Establishing extension services through a research, technology development, extension and grower continuum – a case study

MW Adendorff, PDR van Heerden and A Jumman

Abstract There is a strong link between research, effective technology exchange and social dynamics in facilitating effective adoption of new technologies in agriculture. The adoption of new technology is, however, often slow and erratic, especially in more remote and isolated communities. In this case study, the aim was to demonstrate the value of a strong multi-directional link between formal research, technology development and a strategic extension approach that takes social dynamics into consideration. In 2009, formal extension services were re-established in the Pongola sugarcane production area in South Africa. A goal-orientated, systematic and dynamic approach was used to establish effective knowledge and technology exchange. The extension strategy was based on a survey and study of local sugarcane production practices. In this strategy the required best management practices were prioritised based on potential impact on sucrose yield, sustainability and economic returns. The best management practices were also grouped into short-term, medium-term and long-term strategies based on the estimated time it would take to be successfully implemented. Where possible, the value of best management practices were demonstrated by means of on-farm demonstration trials where the researchers played an active role in establishing grower-extensionist-researcher partnerships. The multi-directional interaction between research, extension and grower was used to generate interest amongst fellow growers as well as to guide further technology development. In association with the above, technology exchange was achieved through traditional extension methods such as grower days, one-on-one farm visits as well as frequent newsletters, again using the relevant researchers where possible. Extension activities took local and broader social dynamics and the classical theory of innovation diffusion into consideration to facilitate knowledge exchange. Within four seasons, disease levels decreased by 75%, sucrose contents increased by 5% and sugar yields improved by 13-20%.

Key words Sustainability, extension, demonstration trials, knowledge/technology exchange, technology development

INTRODUCTION

The South African Sugarcane Research Institute (SASRI), a division of the South African Sugar Association, is an industry-funded institute providing both basic and applied research to South African sugarcane growers. In addition to the research component, SASRI also provides a number of essential services including biosecurity monitoring and extension.

The biosecurity service is an industry funded and statutory activity aimed at ensuring industry-wide biosecurity by means of a number of pro-active and preventative activities. The industry establishes mandatory minimum standards or allowable levels for each of the major pests and diseases. These standards are enforced at mill-supply level through the Local Pest, Disease and Variety Control Committee (LPD&VCC) involving a continuous monitoring program. This is done by a team of pest and disease inspectors. Remedial actions are enforced when the level of pests and diseases exceed the threshold levels set by the industry.

The extension service is provided to growers through a network of extension specialists and technicians based at each mill-supply area. Receiving extension services is voluntary and is funded by a grower levy. Extension activities are aimed at improving grower profitability and sustainability by creating a link between research and growers and to facilitate adoption of best management practices (BMPs). The extension program of work is set annually, by the local grower community in association with SASRI management. To facilitate this, a Research Development and Extension (RD&E) Committee was established in each mill-supply area. The role of the RD&E Committee includes setting of local extension priorities and determination of local research priorities which are submitted to SASRI for consideration and inclusion in the research program.
It is a worldwide phenomenon that grower adoption of research recommendations, new agricultural innovations and BMPs is commonly very slow and erratic (Pannell 1999). This lack of adoption often increases with distance from the source of the research and remoteness of the grower community. The reasons for this are numerous and has formed the basis of a number of studies. The reasons for lack of adoption include: resistance to change, lack of technical know-how, perceived complexity of BMPs, an inability to interpret scientific results, lack of knowledgeable support and guidance, financial limitations, not understanding the relevance and ‘risk-aversion’ on the part of growers (Pannell 1999). Cultural differences and language barriers also often play an important role, especially in rural areas. In addition BMPs are often not fully implemented or are modified resulting in a lack of efficacy leading to further resistance to future adoption of BMPs. Often adoption is poor due to the physical distance from the origin of new recommendations resulting in growers questioning the local relevance of scientific information. For example, Lindner et al. (1982) demonstrated how distance from the research location led to a decrease in adoption of a new micro-nutrient fertiliser innovation.

For effective knowledge/technology transfer of BMPS, research results and new technology often need to be customised or ‘repackaged’ to promote local adoption. Extension specialists with the support of researchers play an important role in facilitating this process.

The Pongola mill-supply area is made up of large-scale growers with 21,500 ha fully irrigated cane and small-scale growers with 3,500-4,500 ha of both irrigated and non-irrigated cane. During 2003-2007 the extension and biosecurity services were discontinued. During 2002-2009 a number of additional factors such as poor mill performance, land claims and financial pressures all contributed to a huge decline in grower moral, lack of reinvestment, yield decline and proliferation of pests and diseases. Exposure to research results and BMPs were restricted and created fertile ground for disinformation.

Being a statutory position, a new Biosecurity Officer had to be appointed. In 2009 the Pongola growers decided to use the opportunity to reinstate extension by combining the positions of Extension Specialist and Biosecurity Officer, a similar model implemented by two other mill-areas. This paper reflects on the re-establishment of extension and biosecurity services at Pongola and demonstrates the development of a research, technology development, extension and grower continuum that accelerated the adoption of existing and new BMPs.

METHODS

In the process of re-establishing extension services and biosecurity monitoring, the envisaged research, technology development, extension and grower continuum was developed by a goal orientated, systematic and dynamic approach. The approach was based on seven key principals combined with a number of different activities.

Seven key principals

*Extension and biosecurity services seen as an integrated service with a common goal*

Although commonly seen as two separate services and activities, the objective of both is to improve grower profitability and sustainability. Biosecurity monitoring was therefore also seen as an extension tool to facilitate change as well as to pro-actively identify potential pest and disease threats to grower productivity. The threats posed by pests and diseases were addressed in the Extension program of work. In so doing, pest and disease management was more proactive and preventative rather than re-active by nature. Information obtained from pest and disease inspections was also used when giving advice on variety disposition. The biosecurity function also ensured a source of healthy seedcane and was used to train farm labour to identify and manage major pests and diseases at the farm level.

*Develop and maintain the extension and biosecurity services based on a situation analysis*

A questionnaire was used during farm visits to gauge grower perceptions, yield potential, the current use of BMPs and the real and perceived pest and disease situation in the area. In the process, extension and research needs were also identified. Where possible, historic and present data on cane yield, cane quality, pest and disease problems and variety disposition were obtained. This situation analysis served as the initial basis for both the extension and the biosecurity activities. In the future this base information will continuously be reassessed and adapted as and when required.
Develop, rank and prioritise a list of extension and biosecurity issues

A list of issues was developed based on the situation analysis, milling priorities, industry and legislative requirements. Issues were ranked based on importance and impact on profitability and sustainability and also prioritised into short-, medium- and long-term objectives.

The ranking and prioritisation was set to achieve quick, continuous and sustainable results with a noticeable impact. A number of important issues that would result in a quick and marked response were prioritised as short-term goals to provide initial momentum to address the more challenging medium- and long-term issues. For example, promoting the use of chemical ripeners was prioritised as high priority with a short-term goal to improve cane quality.

The ranking and prioritisation was used to facilitate a systematic approach to extension, whereby clear and specific targets were set for present and future extension activities. By means of this systematic and defined approach it was also possible to clearly identify the most suitable BMPs to be promoted, and how to find synergies when resolving different extension issues.

The ranking and priorities of different issues was re-assessed regularly to ensure relevance and continuous re-enforcing of adopted BMPs.

Use of local socio-economic dynamics to facilitate change

Close co-operation was maintained with the cane supply unit at the mill as well as local agrochemical representatives, resulting in a combined effort to facilitate change. Local socio-economic factors and dynamics that could be used to promote BMPs were identified. Local innovators and leaders (industry and social) were involved in extension activities to facilitate change by means of the diffusion of innovation theory (Rogers, 2003). Where possible, demonstration trials were established on the farms of innovative and respected leaders. Production data from leader growers were built into the content used to promote the adoption of BMPs. In addition grower and scientist interactions were encouraged by promoting grower participation in research as well as on farm visits by scientists to the farms especially of leader and innovative farmers. This increased interaction ensured that factors motivating the implementation of BMPs, and also the barriers to adoption were identified and understood. Strategies to overcome or remove these barriers were developed.

Develop a research, technology development, extension and grower continuum

Traditionally knowledge/technology transfer was implemented with a one way (top down) approach where research results were 'packaged' and transferred by various means to growers for them to implement. Knowledge/technology transfer was done through a limited number of activities such as newsletters, articles in popular magazines, etc. This process often resulted in uncertainty about how to implement the new technology, limited interaction with those who developed the technology as well as poor feedback from growers and limited measurement of adoption.

A research, technology development, extension and grower continuum facilitates knowledge/technology exchange through multi-directional communication and interaction, involving extension, researchers/experts and growers. In this process, extension, with the help of researchers, ‘packaged’ and adapted new technology to develop BMPs which are easily understood and which meets local conditions and requirements. Where possible researchers collaborated with extension to, over time, communicate and demonstrate the benefit of BMPs in a number of ways.

Where possible the benefits of BMPs were demonstrated by means of on-farm demonstration trials to demonstrate the local relevance, and they also bridged the problem of physical distance between source of research and growers (Van Heerden 2014). As suggested by Pannell (1999) these trials might often be the most important step in determining final adoption or non-adoption of new recommendations.

Multi-directional interaction with growers was actively promoted at all levels. Feedback from growers on the process of adopting and implementing BMPs was actively promoted to further develop specific BMPs and to address possible difficulties and problems in adoption. Research needs of growers were actively gauged and communicated to the research institute.

Facilitate knowledge exchange by means of a systematic and multidimensional approach

Traditionally adoption of BMPs is a slow process and can take up to a number of decades to be achieved. A systematic and multidimensional approach to technology exchange comprised of setting clear objectives and outcomes, as well as a
series of activities over a period of time aimed at facilitating effective adoption of BMPs. The process allowed for objectives, activities and timelines to be adjusted if deemed necessary to overcome unforeseen obstacles or due to a change in extension priorities.

The knowledge exchange activities comprised of six overlapping stages. During the critical first two stages growers were, over time, made aware of the availability of new BMPs as well as the need for change. Once awareness was created the need for change was demonstrated and strengthened by highlighting existing shortcomings, losses as well as the benefits associated with the new or alternative practice. The first two stages in most cases, extended well into the later stages.

Once awareness was created and the need for change was shown, a number of events were planned to facilitate knowledge/technology exchange over a period of time. The knowledge exchange was done using as many communication pathways as possible. This included on-farm demonstration trials, grower days, newsletters, articles in the Link\(^1\), on-farm visits and one-on-one extension activities. Where possible researchers and experts were included in the exchange activities and where possible the financial benefits of BMPs were shown.

Knowledge exchange activities were followed up with continuous feedback on progress and results regarding implementation and the impact on profitability to both growers and researchers. Where possible the success of uptake was measured and perceptions or reservations were continuously reassessed to realign the process of knowledge exchange. This ‘moving target’ will also be used to guide future follow up actions to reinforce BMPs.

Continuous training and refreshing of skills for both Extension Specialist and Biosecurity personnel

Effective knowledge exchange can only be facilitated by suitably qualified, knowledgeable and skilled personnel. Where and when required the Extension Specialist as well as biosecurity personnel attended new and refresher training to improve or maintain knowledge and skills to advance their ability to facilitated effective knowledge exchange.

Monitoring progress

The process of knowledge exchange was continuously monitored and where possible records were kept on key indicators of grower profitability and sustainability. The records and data were used to gauge progress, to give feedback, monitor and guide present and future extension and biosecurity activities as well as to ensure the maintenance of biosecurity.

The results of all biosecurity inspections were kept on a database shared with researchers at SASRI. Regular reports were produced to inform growers and industry about the level of the major pests and diseases. Trends in the local pest and disease levels were used to plan future biosecurity activities, both to correct and pro-actively prevent problems.

Data, down to field level, on yield, cane quality (sucrose content), cane age, variety disposition, variety performance, irrigation system in use, etc. were kept on a GIS database which is maintained by the local Mill Group Board, mill cane supply office and extension office.

The results and recommendations of all soil analyses done by the SASRI Fertiliser Advisory Services were kept on record, as well as the results of nematode counts. Where applicable and possible, records were kept of other activities and factors such as area chemically ripened.

RESULTS AND DISCUSSION

Improvement in crop production, sustainability and profitability was in most cases due to the combined effect of the implementation of a number of BMPs. On the other hand, the lack of improvement could often be attributed to the presence of other limiting factors rather than the failure of new BMPs. It is therefore difficult to measure the success of the implementation of a single BMP. To overcome this problem and to illustrate the value of a single BMP, it was critical to use on-farm demonstration trials, where other growth factors were kept at a constant.

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1. The Link is a technical newsletter published by SASRI three times a year, containing practical recommendations for sugarcane farmers.
There is no simple way to measure the direct success of extension activities. In this case study, however, extension services were resumed in 2009. Through the goal-orientated and systematic approach of developing the research, extension and grower continuum it was possible to realise marked improvements in a number of extension issues over a short period. The improvement in a selected number of these issues illustrated the improvements that have been made as indicators of extension success. It should be noted, however, factors, other than extension, also contributed to the improvements.

**Pest and diseases**

Continuous high levels of Ratoon Stunting Disease (RSD) were identified as a major problem. To address the problem and to show the need for improvement, the number of fields annually surveyed for RSD was increased by 666%. The results of these surveys were used to promote a large replant program using disease-free seedcane, resulting in a 333% decrease in RSD levels (Fig. 1).

![Fig. 1. Annual incidence of RSD and number of fields tested.](image)

**Variety composition**

Out-dated varieties, large areas under single varieties and old ratoons were seen as yield-limiting factors as well as pest and disease threats. On-farm variety trials were planted and the yield data from these trials, in combination with the results from formal plant-breeding trials, was used to promote improvement in variety composition. Varieties were also compared with one another by calculating the annual average yield per hectare from the mill crush data. This information was used to give advice on improving the variety composition and harvest seasons.

With accurate data progressively becoming more available, variety performance for each harvest month will in the future be used to further promote sound variety management. Annually the level of pests and diseases on each variety were used to promote the use of disease resistant varieties and in so doing reduce the pest and disease threat.

From 2010, there was a dramatic increase in the use of new varieties in combination with proven older varieties. As an example, the area planted to the variety N25, a low-sucrose and disease-susceptible variety, decreased from 28% to 8% of the area under cane. The improved variety composition combined with the large replant program contributed to the marked improvement in yield, cane quality and decrease in RSD levels.

**Nutrition**

In the past, fertiliser application was not based on soil analyses and mostly consisted of nitrogen application only. Following a number of grower days and newsletters and arrangement of a weekly courier service to transport soil samples to the
analytical laboratory, there was a dramatic increase in the submission of soil samples from the Pongola area to the SASRI Fertiliser Advisory Services (Fig. 2).

**Fig. 2.** Number of soil samples submitted from the Pongola area to the SASRI Fertiliser Advisory Services.

### Cane quality

Continuous poor sucrose content in cane delivered to the Pongola mill was identified as one of the important extension issues. The major factors affecting sucrose content were identified, listed, ranked and prioritised (Table 1). The lack of relevant information, misconceptions and grower resistance due to failed attempts to use chemical ripeners in the past, were identified as major barriers to adoption.

**Table 1.** Ranking and prioritisation of factors affecting cane quality (sucrose content) as an example of an extension issue.

<table>
<thead>
<tr>
<th>Factors affecting cane quality</th>
<th>Potential Impact</th>
<th>Time to achieve</th>
<th>Prioritisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical ripening</td>
<td>High</td>
<td>Quick results</td>
<td>Short-term</td>
</tr>
<tr>
<td>Effective drying off</td>
<td>High</td>
<td>Quick results</td>
<td>Short-term</td>
</tr>
<tr>
<td>Base cutting and topping</td>
<td>High</td>
<td>Quick results</td>
<td>Short-term</td>
</tr>
<tr>
<td>Harvesting cycle</td>
<td>High</td>
<td>Delayed impact</td>
<td>Medium-term</td>
</tr>
<tr>
<td>Variety composition</td>
<td>Medium</td>
<td>Delayed impact</td>
<td>Medium-term</td>
</tr>
<tr>
<td>Harvest to crush delay</td>
<td>High</td>
<td>Quick results</td>
<td>Ongoing</td>
</tr>
<tr>
<td>Nutrition</td>
<td>Low</td>
<td>Ongoing</td>
<td>Ongoing</td>
</tr>
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The miller proposed an incentive scheme to promote improvement in cane quality. Extension suggested that the use of chemical ripeners was a way to achieve quick and marked improvements. The miller and extension collaborated to get a contractor to carry out aerial ripener application and the miller instated a subsidy scheme for part of the costs. To protect fruit and vegetable growers from possible chemical drift, extension developed a ripener application protocol and promoted the judicious use of chemical ripeners.

Over four years, awareness and knowledge exchange was facilitated by means of two on-farm demonstration trials (van Heerden et al. 2014), five grower days, eight newsletters, an article in *The Link*, numerous on farm visits and the development of an annual ripener program.

As a result, the area ripened annually increased more than 11-fold (Fig. 3) contributing to a 6.2% increase in annual average sucrose content (Fig. 4). This equated to an increase of ZAR 25.00 per tonne of cane (5% improvement based on local payment system) which equated to an additional income of ZAR 33.8 million per season for the grower group.

The improvement in cane quality was also attributed to improvement in the variety composition, reduction in harvest-to-crush delay, improved base-cutting and accurate topping (not reported on).
Fig. 3. Area chemically ripened each year.

Fig. 4. Improvement in cane sucrose content.

Fig. 5. Improvement in sucrose yield.
Yield

Cane yield showed a marked increase and in combination with the increase in sucrose content the sucrose yield per hectare increased (Fig. 5) representing an average increase in annual income of ZAR 7,466/ha or ZAR 108.3 million for the grower group as a whole.

Establishing synergy between different BMPs

Clearly defined BMPs and a planned process of knowledge exchange made it possible to find synergies among implementation of different BMPs, which allowed for multiple goals to be achieved with fewer actions.

For example, the informed use of chemical ripeners to improve cane quality together with choice of suitable varieties made it possible to enhance both cane quality and encouraged adoption of new varieties. In addition, the high levels of RSD and aging ratoons necessitated a large replant program that also provided the ideal platform to promote the adoption of new varieties, matching varieties to soils and optimising harvest seasons. All these contributed to improved yield, improved cane quality and decrease in disease levels.

CONCLUSIONS

This paper described the process and principles used to develop a research, technology development, extension and grower continuum to facilitate effective knowledge exchange. Grower income was markedly improved by the noteworthy increase in yield and sucrose content. Sustainability was enhanced by changes in the variety disposition, the large replanting program, younger ratoons, decrease in disease levels and the use of BMPs, such as a nutrition programme based on soil sampling, chemical ripening and base cutting.

The results achieved over a relatively short period demonstrated the value of a goal orientated, systematic and dynamic approach in developing an extension programme. This case study provided evidence of the value of combining extension and biosecurity strategies with local socio-economic dynamics to facilitate rapid and lasting adoption of BMPs. The value of dedicated extension based at each mill area was clearly shown in terms of the increase in revenue.

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REFERENCES


La mise en place d’un service de vulgarisation a travers un partenariat continu recherche et développement de technologies, vulgarisation et agriculteur – une etude de cas

Résumé. En agriculture, un lien étroit entre la recherche, le transfert efficace de technologies et les dynamiques sociales peut faciliter une adoption effective de nouvelles technologies. Cependant, l’adoption d’une nouvelle technologie est souvent lente et erratique, particulièrement au sein des communautés éloignées et isolées. Le but de cet étude était de démontrer la valeur de ce lien étroit et multidirectionnelle entre la recherche formelle, le développement de la technologie et une approche stratégique de vulgarisation qui tient en compte la dynamique sociale. En 2009, les services de vulgarisation formelles ont été rétablis dans la zone sucrière de Pongola en Afrique du Sud. Une approche systématique, dynamique et orientée vers les besoins des agriculteurs a été utilisée pour le transfert de connaissances et technologies appropriées. Cette approche était basée sur une étude des pratiques de gestion de la culture cannière au niveau local. Dans cette stratégie les meilleures pratiques requises ont été classées en ordre de priorité sur la base de leur impact potentiel sur le rendement en saccharose, leur viabilité et rentabilité économique. Ces meilleures pratiques ont également été regroupées en des stratégies à court, moyen et long terme dépendant du temps qu’il faudrait pour réussir leurs implémentations. La valeur de certains de ces
pratiques a aussi été vérifiée à travers des essais de démonstration chez les agriculteurs eux-mêmes avec une participation active des chercheurs afin d'établir des partenariats agriculteur-vulgarisateur-chercheur. L’interaction multidirectionnelle émanant de ces partenariats a été utile pour susciter un intérêt parmi les agriculteurs et aussi à mieux orienter le développement futur de nouvelles technologies. Le transfert de technologie a été effectué, par le biais des méthodes traditionnelles de vulgarisation, tels que la journée des agriculteurs, la visite personnalisée aux champs et le feuillet d’information sur une base régulière, et autant que possible, en collaboration avec les chercheurs concernés. Afin de faciliter le transfert de connaissances, les activités de vulgarisation ont tenu en compte les dynamiques sociales locales et exogènes et la théorie classique de la diffusion des innovations. Au bout de quatre années, le niveau de maladie dans la canne a diminué de 7%, la teneur en saccharose a augmenté de 5% et les rendements en sucre ont connu une amélioration variant de 13 à 20%.

Mots-clés: Durabilité, la vulgarisation, parcelles de démonstration, transfert de connaissances et technologies, développement de technologie

Estableciendo servicios de extension a través de la investigacion, el desarrollo tecnologico, la extension y la continuidad agricol - un estudio de caso

Resumen. Existe una fuerte relacion entre la investigacion, el intercambio tecnologico efectivo y la dinamica social en el proceso de facilitacion de la adopcion efectiva de nuevas tecnologias en agricultura. La adopcion de nuevas tecnologias es, sin embargo, a menudo lenta y erratica, especialmente en las comunidades mas remotas y aisladas. En este estudio de caso, el objetivo fue demostrar el fuerte valor de la relacion multi-direccional entre la investigacion formal, el desarrollo tecnologico y el enfoque de una extension estrategica que toma en consideracion la dinamica social. En 2009, los servicios de extension formal fueron reestablecidos en el area de produccion de caña en Pongola en Africa del Sur. El enfoque de objetivo preciso, sistemático y dinamico fue utilizado para establecer conocimiento efectivo e intercambio tecnologico. La estrategia de extension se baso en una encuesta y un estudio de las practicas de produccion cañera local. En esta estrategia el requisito de mejores practicas gerenciales fueron priorizadas con base en el potencial de impacto en el rendimiento de sacarosa, sustentabilidad y rendimiento economico. Las mejores practicas gerenciales fueron tambien agrupadas en estrategias a corto, mediano y largo plazo basadas en el plazo estimado para que fueran exitosamente implantadas. Donde fuera posible, el valor de las buenas practicas gerenciales fueron demostradas por medio de ensayos demostrativos en campo donde los investigadores jugaron un papel activo en el establecimiento de un alianza cañero-extensionista-investigador. La interaccion multi-direccional entre investigacion, extension y cañero fue utilizada para generar el interes entre los companeros cañeros asi como para orientar el desarrollo de mas tecnologia. En relacion con lo anterior, el intercambio tecnologico se logro a través de los metodos de extension tradicional como los “dias del cañero”, visitas uno a uno a los campos asi como comunicados escritos frecuentes, usando una vez mas a los investigadores donde era posible. Las actividades de extension involucre la dinamica social local y mas alla, y la clasica teoria de la diffusion de la innovacion fue tomada en consideracion para facilitar el intercambio de conocimiento. En el lapso de cuatro zafras. El nivel de enfermedades bajo en 75%, el contenido de sacarosa incremento en 5% y el rendimiento en azucar mejoro en 13-20%.

Palabras clave: Sustentabilidad, extension, ensayos demostrativos, intercambio de conocimiento/tecnologia, desarrollo tecnologico