Wamala
Vincent Lwanda
Tabitha Mkude

Group 3: Recommendations 9, 10, and 11

Fridah Mugo
Virginia Njeri
Joseph Wachiuri
Josephine Mwankusye
Elifadhili Mgonja
Simon Lushakusi
Hans Mhalila

Recommendation 12 was knowledge dissemination and how it can be achieved at all levels.

The groups were given one hour and twenty minutes to discuss the issues and come to some conclusions. They were then asked to report back in plenary, the results of which are shown below:

Report in Plenary

Group 1: Recommendations 1 to 4

1. Extend motorable roads closer to farms

- Yes this is an implementable recommendation
- Capacity building to local community is needed for road construction/maintenance techniques, at present they do not know the technical details or skills
- Promote civic education for the community to demand for rural infrastructure from the government. This would empower farmers and local communities to lobby for better roads.
- Establish Road Maintenance Task Force Groups in the districts with equipment i.e. towed tractors. At present funds and equipment for rural road maintenance are very limited in both Kenya and Tanzania.

2. Stimulate transport services by improved infrastructure and economic activities

- Yes this is implementable
- Develop a rural land use plan so that the expansion of economic activities can be planned, along with the transport services that use it.
- Ensure all weather access. At present the study areas suffer from wet season closures and access problems, better access would allow farmers to invest more because of less risk in crop transport.
- Devise subsidies and guarantee schemes for operators of RTS. It can be difficult to get RTS suppliers to establish new services, and even to keep old services going, due to risks, poor roads and lack of profits. If subsidies could be provided for rural transport then it would encourage private operators to establish appropriate services.

3. Community participation in road construction/rehab./maintenance

- Yes this is implementable
- First capacity building and training would be necessary for local communities on road construction/maintenance techniques. Some basic tools and materials may also be needed.
- Establish road maintenance groups at village levels. Those trained would benefit from being in maintenance groups, because they would be able to share their workload, seek advice and support each other.

4. Establish a framework for community involvement in road construction and maintenance

- Yes this is implementable
- Necessary to add '**in road construction and maintenance'** to this recommendation.
- Establish legal and policy framework to recognise community participation in road works. This would provide communities with some protection and justification to work on the road.
- Suggestion that tractor technology could be used, i.e. as per ReCAP project in Zambia (ZAM2059B).
- TARURA can only spend funds on classified roads, which rules out the majority of First Mile roads. TARURA also needs to build capacity as it is a new organisation. It needs to understand how to work with the community.
- Procurement act could be used. Instead of an ad-hoc group, create a formal community institution for road issues, such as the RTTP coordinator. Small scale interventions.
- Institutional framework is there, but not enforced. A pilot was made, but was not scaled up. Funds need to be allocated, but need government funds for it to work.

Group 2: Recommendations 5 to 8

5. Encourage local government involvement

- Agreed and Implementable
- Set aside policy direction for every year of road maintenance
- Use money set up for youth and women to implement road maintenance. There was some doubt amongst the workshop that this would be allowed under current regulations.
- Set up committees for road maintenance at the local level.
- Involve a Local Government Task Force (LGTF)
- Provide training to local government and community, in communications and administration as well as technical subjects.
- An issue is that most work is contracted, so would need direct support by government.
- Local government could set up a special fund to support infrastructure in rural areas.

6. Establish district based coordinators

- Agreed and implementable in Tanzania, but not in Kenya.
- Funding technicians at district level to support road maintenance.
- Use of government programmes and policies to identify and establish coordinators.
- Move funds to be invested in the programmes.
- Cooperation with roads organisations necessary.
- In Tanzania government policy exists, in KeRRA there is a system of local road maintenance.

7. Form/strengthen farmer's associations and cooperatives

- Agreed and Implementable.
- Use DCO's and extension officers.
- Use collective farm storage in common for safe and long-term storage. This could be managed by farmer's associations.
- Assist farmers in market access, i.e. better communications, mobile phones, assistance from cooperative officers and other extension officers.

8. Encourage farmers to liaise/amalgamate loads

- Agreed and Implementable
- Aim to reduce number of trips and spoilage.
- Use DCO'S and extension officers
- Use collective farm storage in common for safe and long-term storage
- Assist farmers in market access

Group 3: Recommendations 9 to 11

9. Increase competition amongst buyers and transporters

- Government should proactively promote formulation of cooperatives, or revive existing ones. These can help to pool produce and purchase inputs on behalf of farmers.
- Cooperatives can also negotiate with private companies interested in farmer's produce.
- Provide an indicative price to farmers, so they have a basis for negotiation. Allow them to be proactive.
- They can organise transport for farmers by hiring jointly for produce collection and coops can also sell directly on behalf of the farmers.
- Government in Kenya should formulate regulations requiring farmers to be organised by crops/enterprises or geographical regions. In Tanzania the government should enforce the current regulations and proactively promote formalisation of cooperatives for collective action.
- Kenya and Tanzania should start by creating awareness of the benefits of cooperatives and collective action, followed by mobilisation of farmers to form cooperatives. They should also allocate funds to the indicated activities.

- Governments should build the capacity of cooperative leaders to be able to lead effectively.
- Cooperatives should be large enough to be able to hire extension and marketing staff or services.
- In the interest of effective transportation of farmer's produce the cooperative could be supported by government and members to maintain roads. For example the government can provide tractors or some services and the community can provide casual labour or contribute through a small contribution from the farmer's pay.
- There should be a strong government body in both countries to oversee the revival or evolution of cooperatives in order to protect the farmers, i.e. Tanzania has a Cooperatives Board. Kenya should also have a similar body. This body should devise ways of ensuring that there is no corruption in the cooperatives.

10. Facilitate gender and social inclusion

- This is agreed and implementable as recommended.
- In addition there should be special funds set aside by government for women, youth and vulnerable groups to participate in farming enterprises.
- Women had difficulty in irrigating their crops. Women friendly irrigation equipment should be available for their use, such as sprinklers.
- Ensure women are paid directly, not via their husbands
- Make credit easier for women farmers to get.
- Give women access to modern farm procedures.

11. Add value at the farm

- Agreed and implementable
- Value addition should be promoted for enterprises with potential. For example juice production from pineapples. Technologies such as solar power could be used to allow processing of the crops.
- The recommendation should be adopted as is, but the pineapples should be graded as 1, 2 etc. Grade 1 could be exported as fresh fruit and Grade 2 could be processed into juice for local consumption. Even for French Beans that cannot be exported, they can be processed and marketed locally as packed vegetables.
- Any organic waste could be composted to be used as organic fertiliser.
- May need improved services such as water, electricity, etc. before value can be added.

All Groups

12 Raise awareness, dissemination and guidance, framework for advice

The following knowledge dissemination initiatives were proposed and discussed:

Farm level

- Produce leaflets to raise awareness on regulations
- Leaflets could be picture based to include illiterate farmers
- Training at the farm level
- Local programmes for awareness raising and barazas (a public meeting place in East Africa)
- Use cooperative officers and extension workers to raise awareness and implement training, help to interpret rules and regulations.
- Introduce modern farm procedures, through extension workers or cooperatives.

Village level

- Village meetings or village council meetings to raise awareness.
- Use cooperative officers and extension workers to raise awareness and implement training, help to interpret rules and regulations.

District/County level

- Raise awareness of regulations
- Value addition
- Use district or country meetings
- Use radio programmes
- Set regulations
- Use cooperative officers and extension workers to implement training

Central level

- Printed brochures could be appropriate at this level
- Regulation
- Laws
- Policies
- Research funding
- Radio programmes
- Use cooperative officers and extension workers to raise awareness
- Government tends to work in silos, but cooperation should be fostered between Ministries and departments.

General:

- Start from the grass roots, at the First Mile.
- Resources are always scarce, needs initiative to design a mechanism for cooperation.
- Some discussion over setting a uniform market price, but many felt this was not possible/appropriate.
- Some recommendations are implementable, but need to look at the sustainability.

Annex 2 Workshop Participants

Tanzania			
Mr.	Shedrack	Willilo	IFRTD
Mrs	Josephine	Mwankusye	Dar es salaam
Mr	Hans	Mhalila	Private
Mr	Elifadhili	Mgonja	Transaid
Dr	Simon	Lushakuzi	NIT
Mr	Samson	Kalesi	Independent
Ms	Zainab	Mshana	NIT
Mr	Elikana	Kagoma	Independent
Mr	Frank	Mwangoka	Consultant
Ms	Tabitha	Mkude	STET International
Mr	Bruno Abas	Kinyaga	TARA
Mr	Filemon	Namwinga	Kilolo Distric Council
Mr	Ahmed Omar	Wamala	Independent
Kenya			
Mrs	Grace	Wahome	IFRTD
Mrs	Mugo	Fridah	Independent (IFRTD)
Mr	Joseph Ndirangu	Wachiuri	P.A. to the DIG Police
Mr	Dennis	Onkundi	Deputy Director Ministry of agriculture
Mr	Steve	Miano	Consultant
Ms	Virginia	Wainaina	Stanbic Bank Customer Service Consultant
Ms	Sylvia	Karebe	AWAN Africa Women in Agribusiness Enterprise
Mr	Kelvin	Ritho	Independent
United Kingdom			
Dr.	Annabel	Bradbury	ReCAP PMU
Mr.	Henry	Nkwanga	ReCAP PMU
Mr.	Robin	Workman	TRL
Mr.	John	Hine	TRL/Independent
Mr.	Paul	Starkey	Independent

Annex 3 Workshop Assessment

First Mile Workshop assessment form, 14th November 2018

1 List 3 things that you have learned from this workshop:

	Very Good	Good	Fair	Poor	Very Poor
2: How useful was the workshop?					
3: To what extent did the workshop meet your expectations?					
4: Could you contribute to the workshop?					
5: How do you rate the workshop schedule?					
6: How were the logistics and management of the workshop?					
7: How do you rate the workshop presentations?					
8: How do you rate the workshop discussion and feedback?					
9: How do you rate the summary of the workshop?					
10: What were the two best aspects of the workshop?					

11: How could the workshop have been improved?

12: Do you have any other comments or suggestions?

Thank you!

Feedback from the assessment forms:

Question 1 List 3 things that you have learned from this workshop:

- How government could be involved in implementation
- Poor roads affect farm produce
- How communities can benefit from infrastructure
- Road network is the backbone of agriculture
- Most farmers need government input
- There is a major need for sensitisation
- Community are not so involved in planning road projects
- More studies needed to address the gap between planners and beneficiaries of roads
- Farmers/communities can get involved to solve problems
- Management of roads in other countries
- Comparing best practice in road maintenance
- Farmer organisations are critical for good business
- Need to enforce transport policy
- How to establish cooperatives
- How to educate small-scale producers
- First Mile is a critical bottom-up process for perishables transport
- First Mile access problems are crucial to farmers
- Government should support access to the local communities
- Farmers can help solve problems by forming societies
- Research dissemination is key to share results
- Most research findings are not implemented
- Financing is a crucial element of implementing research
- Increasing competition amongst buyer is important
- Motorcycles are a good means of rural transport
- Importance of head/backloading
- Road network can affect profits of farmers
- High yields can be achieved through empowerment of farmers
- Local government plays role in success of farmers

Questions 2 to 9 inclusive:

		Ratings				
No.	**Questions**	**5**	**4**	**3**	**2**	**1**
2	How useful was the workshop?	87.5%	12.5%	0.0%	0.0%	0.0%
3	To what extent did the workshop meet your expectations?	62.5%	31.3%	6.3%	0.0%	0.0%
4	Could you contribute to the workshop?	68.8%	25.0%	6.3%	0.0%	0.0%
5	How do you rate the workshop schedule?	56.3%	31.3%	12.5%	0.0%	0.0%
6	How were the logistics and management of the workshop?	56.3%	37.5%	6.3%	0.0%	0.0%
7	How do you rate the workshop presentations?	68.8%	31.3%	0.0%	0.0%	0.0%
8	How do you rate the workshop discussion and feedback?	75.0%	25.0%	0.0%	0.0%	0.0%
9	How do you rate the summary of the workshop?	43.8%	50.0%	6.3%	0.0%	0.0%

Ratings: 5=Very Good, 4=Good, 3=Fair, 2=Poor, 1=Very Poor

Question 10: What were the two best aspects of the workshop?

- Group participation
- The presentations
- Discussions
- Good statistics
- Sharing experiences with other participants
- Interactions
- Sincerity of the sharing
- Analysis of First Mile access
- Cost benefit analysis
- Extent to which farmers lose due to access problems
- Strategies available for relief
- Networking

Question 11: How could the workshop have been improved?

- More time
- More different stakeholders
- Learning about farmers in other countries
- Summaries in advance to have deeper understanding
- Literature on cost benefit analysis
- Communication
- Get key policy makers to attend
- More time for presentations

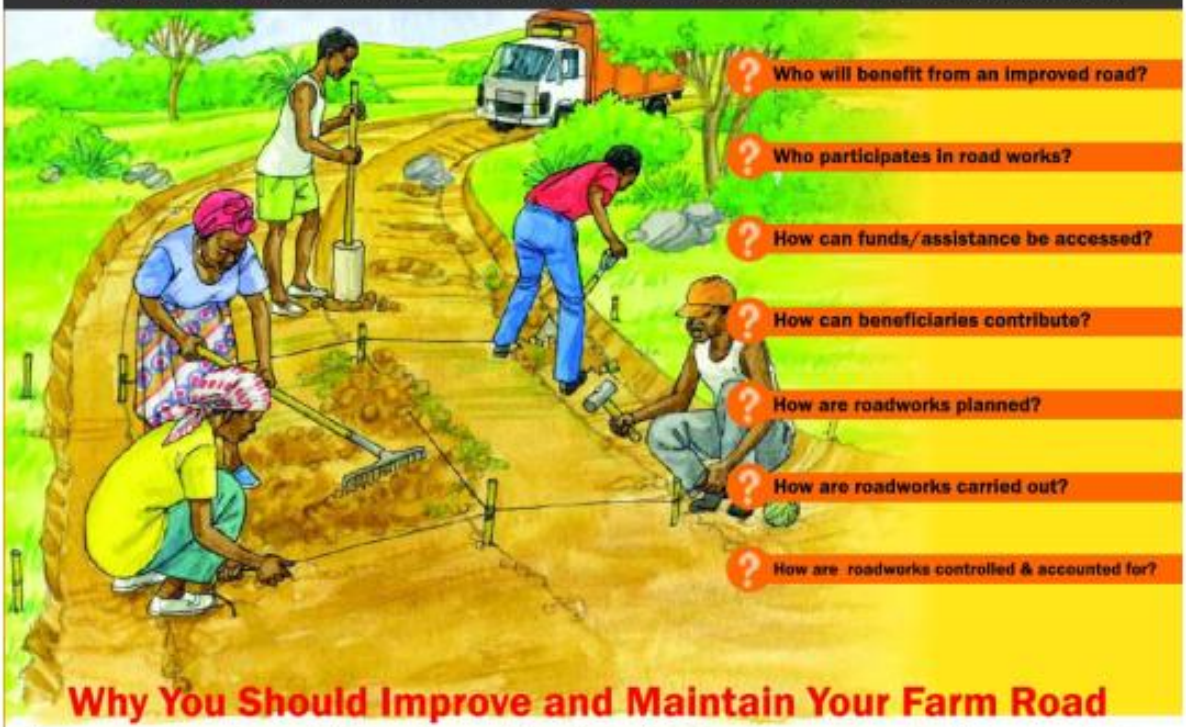
Question 12: Do you have any other comments or suggestions?

- Participation was good
- Workshop very informative
- Should be held more often
- Hearing from other countries is very important for experience sharing
- More information on ways of assisting farmers in rural areas
- Should be more interactive
- Share conference materials
- Clarity of expectations from participants
- Good workshop, well organised, but venue was not so good
- Need to find ways to disseminate research
- Site visit would have been good
- Very informative, a lot to learn from neighbouring countries

Annex 4 Supplement to 'The Organic Farmer' in Kenya

MY FARM ROAD

SELF-HELP GUIDELINES FOR FARMERS AND COMMUNITIES ON HOW TO IMPROVE AND MAINTAIN ACCESS ROADS



Why You Should Improve and Maintain Your Farm Road

Farmers need a road or track that can be used throughout all seasons to transport goods to the next market or collection centre in good condition. Maintained roads encourage new services and investment, making your life more comfortable. Good condition roads also reduce your input and transportation costs and improve the possible profit on agricultural goods.

INTRODUCTION

The Kenya Roads Board is mandated with the oversight of maintenance of all public roads in Kenya – from the biggest dual carriageway to the smallest farm access road.
Every link is important – if any road section is in bad condition then the cost of transport increase and the farmer suffers.

Through the Fuel Levy Funds paid to KRB by all road users, KRB is able to finance maintenance and improvements of roads throughout the country. However, the needs of the nearly 200,000 km are much greater than the available resources. KRB is therefore actively encouraging all stakeholders to participate and cost share in the provision and maintenance of roads.

At the District level KRB currently distributes KSHs 17 million per constituency per year for rural roads through the District Roads Committee. These funds can be accessed through the District Roads Engineer for support to community-farm access roads but the farming community must take the lead! If you improve and maintain a road I am sure the District Roads Engineer will assist you.

In this regard KRB has supported the development of this Farm Road Guideline to assist farmers to improve their roads and I look forward to visiting the first road improved using this guideline.

Dr. F. N. Nyangaga, *OGW*
Executive Director Kenya Roads Board

REMEMBER TO CARRY OUT THE RIGHT WORK AT THE RIGHT PLACE AT THE RIGHT TIME

How to Organise YOUR Roadworks

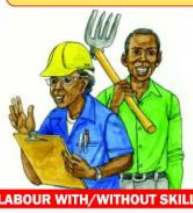
USEFUL TIP

- Form a Road Committee that manages the road works and organises the necessary resources. It may be formed by farmers groups, church groups, or concerned road users.

What do you require?

MATERIALS

Existing soil, stones, timber and gravel or quarry waste where locally available. For structure works aggregate, sand and cement need to be bought.



LABOUR WITH/WITHOUT SKILL

Skilled labour is used for any masonry, concrete or carpentry works, mainly for structures.

FINANCES

Through contributions from road users or from public development programmes like CDF, RMLF, DRC and LATF.

TRANSPORT

Any kind to transport materials, be it a hired vehicle or locally available ox/donkey cart.

HAND TOOLS

Mostly farm tools, such as hoes, shovels, pangas, rakes, wheelbarrows are suitable for road works. Additional tools required are tape measure, strings and pegs, sledge hammer, etc.

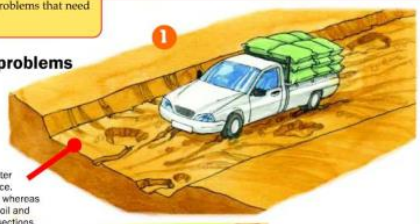
REMEMBER THAT ...

Usually farm roads do not 'belong' to one farmer alone but serve several farms and homesteads in one way or the other. It is therefore obvious that all those benefiting from the road should also participate in improving and maintaining it. The work methods must be simple enough so that farmers can carry out the improvement works themselves and maintain the roads afterwards while materials should ideally be locally available in order to reduce costs.

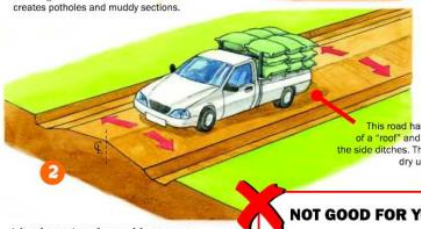
USEFUL TIPS

- Road works have to be affordable to the farming community or the people living along the road.
- Before starting any road works one has to know and understand the problems that need to be tackled.

Identifying your problems



This road is a channel and water cannot flow off the road surface. Flowing water creates erosion whereas standing water weakens the soil and creates potholes and muddy sections.



This road has the correct shape of a "roof" and drains the water to the side ditches. The road surface can dry up quickly after rain.

After knowing the problems one has to identify the causes. Usually it is not one factor alone but a combination. However, one has to clearly identify and analyse each and every problem to plan for the correct treatment.

NOT GOOD FOR YOUR FARM ROAD

1. **Trouble spots**
   Very often one gets stuck at particular problem spots because of a muddy place, a bridge or culvert that is missing or a steep section that is too slippery.

2. **Rain**
   The biggest enemy for an earth or gravel road is water. Heavy rains can destroy a road in no time. The secret of a good road is simple: Keep water off the road!

3. **Traffic**
   Especially heavy vehicles, like tractors and lorries, can destroy a road during rains when water softens the soil.

4. **Soil type**
   Some soils are weak, such as black cotton and dusty soils. They may need to be improved or covered with better material.

ALWAYS CHECK ...

- Where the trouble spots are,
- Whether water can drain from the surface to the side ditch and therefore dries up quickly,
- Whether water can cross the road through culverts or drifts or open channel across the road,
- Whether heavy vehicles damage the road during rains,
- What type of soil there is.

How to Improve YOUR Road

USEFUL TIP

- After diagnosing the problems and causes, you now have to prioritise the work to be done. Identify those problem spots that are the worst and are the main reason why your transport gets stuck.

CASE 1

Blocked or non-existing drainage

ALWAYS CHECK ...

During rains walk along the road and identify the places/sections where a lot of water runs along the road and where it ponds, and mark those sections with pegs for drainage improvement.

NOTE

The first priority is to open the drainage so that water can quickly flow away from the road surface. This is the most effective way to improve your road. This activity does not require any material, only tools and labour.

Farmers often regard water from culverts and ditch outlets as a threat to their shambas and crops. This is not a problem as long as the amount of water running off the road and into the shambas is controlled using the following methods:

- First of all discuss with landowners about the problem and possible solutions before starting the work.
- Dig as many ditch outlets as possible to reduce the effects of large water volumes.
- Culvert and outlets cannot always be directed into existing water streams, so small dams can be built at the end of the outlets and may even serve as small water reserves during dry seasons.
- Soak-away pits can be excavated and filled with stones to allow water to seep into the ground.
- Water from the ditches can also be directed into fanya juu irrigation channels in the shambas.

How to Improve YOUR Road

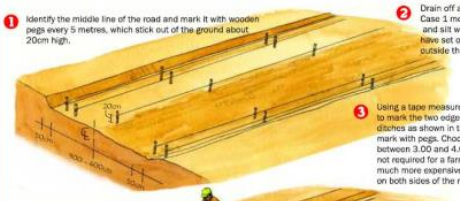
DO NOT USE QUARRY DUST!

Be very careful about your choice of material for building your road. Very often farmers use quarry dust on their roads because it is cheap and easy to acquire. This ends up damaging your road even more in the long run. Use only the best soils, gravel or stone on your road! However, quarry waste, which usually consists of stones and chippings may be used as surface material but needs to be carefully placed (see page 9 for details).

CASE 2

Muddy road sections where road is flat or sunken

1. Identify the middle line of the road and mark it with wooden pegs every 5 metres, which stick out of the ground about 20cm high.
2. Drain off any standing water using Case 1 methods. Remove any topsoil and silt within the area you have set out and deposit it well outside the road.



3. Using a tape measure, from the middle or centre to mark the two edges of your road plus the ditches as shown in the drawing and also mark with pegs. Choose the road width to be between 3.00 and 4.00 metres (a wider road is not required for a farm road and would make it much more expensive). Also set out the ditches on both sides of the road, about 50cm wide.

4. Dig the ditch about 40cm deep and 50cm wide and throw the excavated material to the middle of the road. If the drain soil is weak or unsuitable, then discard it away from the road and use locally available better quality soil.
5. Spread the material from the middle towards the edge (ditch) and make sure you get a "roof shape".

6. Compact the spread material using a loaded vehicle. Drive several times over the road from one edge to the other.
7. Reshape again in case of uneven places and correct the "roof shape" where necessary.
8. Open ditch outlets as described in Case 1. If the water will still not drain away, then it may be necessary to use more material to build up the road "roof" to a higher level. This will cater for the frequent sunken road profile where the road needs to be effectively built up on an embankment.
9. Add gravel or quarry waste as described on page 9.

ALWAYS CHECK ...

- That the middle of the road is at least 20cm higher than the edge.
- That the ditch is at least 40cm deep, 50cm wide and that the bottom has a uniform gradient.
- That water can drain from the surface to the side ditch and therefore dries up quickly after rains.
- Where potholes are; usually where the road is too flat or often under trees where the road cannot dry up quickly after rains.

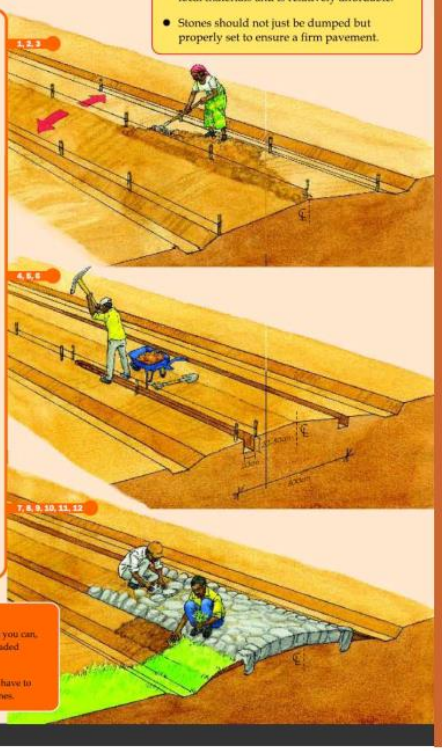
CASE 4
Steep, slippery section

Stone Paving

1. Construct the road first with a 'roof' shape as shown in Case 2.
2. Let the road section settle for at least one rainy season or use a compactor to improve the surface.
3. Reshape the road again to ensure the surface is smooth and has the 'roof' shape.
4. Set out the 3m wide pavement area.
5. Excavate trenches about 20 - 30cm deep and 20 cm wide along both pavement edges.
6. Firmly set the biggest stones in those trenches so that they still protrude about 10 to 15cm.
7. Fill in between the two edges (kerb) with well placed stones.
8. Fill the gaps between the larger stones with small ones and wedge them in well.
9. Should you have sand nearby you can fill the gaps between the stones with a mixture of sand and clay.
10. Fill material from the ditch along the kerb on the shoulder and compact well.
11. Plant grass on the shoulder to ensure it stays firm.
12. Stone paving can also be used as a surface for other problem road sections.

USEFUL TIPS

- Earth or gravel steep sections will quickly erode and should be covered with a more durable surface.
- Stone paving is a durable solution that utilises local materials and is relatively affordable.
- Stones should not just be dumped but properly set to ensure a firm pavement.



ALWAYS CHECK ...

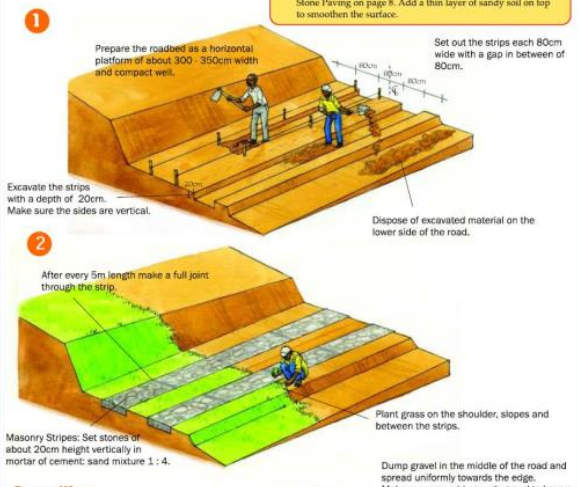
- Compact the surface as much as you can, using either a roller or a fully loaded tractor or lorry.
- If you cannot compact you may have to regularly add/replace some stones.

Running Strips

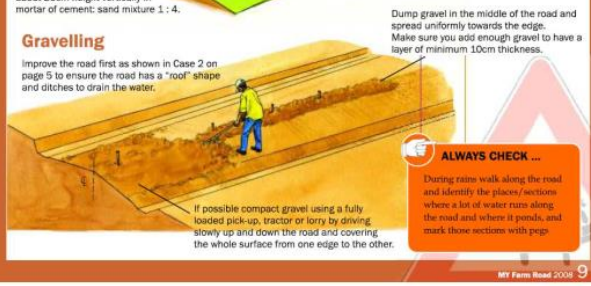
This is an alternative economic solution for steep, short sections with little traffic on poor soil. They can be made using stone masonry.

USEFUL TIPS

- Use gravel only if it can be found near the road and if it is of acceptable quality (see quality guideline on last page). Long transport distances can make gravel very expensive.
- Instead of gravel also quarry waste can be used. Quarry waste consists usually of stone chips and stones. Do not just dump stones onto the road but place them carefully as explained for Stone Paving on page 8. Add a thin layer of sandy soil on top to smoothen the surface.



Gravelling



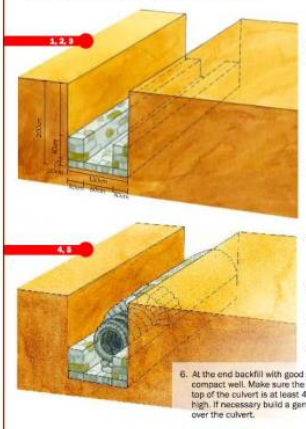
ALWAYS CHECK ...

During rains walk along the road and identify the places/sections where a lot of water runs along the road and where it ponds, and mark those sections with pegs

CASE 3
Missing cross-drainage (culverts, drifts)

Masonry Arch Culvert

This is a possible solution where stones are available.



6. At the end backfill with good soil and compact well. Make sure the fill at the top of the culvert is at least 40 - 50cm high. If necessary build a gentle ramp over the culvert.

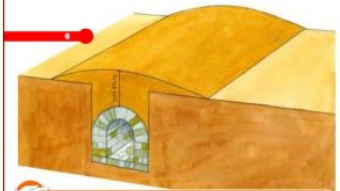
CULVERTS

In cases where roads are passing through land that is sloping across the roadway, water collected in the ditch on the hillside has to be lead through culverts or drifts to the valley-side so that it cannot damage the road.
Concrete culverts are the common solution but are expensive to buy.
Incase you cannot get concrete culverts, making cheaper alternatives is possible, as explained in these two pages.

BEFORE YOU START ANY WORKS

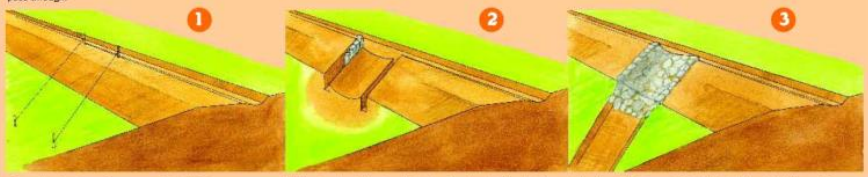
Visit your local District Roads office and ask the District Roads Engineer whether you can be assisted with concrete culvert rings and a technical person who can advise on how to lay them.

1. Dig the trench for the culvert. The width should be about 120cm, the depth should be about 200cm from the road surface. Make sure the bottom of the trench has a slight gradient (about 1cm drop every 25 - 50cm) to the outlet to allow water to run off. You must ensure that the culvert will drain properly from the outlet to the surrounding ground or watercourse. Build up the road surface if necessary.
2. Construct the foundation and bottom about 20cm thick. Either use well shaped stones that fit together with very thin clay joints, or use untrimmed stones with sand-cement mortar joints (usually preferable).
3. Build the sidewalls, each about 30cm thick, to a height of about 60cm.
4. Use old tyres to make a formwork for a section of about 100cm length. Build an arch on top.
5. Remove the tyres carefully and continue with the next section. Make sure the sections interlock well.



Mini- Drift

An open cross-channel leads the water from the upper ditch and the road surface to the other side and off the road. The drift may have to be shallow to enable vehicles to pass through.



1. Set out the location and four corners of the drift. The drift should be about 2 to 3 metres wide and may have to be skewed to ensure a gradient for the water to easily run across and away from the road.
2. Dig the trenches for the two edges. The stones forming the edge have to be at least 40cm high and need to be firmly packed into the soil. Dig out the oval bed for the stones forming the bed.
3. Then place the stones upright which should be at least 25cm high. Voids between the single stones should be filled with smaller stones that are wedged in using hammers and very well compacted. Ensure that the outlet of the drift is freely draining.
If available you can also set the stones into cement mortar (mixture - cement 1 part : sand 4 parts) for a more durable drift.

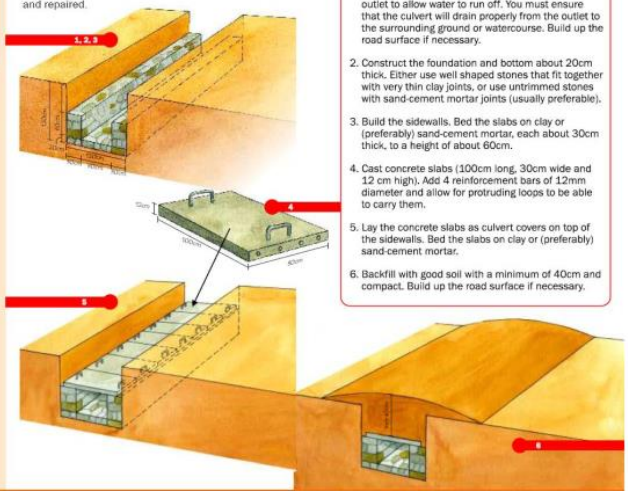
ALWAYS CHECK ...

Establish the correct culvert levels to avoid them getting blocked by ensuring that:

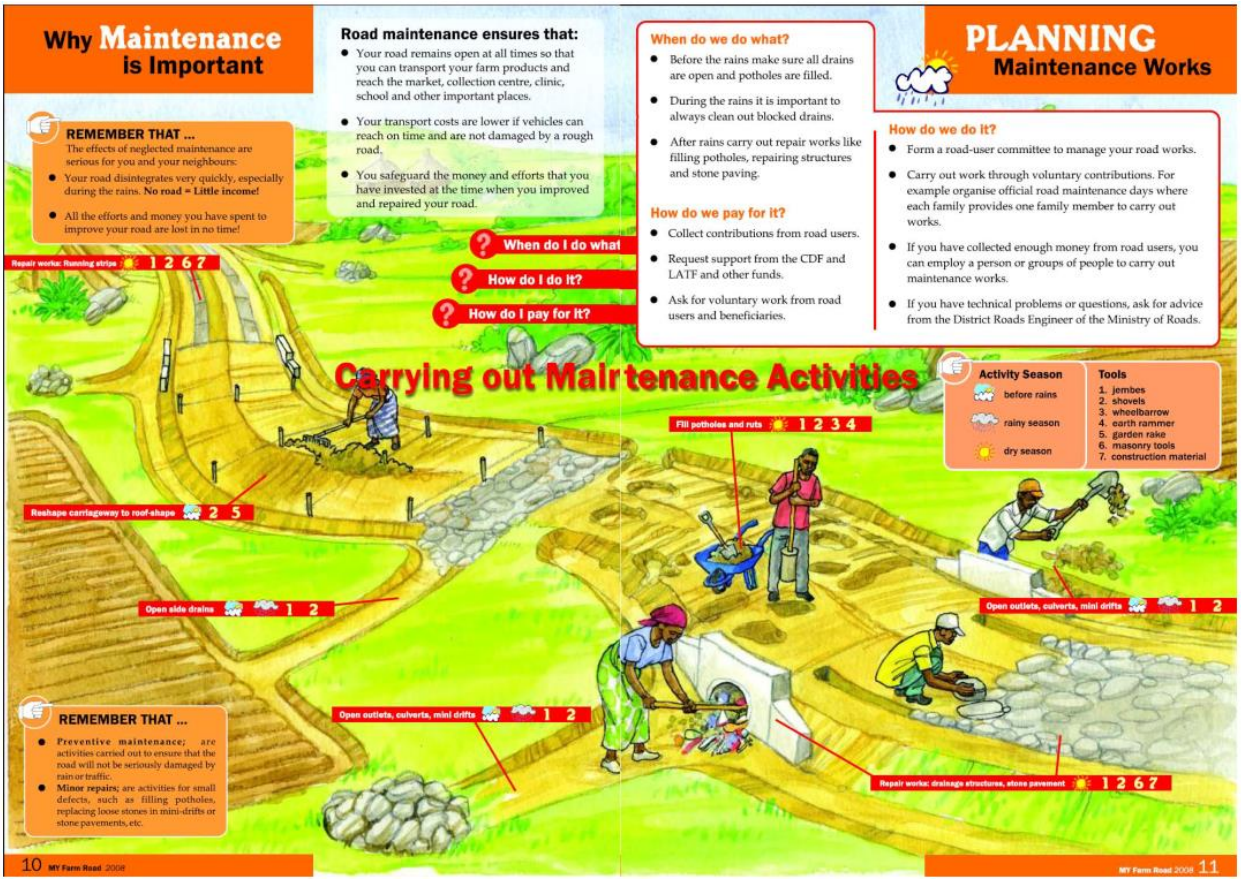
- the inlet level of the culvert is below the ditch level,
- the culvert has a gradient of 2% to 4% (about 1cm drop every 25 - 50 cm),
- the culvert outlet has a similar gradient or is steeper, so that the water can run off freely.

Masonry Box Culvert

This culvert type can be built where stones are available for masonry works but there is insufficient height for an arch. An advantage of this culvert is that it can easily be de-blocked and repaired.



1. Dig the trench for the culvert. The width should be about 120cm, the depth should be about 120cm. Make sure the bottom of the trench has a slight gradient (about 1cm drop every 25 - 50cm) to the outlet to allow water to run off. You must ensure that the culvert will drain properly from the outlet to the surrounding ground or watercourse. Build up the road surface if necessary.
2. Construct the foundation and bottom about 20cm thick. Either use well shaped stones that fit together with very thin clay joints, or use untrimmed stones with sand-cement mortar joints (usually preferable).
3. Build the sidewalls. Bed the slabs on clay or (preferably) sand-cement mortar, each about 30cm thick, to a height of about 60cm.
4. Cast concrete slabs (100cm long, 30cm wide and 12 cm high). Add 4 reinforcement bars of 12mm diameter and allow for protruding loops to be able to carry them.
5. Lay the concrete slabs as culvert covers on top of the sidewalls. Bed the slabs on clay or (preferably) sand-cement mortar.
6. Backfill with good soil with a minimum of 40cm and compact. Build up the road surface if necessary.


Why Maintenance is Important
Road maintenance ensures that:
Your road remains open at all times so that you can transport your farm products and reach the market, collection centre, clinic, school and other important places.
Your transport costs are lower if vehicles can reach on time and are not damaged by a rough road.
You safeguard the money and efforts that you have invested at the time when you improved and repaired your road.
REMEMBER THAT ...
The effects of neglected maintenance are serious for you and your neighbours:
Your road disintegrates very quickly, especially during the rains. No road = Little income!
All the efforts and money you have spent to improve your road are lost in no time!
When do I do what
How do I do it?
How do I pay for it?
PLANNING
Maintenance Works
When do we do what?
Before the rains make sure all drains are open and potholes are filled.
During the rains it is important to always clean out blocked drains.
After rains carry out repair works like filling potholes, repairing structures and stone paving.
How do we pay for it?
Collect contributions from road users.
Request support from the CDF and LATF and other funds.
Ask for voluntary work from road users and beneficiaries.
How do we do it?
Form a road-user committee to manage your road works.
Carry out work through voluntary contributions. For example organise official road maintenance days where each family provides one family member to carry out works.
If you have collected enough money from road users, you can employ a person or groups of people to carry out maintenance works.
If you have technical problems or questions, ask for advice from the District Roads Engineer of the Ministry of Roads.
Carrying out Maintenance Activities
Activity Season
before rains
rainy season
dry season
Tools
1. jembes
2. shovels
3. wheelbarrow
4. earth rammer
5. garden rake
6. masonry tools
7. construction material
Repair works: Running strips 1 2 6 7
Reshape carriageway to roof-shape 2 5
Open side drains 1 2
Open outlets, culverts, mini drifts 1 2
Fill potholes and ruts 1 2 3 4
Open outlets, culverts, mini drifts 1 2
Repair works: drainage structures, stone pavement 1 2 6 7
REMEMBER THAT ...
Preventive maintenance; are activities carried out to ensure that the road will not be seriously damaged by rain or traffic.
Minor repairs; are activities for small defects, such as filling potholes, replacing loose stones in mini-drifts or stone pavements, etc.
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How to Test Soil for Your Road Works
Useful Tips
Soils suitable for road works:
Gravel with Little Clay = GOOD
Gravel with Much Clay = FAIR
Sand with Much Clay = FAIR
Sand with Little Clay = POOR
Clay is suitable for road works in combination with sand and / or stones only (see gravel). Clay acts as the binder to keep the stones and sand grains together.
Soils unsuitable for road works:
Silt and organic soil
Clay only (without stones and/or sand)
What is gravel?
Rule of the Thumb:
Gravel is a mix of:
Fine Grain Soil = 10% Clay and Silt (smaller than 0.06mm looks like powder)
Medium Grain Soil = 40% Sand (0.06mm – 2.0mm)
Coarse Grain Soil = 50% Stones (bigger than 2.0mm – 37.5mm)
How to test:
50% Stones
10% Clay & Silt
40% Sand
1. Collect about two full shovels from the gravel that you think is suitable for your road work,
2. Spread the material on a clean platform and if wet let it dry first,
3. Select all stones from the sample and keep it on a separate heap,
4. From the remaining material try and separate sand and clay/silt from each other,
5. Estimate the approximate percentage of the three separated samples.
How to Differentiate Clay from Silt
Mould a pat of soil to the consistency of putty, adding water if necessary. Allow the pat to dry completely and test its strength by breaking and crumbling between the fingers.
Clay has a high dry strength and does not crumble easily,
Silt has only very slight strength and crumbles easily
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