EXPLORING THE CAUSE OF THE PERSISTING PRODUCTIVITY GAP OF SMALL SCALE SUGAR CANE PLANTERS IN MAURITIUS: NEW DIRECTIONS FOR RESEARCH & DEVELOPMENT AND AGRICULTURAL EXTENSION

by

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Abstract

Despite progress made by Research and Development in the Mauritian sugar cane industry, a productivity gap averaging 1.5 to 2.5 tonnes of sugar per hectare has been constantly observed between large corporate planters and the small planters. Although recent studies (MSIRI, 2010) show that only a small proportion of the small planters have access to research findings, it is strongly believed that this alone cannot be the reason for this productivity gap. To be able to identify other factors that may also contribute to this gap, a qualitative study was undertaken. It comprised focus group discussions with research specialists, extension officers and representatives of farmers' organizations and other service providing institutions to explore explored current extension practices in Mauritius. Secondly, a survey was conducted among a sample of small planters operating in three milling areas, located in the major agro-climatic zones of Mauritius. A realistic and practical sample size, adhering as closely as possible to the intent of the concept of saturation (Mason, 2010:1), was used, due to limited resources and funds. A total of 147 small sugar cane planters were interviewed using a questionnaire designed for that purpose and the information collected was processed and analysed using Microsoft Access and IBM SPSS Statistics 20.0. Knowledge of the demographics of the planters is important to be able to understand the reason for the productivity gap. The study found that the majority of the respondents own small-sized fields (less or equal to one hectare), are males over the age of 40 years, and have more than 15 years of experience in sugar cane farming. In terms of cane yield per hectare, a slight majority of the respondents (52%) indicated that they are not achieving their field potential. Among those achieving good cane yields, the majority are experienced farmers (< 15 years farming sugar cane) who own their sugar cane lands; 46% operate on farm sizes of less than one hectare and 94% adopt good management practices. Income, family tradition and a sense of duty were the most common reasons given by respondents for farming sugar cane. However, no single one of these was identified by a majority of farmers as the primary reasons for engaging in sugar cane farming; most gave a combination of these factors. The contribution of this income to the total income of the small planters is generally insignificant. Among the major conclusions of the study, the phenomenon of risk aversion /disincentive among the small planters towards further investments and

adoption of new technologies is discussed. Three options are identified for the small sugar cane planters in Mauritius - small planters willing to improve their production levels; those willing to maintain the status quo; and those planters willing to opt out of the sugar cane business. It is conceded that to respond to these options, and particularly if there is a desire to improve the livelihood of the small sugar cane planters in Mauritius, research and extension have to review their functioning. They will, henceforth, have to engage themselves in genuine partnerships with the small planters and in this context a framework is proposed for the research process.

Key words: small sugar cane planters, productivity gap, research and extension, livelihood.

Declaration

I declare that the dissertation hereby submitted in fulfilment of a Doctor of Philosophy in Agricultural Extension and Rural Resource Management in the School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, Pietermaritzburg, is my own independent work and has not been submitted by me at another university or faculty.

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Kessawa P Payandi Pillay	Date
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Dr Steven Worth, Supervisor	Date

Dedication

This thesis is dedicated to the small sugar cane planters of Mauritius and other sugar cane growing countries. Three and a half decades back, freshly graduated from the University of Mauritius, I was given the opportunity to start my career with the small sugar cane planters as an extension officer of the then Extension Services of the Ministry of Agriculture. Since then, my whole professional life has been devoted to the cause of this category of farmers. While working at the Ministry, I often had the feeling that the research specialists at the MSIRI were not easily accessible. After joining the Mauritius Sugar Industry Research Institute (MSIRI) as an Extension and Liaison Officer in the mid 1980s, one of my major objectives was to bring the small planters closer to the research specialists at the Institute. This was also motivated by the fact that there was a very strong perception among the small planting community that the fruits of research were not equitably distributed and that the miller and large commercial planters were benefiting the most. I felt that there was an urgent need to dissipate that perception and to build more confidence among the small planters, who were also funding the research activities. Several measures were taken at the level of the MSIRI to reinforce linkages with the small planters even if, due to policy decisions, the institute was not entrusted the responsibility for providing extension and advisory services to the small planter sector.

I shall probably be ending my career soon after the completion of this thesis, but I sincerely hope that the research work which I have undertaken will prove useful to those, who will continue to strive to improve the livelihood of the small sugar cane planters in Mauritius and elsewhere, be it at the level of research, extension or policy making.

Acknowledgements

This thesis has required a vast amount of research work and it would have never materialized without the support, understanding and encouragement of many well wishers. Acknowledging the contribution of all those who have been involved forms part of tradition and it is with a very deep sense of pride that I wish to thank the following people:

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My nephews, Loganaden Veerabadren and Gavin Ramen, for having initiated me in the manipulation of SPSS and Microsoft Access for the analysis of data; thank you, I can manage on my own now!

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My wife Sheila, my two sons, Linganaden and Kessaven, and my daughter, Tarini, for their comprehension and patience.. They have sacrificed quite a number of parties and events to the extent that even my six-year old daughter Tarini nicknamed me *'Papa Project'*; I was so immersed in this research that I would often stay up working until very late at night. I owe them so much.

May God bless you all!

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List of acronyms

ACP	African, Caribbean and Pacific group of countries
AKIS	Agricultural Knowledge and Information System
CCS	Credit Cooperative Societies
EU	European Union
FAO	Food and Agricultural Organization
FARC	Food and Agricultural Research Council
FIRCOP	Fund for Innovative and Regional Collaborative Project In support of the Small-scale Farmers Development
FORIP	Field Operations, Regrouping and Irrigation Project
FSA	Farmers Service Agency
FSC	Farmers Service Corporation
FSCs	Farmers Service Centres
FUEL	Flacq United Estates Limited
GDP	Gross Domestic Product
IA	Irrigation Authority
ICART	Implementation and Coordination of Agricultural Research and Training
LAMU	Land Area Management Unit
LTPA	Long Term Partnership Agreement
MAAS	Multi Annual Adaptation Strategy
MCA	Mauritius Chamber of Agriculture
MCIA	Mauritius Cane Industry Authority
MPCB	Mauritius Post and Cooperative bank
MSA	Mauritius Sugar Authority
MSIRI	Mauritius Sugarcane Industry Research Institute
MSS	Mauritius Sugar Syndicate
PAU	Planters Advisory Units on Sugar Estates
R & D	Research and Development

SADC	Southern African Development Community
SIFB	Sugar Insurance Fund Board
SPMPC	Sugar Planters Mechanical Pool Corporation
SPSS	Statistical Package for Social Studies
STASM	Societé Technologie Agricole et Sucrière de l'Ile Maurice
TCH	Tonnes cane per hectare
TSH	Tonnes sugar per hectare

Chapter 1
Introduction

This thesis concerns the small sugar cane planters in Mauritius and their survival in the context of a changing global trade environment. The Mauritian sugar cane planting community has evolved progressively over the last century with each of its key components, the corporate and the non-corporate planters, assuming a determinant role in its productivity and competitiveness. The corporate planters comprise the miller and the ex-miller planters (those planters who also owned a sugar mill in the past) and the non-corporate planters group is made up of the large, medium and small planters. Increasing costs of production, drastic cuts in sugar prices in the European Union preferential market, scarcity of labour, yield stagnation/decline and significant reduction in area under cane are constraining the sustainability of sugar cane production in Mauritius. It is generally recognized that that the small planters are the most vulnerable group in this conjuncture, but it is also conceded that they still have a fundamental role to play in maintaining the sustainability of the cane business.

From sugar crop statistics data available at the Mauritius Chamber of Agriculture (MCA) and the Mauritius Sugar Industry Research Institute (MSIRI), it is observed that in the 1990s, nearly 55% of the total area under cane (about 40000 hectares) was exploited by the miller and ex-miller planters. With land holdings ranging from 750 to 5200 hectares, the corporate planters were producing nearly 60% of the total sugar output of the island. The large and medium planters, with land holdings exceeding 10 hectares in size, were cultivating 12000 hectares of sugar cane. The small planters (approximately 33000) with farm sizes equal to or less than 10 hectares were growing sugar cane on about 25000 hectares, mostly on a part-time basis. The majority of these planters had farm sizes below 0.5 ha.

The same data indicates that the annual sugar production of the island, which, on average was about 519000 tonnes in the 1950s, jumped to 616000 tonnes in the 1980s. This achievement is generally attributed to progress made by research in areas pertaining to crop improvement, crop management and crop protection. The productivity increase at field level was however not

of the same order of magnitude for each producer group. Although technical findings from research were claimed to have been disseminated to all categories of sugar cane planters, the group of small planters has never been able to attain the same productivity levels as the large commercial planters. Over the period 1950s to 1980s, while the average cane yields of the miller planters increased from 75 to 80 TCH (tonnes cane per hectare), those of the small planters rose from 48 to 62 TCH. In terms of TSH (tonnes sugar per hectare), the corresponding sugar yields were 8.1 to 9.2 for miller planters and 6.3 to 7.0 for small planters. These increases indicate two things. First, there is clearly improvement in the productivity for both general categories of planters. The rate of increase in terms of cane yield across the nearly three decades was 6,7%. It was considerably higher for the small planters at 29,2%. Given the nature of production functions and the law of diminishing returns, it is to be expected that the rate of increase at the upper end of the productivity scale would be smaller than at the lower end. Still, the gap between the two groups has narrowed from a variation of 36% to 22,5%. Secondly, however, this information confirms that despite improvement, the small planters had not reached even the lower productivity level which the large planters had reached in the 1950s.

Thus, while very slowly decreasing, this productivity gap has persisted over the years and has been a cause of concern to all stakeholders. It is surmised by some that the gap could be partly due to the narrow resource base of the small planters and the numerous constraints which they face. In response to this, a number of strategies have been developed to improve production levels among the small planters, as it is believed that they still have a fundamental role to play in the Mauritian sugar cane industry, viewed from the socio-economic, cultural, political and environmental perspectives.

1.1 Problem Statement

The importance of the survival and sustainability of the small planter sector in the overall sugar cane industry cannot be over-emphasized. Recognition of that importance calls for an urgent need for a detailed examination of all the factors impeding the viability of the small planters as a group and to implement the right action that will enable the small planter sector to attain the potential which the sector is theoretically able, and therefore expected, to achieve.

With the pressure for more cane lands for housing development and public infrastructure establishment, it is increasingly evident that the area under sugarcane cultivation would continue to decline, reducing overall production. Concurrently, profitability would also be eroded as a result of the drastic reduction in preferential sugar prices (EU guaranteed sugar price that binds the ACP group of states) (Government of Mauritius, 2006).

These factors put pressure on finding ways to retain the small planters in the sugar cane business, and at the same time, increase their productivity levels – for both social and economic reasons. It is posited that the effect of the continuing abandonment or loss of sugar cane land within the small planter sector over the next decade, as a result of residential development, scarcity and high costs of manual labour, ageing labour population, and ageing small planters, will need to be partially offset by significant and more rapid improvement in productivity of the remaining small cane planters.

One initiative, from which much is expected, is the work of the on-going Field Operations and Regrouping Project (FORIP) of grouping small planters' fields into larger blocks to enable adoption of better crop husbandry practices; more efficient irrigation systems; and mechanized field operations. It is believed that modernizing the small planter sector for its long term viability will only be possible through the grouping of the small planters for more efficient management of their farming operations. However, experience elsewhere (most recently in South Africa's current land reform efforts) has demonstrated that this approach, while good in theory, rarely works for very long in practice. There are too many social and non-production variables that are not solved by the simple consolidation of land and the agricultural production

operations (Hall, 2009). Furthermore, this approach does not generally address the farmer-level issues that lie at the heart of the productivity concerns.

On the other hand, it is also believed that a more efficient research-extension network could contribute towards enhancing the productivity of the small planters. This will initially require a thorough understanding of the physical, biological and socio-economic conditions in which the small planter operates. Several studies have been initiated to examine the factors limiting or constraining improved productivity among the small planters and to devise the most appropriate measures to counteract them. Some relevant studies conducted at the level of the Mauritius Sugar Industry Research Institute (MSIRI) and other collaborators, mainly the Farmers Service Corporation (FSC) and the Sugar Insurance Fund Board (SIFB), are listed below:

- Souvenir Farming Systems Research Project (Berthelot & Payandi Pillay, 1988);
- The small cane planter and the labour shortage and transport problems study (MSIRI, 1990);
- A socio-economic study of small sugar cane planters in Mauritius (MSIRI-FSC, 1994);
- The rehabilitation of abandoned cane land project (MSIRI, 1996a);
- Economics of grouping planters into Land Area Management Units (LAMUs) (Tonta, J, A *et al*, 1997); and
- The FIRCOP study conducted with South Africa (MSIRI, 2010b).

All of these studies have provided a vast amount of information on the small planters – their socio-economic profile, their farming systems and the technical and operational problems constraining their productivity. These studies reaffirm that the Mauritian sugar cane planting community, in particular the small sugar cane planters, are facing many challenges, in particular, significant sugar price reduction; increasing costs of production mainly on small holdings that do not benefit from economies of scale and thus result in low profitability; lack of

sufficient financial resources affecting the timely undertaking of relevant cultural operations and declining soil fertility due to intense mono-cropping of sugar cane and inadequate crop rotation. The small sugar cane planters operate on lands of low fertility status, often rocky and not convenient for mechanized field activities. The industrial expansion of the late 1980s and early 1990s has led to an acute shortage of labour and increased wages as young people move away from the traditional field activities in sugar cane to other sectors of the economy. Research and extension organizations are perceived to lack commitment in effectively supporting the small planters in their quest towards improved productivity and sustainability. Also, a slow adoption rate of good management practices is also believed to contribute to the lower production levels experienced by the small planters sector.

These studies were conducted over a period of more than two decades (from 1988 to 2010) and several measures were devised to counteract the problems which were identified. Various practical solutions were proposed to the small planters, amongst which were: the introduction of more efficient irrigation systems; the provision of a free-of-charge soil analysis service for the small planters; the recommendation of better crop husbandry practices; and providing incentives to the small planters to enable them to operate in groups and have recourse to mechanization. These measures/solutions have certainly contributed to bring some improvements in the performance of the small planters, as discussed earlier in this chapter; but they have not sufficed to significantly close that productivity gap. The reason for this is the central question of this study.

1.2 Research focus and aims and objectives of the study

In the wake of the challenges brought about by globalization, the small planter sector has become a high-risk group. Its survival will be at stake if proper measures addressing the real issues are not urgently taken, mainly lower production levels of small planters compared to large planters; and decreasing area of cane lands occupied by the small planters. It is rightly believed that by increasing the productivity of the small planter sector to a level comparable to that of the corporate sector, the national sugar production can be greatly increased. This is

believed to bring additional income for the country at large and to the small planters, in particular. As productivity is so critical to this dual outcome, the reasons why the productivity gap between small and large planters persists has been made the central research question.

This question was explored through the following subsidiary interrogations:

1. What are the main reasons and purposes for farming sugar cane?

2. To what extent is information on sugar cane accessible and affordable to the small planters?

3. What are the small planters' capacities to organize their farming operations?

4. To what extent are small planters aware of how much do they make use of available research findings, inputs, existing infrastructure/institutions and credit facilities?

5. To what extent are small planters aware of the sugar marketing system in Mauritius?

6. To what extent are small planters reliant on the income from their sugar cane business?

The main objectives of the research work to be undertaken for this thesis are to:

i. identify the main reasons and purposes for the small planters to farm sugar cane;

ii. assess the small sugar cane planters' capacities to organize their farming operations;

iii. assess to what extent the small planters are reliant on their sugar cane income;

iv. identify the main constraints hampering productivity and profitability of the small planter sector; and

v. assess the relevance and contribution of Research and Development (R&D) carried out in sugar cane farming and of the technology transfer effort to the small planter sector.

To provide answers to these interrogations as well as the main research question, a study was designed and implemented among a sample of small sugar cane planters in Mauritius.

1.3 Structure of the thesis

This thesis comprises seven chapters. Following on this introductory chapter setting out the context of the study, the balance of the chapters are composed as follows:

Chapter 2 provides the context for the study, starting with a description of the historical development of the Mauritian sugar cane industry. It discusses the industry's contribution to the Mauritian economy, the role of sugar cane in environment protection, sugar cane farming in Mauritius, the small sugar cane farming systems, the institutions providing services to small sugar cane planters and the performance of the small planters in terms of sugar cane production compared to large commercial planters.

Chapter 3 has two main themes: research and extension. It describes the organization of research and development in sugar cane in Mauritius. This study was set with the premise that improvements in sugar productivity on the part of the small sugar cane planters will depend on the appropriateness of the findings of research (production and farm business solutions). A theoretical framework is proposed for sugar cane research in an attempt to analyze the factors that may influence a research process relying on the total engagement of its stakeholders in the development of production and farm business solutions, instead of the conventional and current system used to develop technology and improved farming practices. This framework is used to propose a reinvigorated approach to research and technology development. The Chapter then reviews the origins and evolution of extension worldwide, the organization of sugar cane extension in Mauritius, its evolution, the extension approach adopted in Mauritius and the different methods of extension in use. A theoretical framework on research – extension linkage, based on a review of literature, is proposed and later used to analyze data and to propose recommendations for augmenting the current extension system in Mauritius.

Chapter 4 provides the methodology used for this study. It includes a literature review to decide on the methods used to collect primary data for the study; the selection of research participants; the planning of focus group discussions; the design and testing of a questionnaire for a survey; the design of a database for entry of data collected from the survey and finally, the choice of a statistical package for processing and analysis of the collected data.

Chapter 5 presents the findings of this study. It covers four key areas: the demographics of the small planters who participated in the study; their farming systems; their perceptions of the sugar cane business in Mauritius; and their knowledge and adoption/utilization of technology, inputs, services and facilities. Building on these themes, the chapter also presents three main aspects of the small scale sugar cane farming systems: the organization of farming operations; the implementation of farm operations and factors influencing implementation; and the productivity potential of small planters' fields. Thereafter, the chapter discusses the factors related to the small planters' sugar cane farms as a business and their reasons for being engaged in sugar cane farming will also be investigated to be able to understand the persistent productivity gap. The role of marketing in sugar cane production, the contribution of sugar proceeds to total income of the planter and the farmers' dependence on income from sugar cane and other sources of income for the household are also discussed. Finally, the chapter discusses: the use of new technologies, including the adoption of new varieties, utilization of inputs, credit and other services and the access thereto; the reasons for the planters' choices and behaviour; the impact of planters' choices on cane yields; and issues around the sources and access to information about technology options.

In an attempt to shed light on the primary research question, Chapter 6 discusses the findings presented in Chapter 5 and includes the following aspects:

- Appropriateness of sugar cane research and development (R&D) to small sugar cane planters;

- Adoption of the technologies most cited by the respondents;

- Information on and accessibility for technology, inputs, services and facilities;
- Purposes and reasons for sugar cane farming;
- Achieving potential sugar cane yields; and
- Relationship between farmers and the extension services and research

Chapter 7 summarizes the major findings of the study conducted among the small sugar cane farmers sampled in the three major milling areas of Mauritius. It also draws some conclusions on the research conducted and the review of literature. It finally offers recommendations for the way forward in view of improving the livelihood of the small sugar cane planters in Mauritius and suggests some areas for future research.

1.4 Limitations of the Study

The extent to which the findings of this study can be generalized is limited.

The study will primarily be applicable to Mauritius, but it may provide wider insights into the functioning of extension and research.

Also, the study necessarily inquired from farmers about matters related to income. These are always sensitive. To ensure viable answers from the respondent planters, the latter were requested to provide percentages and not real figures. For example, they were asked to state the percentage contribution of their income from sugar cane to their own or total household income. In spite of this, it is to be noted that a good proportion of the planters interviewed did not respond to that question.

A further significant limitation was that while the study was being conducted, the entire research and extension system was revised. Some of the institutions referred to in the study no longer exist and the arrangement of functions and service delivery mechanisms were changed. It was not possible to restart the research in terms of the questions included in the planter

questionnaires, and doing so would not have produced much valuable data, as the planters had not yet had any practical experience with the new arrangements. However, the questions are set in the context of relationships with the MSIRI, for example, and the findings and conclusions are presented in that context; they are entirely applicable to the new agencies responsible for research and extension.

Finally, it was not possible for the researcher alone to conduct all the planters' interviews. At a certain stage, the assistance of some colleagues from the Farmers' Service Corporation (FSC) was required. To avoid misinterpretation of certain questions which were initially set in English, all the questions were translated into the local 'creole' dialect. The objectives of the study and the need to have valid information were impressed upon the enumerators.

1.5 Expected outcomes of the study

The study will have the following outcomes.

First and foremost, these findings will be shared with various authorities in research and extension in Mauritius - the research specialists at the MSIRI and extension officers at the newly created Farmers Service Agency; the management of the Mauritius Cane Industry Authority; and relevant policy-makers. This will be achieved through local seminars and brainstorming sessions.

Also, some of the chapters, particularly chapters 2 to 7, will be developed into papers for publication. The findings will also be presented at relevant international extension conferences and symposia.

Chapter 2
Small scale farming in Mauritius

This chapter provides the context for the study, starting with a description of the historical development of the Mauritian sugar cane industry. It will further discuss the industry's contribution to the Mauritian economy; the role of sugar cane in environment protection; sugar cane farming in Mauritius; the small sugar cane farming systems; the institutions providing services to small sugar cane planters; and the performance of the small planters in terms of sugar cane production, compared to large commercial planters.

2.1 Historical development of the Mauritian sugar cane industry

Sugar cane was introduced into Mauritius by the Dutch in 1639 (Julien, 1996). For more than 372 years, sugar has been associated with the historical and cultural development of the country. In the early 19th Century, some 60 to 80 factories producing over 3000 tonnes of sugar were in operation (Koenig, 1988). The sugar industry expanded to attain a peak of 259 factories in 1838. Later, through a constant process of modernization and centralization, the number of factories decreased sharply. By 1990, some 17 sugar factories were producing around 630000 tonnes of sugar annually (MSIRI, 1990). In 2010, only seven factories remained in operation, with a total sugar production of just over 452000 tonnes (MSIRI, 2010a). This decline in production is mainly attributed to the decrease of the area under cultivation. Figure 2.1 illustrates the phenomenon of sugar cane lands decrease during the period 1963-1967 (82000 ha) to 2008-2011 (59000 ha) compiled from annual reports of MSIRI and data obtained from the Mauritius Chamber of Agriculture (MSIRI, 1958-2011;Mauritius Chamber of Agriculture, 2008-2009).

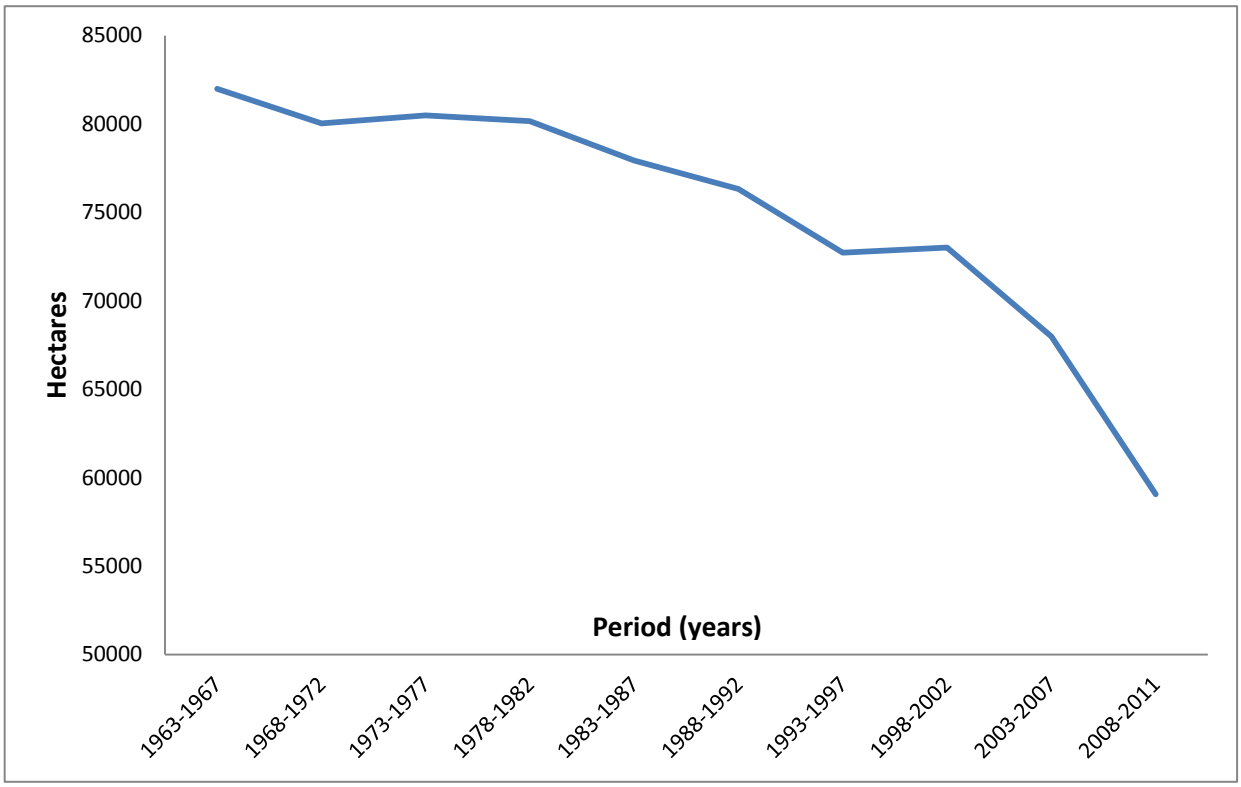


Figure 2.1: Area harvested (hectares) during the periods 1963-1967 to 2008-2011

(Source: compiled from MSIRI Annual reports (1958-2011); Annual Report Mauritius Chamber of Agriculture (2008-2009).

The decrease in area under sugar cane was related to pressures for the conversion of agricultural lands for industries, residences and the expansion of roads. The decrease is also due to land abandonment by the different categories of planters. In the country report of the Food and Agriculture Organisation of the United Nations (FAO, 2001), there is a reported continuing loss of sugarcane fields of some 500 hectares a year, as a result of residential and industrial development. The FAO anticipated that the cane area would continue to decline, and profitability would likely to come under pressure from stagnant or even falling prices and increasing competition in the European Union (EU) (FAO, 2001).

Reform in the sugar industry has been an on-going process since 1859. Competitiveness Improvement Programmes have been a permanent feature of the sugar industry ever since 1984, when for the first time Government developed an overall strategy for the sugar industry, 'the Mauritius Action Plan: 1985-1990'. This strategy was reviewed in 1988 through a major

study, the Sugar Industry Efficiency Study, which laid down the framework for action for nearly a decade. Later in 1991, the 'Bagasse Energy Development Programme' was proposed. This was followed in 1997 by a 'Blueprint on Centralisation of Milling Operations in Mauritius'. Constant efforts have been made to improve and maintain the economic viability of this industry, as evidenced by the 'Sugar Sector Strategy Plan 2001-2005' and later the 'Multi-Annual Adaptation Strategy – Action Plan 2006-2015: Safeguarding the future through consensus' (MAAS) (Government of Mauritius, 2006).

The primary aim of MAAS is to increase the competitiveness of the Mauritian sugar sector, with the overall objective to ensure that the sugar sector remains commercially viable and sustainable and that it continues to fulfil its multi-functional role in the Mauritian economy. The principal measures and intervention areas outlined in MAAS are the following:

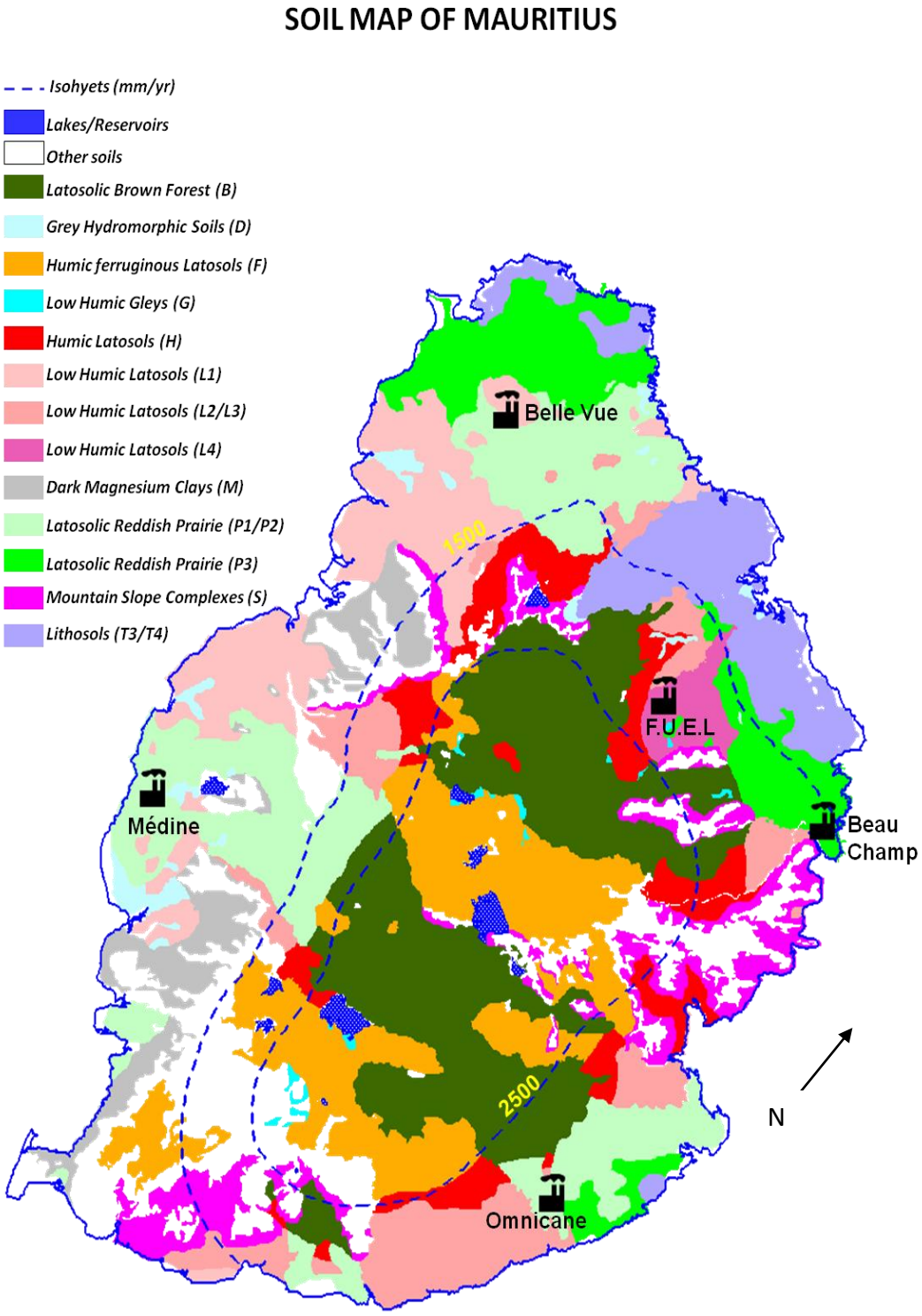
- to improve the cost competitiveness of sugar milling through the centralization of existing sugar factories, which totalled eleven in 2006, into only four with higher milling capacities. These are to be located in each of the geographical sectors of the island (Figure 2.2), one in the North at Belle Vue Mauricia, one in the East at FUEL, Camp de Masque, one in the South at Savannah, L'Escalier and one in the West at Médine, Bambous. The implementation of this intervention will be accompanied by providing compensation packages to enable the rightsizing of the labour force, amongst others;

- to accelerate land preparation and field planning for mechanization of field operations to improve the cost competitiveness of sugar cane production and to increase productivity in terms of sugar yield per hectare. A project known as the FORIP (Field Operations and Regrouping and Irrigation Project) is currently being implemented with the small planters; and

- to develop sugar cane clusters and enhance their contribution to the national electricity production through installation of new power plants in each sugar cane cluster.

A sugar cane cluster implies the centralization of smaller factories into a larger one. One concrete example is Omnicane, found in the southern part of Mauritius where four sugar mills in that geographical sector (Saint Félix, Riche en Eau, Mon Trésor and Union Saint Aubin) were closed and one (previously called Savannah) expanded with higher milling capacity (presently known as Omnicane) (Omnicane, 2009). This sugar mill, equipped with latest technology, is crushing more cane per hour than it was in 2005 (439 tonnes per hour in 2010 compared to 142 tonnes per hour in 2005). It also has the capacity to produce white sugar at a standard marketable quality for the European Union and refined and special sugars. The installation of a coal/bagasse power plant has also enabled Omnicane to provide electricity to the national grid managed by the Central Electricity Board (CEB). In so doing, it is optimizing the use of bagasse for combustion, thus contributing to reducing the imports of coal. With the installation of a distillery, Omnicane also envisages being able to produce ethanol, which will also reduce the import of oils. In MAAS, an annual production of 30 million litres of ethanol is targeted to be produced from molasses.

Concerning the intervention area of mechanization of field operations, it is worthwhile to note that due to an acute shortage of labour during the 1972 harvest, large commercial planters had already embarked on this aspect (MSIRI, 1973), but this had not been popular amongst small-scale sugar cane planters. Due to their small sized fields, it is argued that the only alternative for the small planters to reap benefits from mechanization remains that they group themselves into larger units, while maintaining their right of property. It is also estimated that in so doing, they will further benefit from economies of scale. This objective presents a formidable challenge to the small planters; they will need to be convinced of the advantages of working in groups and of sharing resources.



Adapted from Parish & Feillafé (1965)

Figure 2.2: Soil map of Mauritius and the sugar mills

2.2 The contribution of sugar cane to the Mauritian economy

Sugar is produced in Mauritius mainly for export and mostly to the EU. It has been marketed under the Commonwealth Sugar Agreement since 1951 and under the Sugar Protocol since 1975. Before the crop year 2011-2012, a large proportion of the sugars produced were exported as raw sugars. Since 2012, all the sugars produced in Mauritius were sold as value-added products. From the 2011 crop, out of a total production of 435000 metric tonnes of sugar, approximately 312000 tonnes were exported as white refined sugar under the Long Term Partnership Agreement (LTPA) with 'Suedzucker', a group based in Germany. Some 120000 tonnes were sold as unrefined special sugars to various foreign customers. The difference, supplemented by imports from other countries, was used for local direct consumption -- a total of around 15500 tonnes (Mauritius Sugar Syndicate, 2012).

As shown in Table 2.1, in 2011 at basic prices (excluding taxes and levies), agriculture contributed 3.7 % to GDP, of which the share of sugar cane was 34.4%. This share was 35.6% in 2009 and 31.5 % in 2010. At the level of employment, agriculture provided around 44,400 jobs, contributing to around 7,9% to total employment, out of which, some 16 000 were in the sugar cane sector.

Table 2.1: Share of agriculture in the economy

Category	2009[1]	2010[2]	2011[2]
Share of agriculture in GDP at basic prices*	3.9	3.7	3.7
Share of sugar cane in agriculture	35.6	31.5	34.4
Employment in agriculture	44,900	44,900	44,400
Share of agriculture in total employment	8.2 %	8.0%	7.9%

[1] Revised estimates [2] Provisional (Central Statistical Office, 2011)

Of all the cultivated crops in Mauritius, sugar cane is known to be the most efficient converter of solar energy and thus of biomass production; sugar cane produces around 35-90 tonnes per hectare per year of dry matter compared to maize (10-40 tonnes per hectare per year) and wheat (5-20 tonnes per hectare per year). It is a local, renewable and environmentally friendly

resource. While sugar has always been considered as the main product of the sugar cane plant, it will henceforth be only one among the several products that this plant can offer. In this respect, sugar cane represents an invaluable asset in terms of producing renewable and environment friendly energy. It can also be an efficient bio-factory for delivering high value-added products including proteins, pharmaceuticals, vaccines, polymers and textiles (Autrey, 2006).

2.3 Role of sugar cane in environmental protection

With regard to the protection and preservation of the environment, the sugar industry contributes to soil conservation, biological control of pests with minimal use of pesticides, carbon sequestration and the maintenance of a green landscape. Sugar cane has a relatively low negative impact on the environment, in comparison to other crops, as it uses relatively low doses of agro-chemicals. The breeding and selection of sugar cane varieties resistant to pests and diseases has encouraged minimal to zero use of pesticides. As a perennial crop, it preserves the soil structure for a long period and controls soil erosion very effectively (Autrey, 2006).

Mauritius is a small island with a very sensitive ecosystem. The lands, of volcanic origin, have a thin top soil layer. The island is surrounded by a fragile coral reef barrier that protects the lagoon and its marine life and sandy beaches. The cultivation of sugar cane has enabled the establishment of a permanent cover crop that can protect against soil erosion and can also improve soil moisture by retaining capacity and organic matter content. The adoption of modern processing methods in sugar manufacturing has resulted in a clean and efficient industry in comparison to other industries. Almost all the by-products can be utilized to meet environmental norms, for example no pollution to surface and underground waters; no emission of toxic gases; and soil conservation (Government of Mauritius, 2006); the cane trash and bagasse to generate electricity; scum and fly-ash to improve soil structure and organic matter content; molasses for production of ethanol and as an ingredient in livestock feeds; and vinasse for fertilization. The contribution of sugar cane in keeping the island green for the

tourism industry is recognized both locally and internationally (Government of Mauritius, 2006).

It is argued that any absence of cane as a cover crop or its abandonment may cause '*irreversible damage to the whole ecosystem*' (Government of Mauritius, 2006, p. 24), and would have significant (negative) implications for the environment, the fishing sector, the tourism industry and the economy at large. If it were to be replaced with a less stable crop in the steeply sloped marginal areas, soil erosion would become more of a concern (Government of Mauritius, 2005).

2.4 Sugar cane farming in Mauritius

Two distinct producer categories are involved in sugar cane farming in Mauritius: Corporate planters, grouping the miller and non-miller planters; and Non-corporate planters, grouping the large, medium and small planters. Their evolution is illustrated in Figure 2.3 which has been compiled from annual reports of the MSIRI and the Mauritius Chamber of Agriculture for the period 1963 to 2011. The area cultivated by the corporate planters has decreased over the years, from 42200 hectares in 1963 to 37911 hectares in 2011 -- an average decrease of 87,9 hectares annually. At nearly five-fold the rate among corporate planters, land planted to sugar cane by the non-corporate planters has decreased from approximately 39700 hectares in 1963 to 18700 hectares in 2011-- an average annual decrease of 427,4 hectares per year.

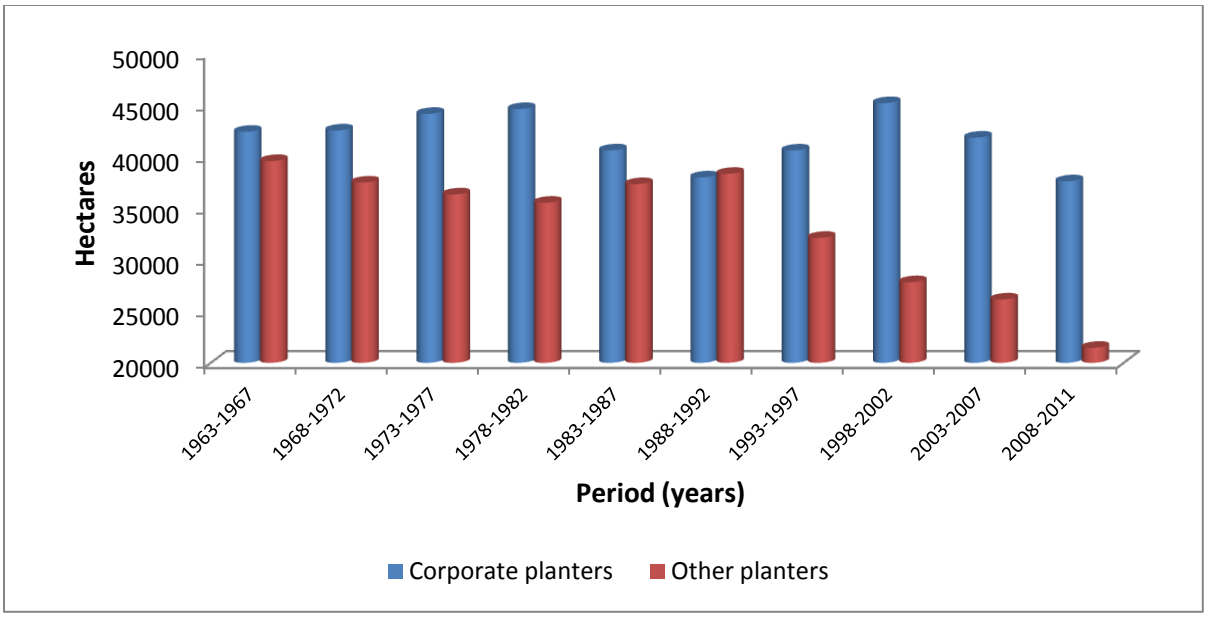


Figure 2.3: Evolution of the areas cultivated (hectares) by corporate and other planters (1963 to 2011)
(Source: compiled from MSIRI Annual reports (1963-2011); Annual Report Mauritius Chamber of Agriculture (2002-2011).

The non-corporate category comprises the large and medium planters with farm sizes above 10 hectares and the small planters with farm sizes of 10 hectares or less. A further analysis of data available for the period 2002 to 2011 from the Mauritius Chamber of Agriculture revealed that the loss of cane lands was more pronounced among the small planters (Figure 2.4). Some 8000 ha of cane lands were lost to production during that period and some 10000 fewer small planters harvested cane in 2011, as compared to 2002.

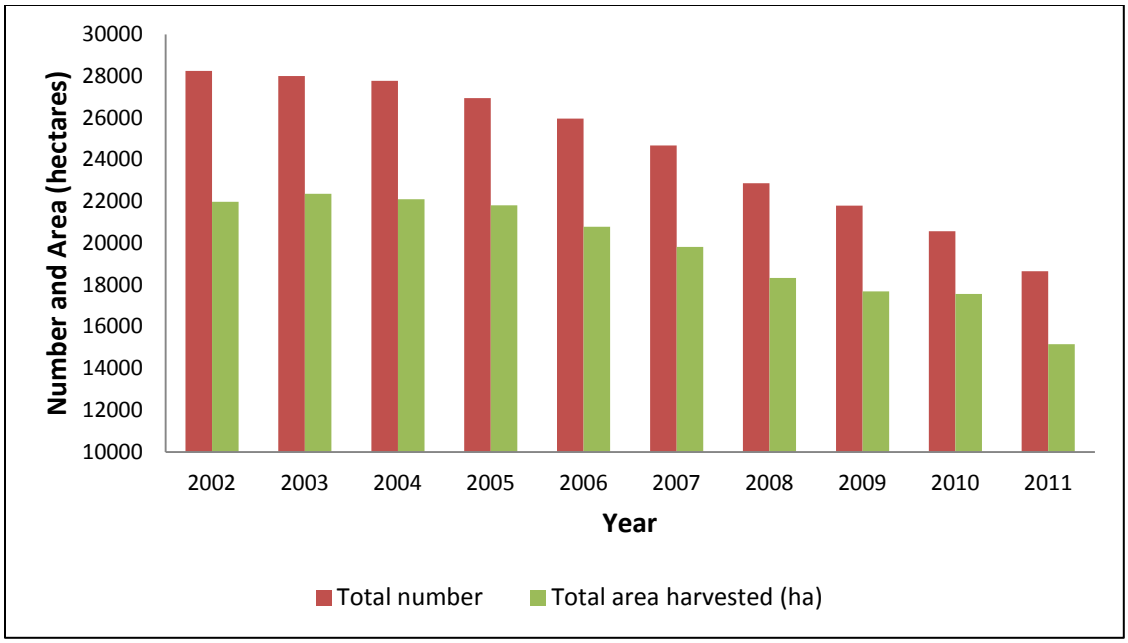


Figure 2.4: Evolution of the number of Small-planters and their area harvested (2002 to 2011)
Source: compiled from Annual Reports Mauritius Chamber of Agriculture (2002-2011).

Table 2.2 summarizes the area under cane, that is the area cultivated and the area harvested during the period 2006 to 2010. From these figures (MSIRI, 1958-2011), there is a clear indication that both the area under cane and the area harvested have been gradually decreasing. This is a cause of great concern in view of ensuring the supply of a critical mass of cane to the mills and the need to meet production objectives (Government of Mauritius, 2006). However, it is interesting to note that in terms of productivity (tonnes sugar per hectare); apart from 2007, there has been some stability and even a slight improvement seen.

Table 2.2: Area under cane and the area harvested during the period 2006 to 2010

Year	Area under cane (ha)	Area harvested (ha)	Cane harvested (t)	Sugar produced (t)	Tonnes cane per ha	Tonnes sugar per ha
2006	70781	66657	4748902	505857	71,2	7,59
2007	68523	64260	4235449	435972	65,9	6,78
2008	65436	62024	4533000	455062	73,1	7,34
2009	64120	60380	4667234	467234	77,3	7,74
2010	64132	58755	4365852	452473	74,3	7,70

Source: compiled from MSIRI Annual reports (1958-2011)

The 2010 statistics (Central Statistical Office, 2011) relating to the two producer categories mentioned earlier are shown in Table 2.3. Each of the corporate planters (miller and non-miller) has an established management team and cultivates more than 500 hectares of sugar cane. More than 99% of the non-corporate planters are classified as small planters. They occupy around 92% of the total cane area cultivated by this category.

Table 2.3: The different sugar cane producer categories in Mauritius

Farmer category		Number	%	Area harvested (ha)	%
Non-corporate planters	Small (< 10 ha)	20906	99,4	21216	34,0
	Medium and Large (> 10 ha)	91	0,4	3605	5,8
Corporate planters	(Millers and Non-Millers)	28	0,1	37539	60,2
Total		21025		62360	

Source: compiled from Annual report, Central Statistical Office (2011)

Table 2.4 shows that in 2011, 19829 non-corporate planters harvested a total area of 17301 hectares and have contributed some 24% to the total island sugar cane delivered at the sugar mills (Central Statistical Office, 2011). It can also be seen that although there has been a significant decrease in the number of small planters and the area harvested, the percent contributed to the cane delivered remained fairly constant at approximately 24%.

Table 2.4: Statistics on non-corporate planters according to farm size (period 2009 to 2011)

Farm size (ha)	No. of planters			Area harvested (ha)			% of total island cane delivered		
	2009	2010	2011	2009	2010	2011	2009	2010	2011
<= 10	22067	20906	19742	18238	17170	15797	23,9	24,6	24
>10 - 25	71	65	76	1057	950	1114	1,4	1,4	1,7
>25 - 50	11	10	11	401	360	390	0,5	0,5	0,6
Total	22149	20981	19829	19696	18480	17301	25,8	26,5	26,3

Source: compiled from Annual report, Central Statistical Office (2011)

2.5 The small sugar cane farming systems

This section describes the small sugar cane farming systems in Mauritius. It further discusses the distribution of the small sugar cane planters, their evolution during the period 2000 to 2012, their demographics, their performance compared to the large commercial planters in terms of sugar production, and, briefly, the role and functions of the main institutions providing services to them.

2.5.1 Distribution of the small sugar cane planters

In Mauritius, planters owning or farmers utilising up to 10 hectares of cane lands are categorized as small planters. Even though 10-hectare farms are included in Table 2.5, the distribution of the farm sizes within this categorization indicates that they are characterized by very small-sized farms. More than 79% of the small planters cultivate sugar cane on farm sizes of less than one hectare and occupy just over more than 42% of the total cane area managed by the small planter sector.

Table 2.5: Distribution of the small planters according to farm size as at end 2012

	Farmer		Area harvested	
Farm size	Number	%	Hectares	%
0.01 - 0.25	4777	27,4	749	5,5
0.25 - 0.50	4561	26,2	1733	12,6
0.50 - 1.00	4460	25,6	3326	24,3
Up to 1.00	13798	79,1	5808	42.4
1.00 - 2.00	2266	13,0	3143	22,9
2.00 - 5.00	1174	6,7	3390	24,7
5.00 - 10.00	201	1,2	1368	10,0
Total	17 439	100.0	13709	100.0

Source: compiled from data provided by the Mauritius Chamber of Agriculture, September 2013

Given that very small farms comprise such a significant percentage of the number of planters and the area harvested, their performance and the consequential potential impact on the Mauritian economy and the livelihoods of thousands of families are a matter of concern. This will be discussed later in this chapter.

The sugar cane industry is currently divided into five geographical sectors (North, East, Centre, West and South) and into five milling areas (Belle Vue, now known as Terragri Ltd in the North, FUEL and Beau Champ, both form part of Alteo Ltd in the East and Centre, Médine Ltd in the West, and Omnicane in the South). The small planters are distributed as shown in Table 2.6. FUEL, Omnicane and Belle Vue are most important in terms of the number of small planters and the cane area which they occupy. Thus, these three milling areas formed the focus of this study.

Table 2.6: Evolution of the small planters over the period 2000-2012

Sector	Milling area	2000		2005		2010		2012	
		Number	Ha	Number	Ha	Number	Ha	Number	Ha
North	Belle Vue / Terragri	8082	5451	7768	5635	5304	3997	4309	3361
East	FUEL - Beau Champ / Alteo	9239	7223	8681	6830	6683	5601	7553	6 119
Centre		4737	3816	3931	3239	2586	2195		
West	Médine Ltd	450	554	409	623	231	332	378	418
South	Omnicane	7865	6190	7974	6379	6102	5044	5199	3811
Total		30 373	30 373	23 234	28 763	22 706	20 906	17 169	17 439

Source: compiled from Annual reports, Mauritius Chamber of Agriculture (2002-2012)

2.5.2 Demographics of the small planters in Mauritius

The demographics of the small planters in Mauritius are extracted from a study (FIRCOP) conducted among small-scale sugar cane planters in Mauritius and South Africa in 2008-2009 (MSIRI, 2010b). The following aspects will be discussed: the socio-economic profile of the small planters; their resource base in terms of availability of labour and transport facilities; and their membership in planters' organizations.

2.5.2.1 Socio-economic profile of the small planters

About 70% of the small planters in the FIRCOP study are male, over 40 years of age and are heads of their households. The female planters are mostly dependents of the householder/ head of the household. Most of the small planters are literate and have at least completed six years of full primary schooling. Only about 10% of the respondents in the MSIRI study (MSIRI-FSC, 1994) have never attended school and some 20% of the respondents in that study have only partial primary education.

The majority of the small planters have acquired knowledge on sugar cane farming and production by themselves or through parents and family members. Contacts with other planters and visits to their fields have also contributed to the acquisition of knowledge. Formal training in sugar cane farming occurs only in a minority of the small planters.

About 85% of the small planters cultivate sugar cane on a part-time basis, and are either pensioners or are employed full-time in non-farming activities. A good majority have more than 10 years experience in sugar cane farming. Nearly 50 % of these planters are in sugar cane farming because it forms part of their tradition and culture, or is a family or inherited business. Sugar proceeds are an important source of income for some of the planters, either as a main source and or an additional source of income.

As to succession planning, about 54% of the small planters know who will take over their cane business in the future. The remainder have not yet identified a clear successor.

2.5.2.2 Availability of labour and transport facilities

Due to their small-sized fields, the small planters cannot afford to keep hired labour on a permanent basis. A majority (97% of the respondents in the FIRCOP study) have recourse to hired labour on a part-time basis for the various field operations, e.g. land preparation, planting, fertilization, weed control, harvest and ratoon management. For 60% of the planters, hired labour comes mostly from old-aged and retired workers; the balance of the labour is sourced from other small planters (about 30% of the respondents), contractors (9%) and sugar Estates (1%). Availability of family labour to cater for the farming operations of small planters is

now a thing of the past. Most of the small planters rely on private contractors or taxi lorries to transport their canes to the sugar mills.

2.5.2.3 Membership in planters' organizations

A majority of the small planters (60% of the respondents in the FIRCOP study) are members of Credit Cooperative Societies (CCS) which are grouped under the Mauritius Cooperative Agricultural Federation (MCAF). Beyond facilitating cane payment and provision of credit facilities, most of these planters expect that their CCSs also offer them certain other services like labour and transport. A significant minority of the small planters are 'stand alone' planters and prefer to deal directly with the Mauritius Sugar Syndicate for their cane payment, instead of going through the CCS middlemen.

2.5.3 Sugar cane yield performance of the small planters compared to the large commercial planters

From 2005 to 2011, an aggregate average of 4.6 million tonnes of cane was harvested every year by the whole industry. However, while the small planters harvested around 30.1% of area under cane, they contributed to only 26.0% of total cane produced. The average yield of the small-planters was around 60.4 TCH and 6.1 TSH, while the average for the large producers (large, corporate and miller planters) was 79.4 TCH and 8.5 TSH. Figure 2.5 illustrates a persisting productivity gap varying between 1.8 to 2.4 TSH between the corporate and the non-corporate planters (MSIRI, 1958-2011; Central Statistical Office, 2011).

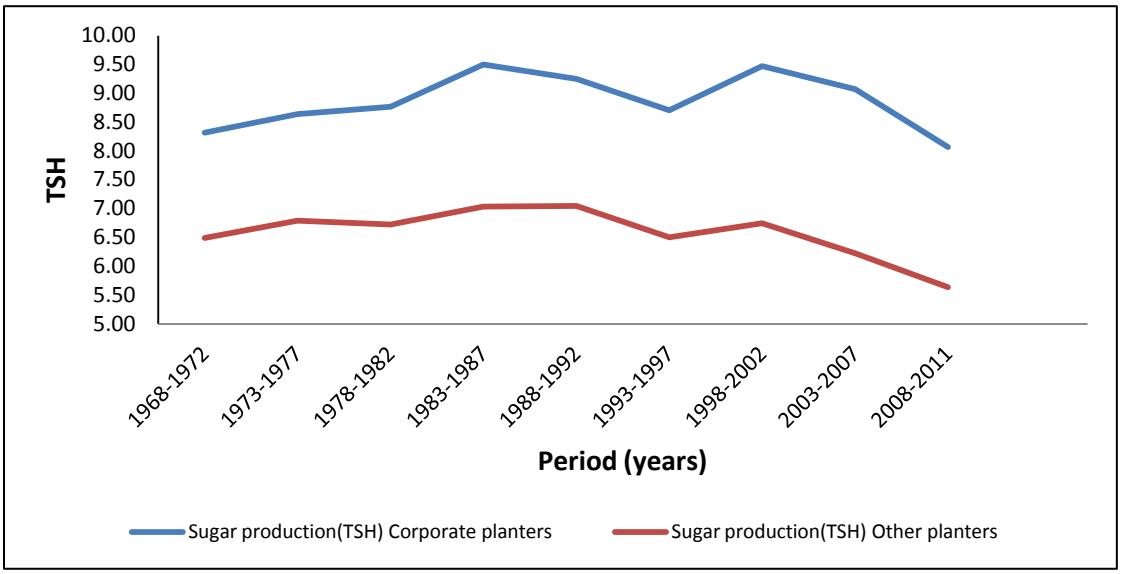


Figure 2.5: Productivity gap (TSH) between Corporate and non corporate planters (1968 to 2011)
Source: prepared from data obtained from Annual reports MSIRI (1958-2011); Central Statistical Office, 2011

In many other sugarcane producing countries, small-scale production is facing similar constraints as Mauritian producers: increasing production costs and reduced production levels. In South Africa, there is also a significant production level gap between the small-scale and large-scale planters, with an average cane yield of 66 TCH for large-scale planters and 33 TCH for small-scale planters (Eweg, 2006). During consultations with research organizations in Reunion island (*Centre de Coopération International en Recherche Agronomique pour le Dévéloppement,* CIRAD, now ERcane) and Tanzania (Kibaha Sugarcane Research Institute) during the preparation of a joint research project to be submitted to the 'Implementation and Coordination of Agricultural Research and Training Organization' (ICART) under the aegis of the SADC in 2007. The following information was obtained: in Reunion Island, cane yields ranging between 52 TCH and 72 TCH have been reported for the small-scale planters, compared to an average yield of 80 TCH for the large-scale planters; in Tanzania, sugar cane productivity experiences a similar gap; averaging 70 to 95 TCH in estate fields and 40 to 55 TCH in the small-scale out-growers' fields. Furthermore in Zimbabwe, recent figures have revealed a yield gap of up to 30 TCH between the large estates and the small-scale planters (per. comm., Zimbabwe Sugar Experiment Station, 2012).

In Mauritius, the small sugar cane planters are far from being a homogenous group with many inherent characteristics: an ageing population, with little or no formal schooling, with small-sized and fragmented holdings, with employment, for the majority, as manual workers for the large corporate planters and employees in the civil service and parastatal bodies; and for a minority, as professionals in legal, medical and political fields. Hence for the majority of the small planters, sugar cane cultivation is a part time activity. Within these broad parameters, there exists a diverse range of livelihood strategy combinations with varying and changing levels of sustainability. As the study will show (Section 5.3.1: 101), reasons for being involved in sugar cane planting vary and subject to change. This diverse and dynamic nature of the small planter 'community' presents a primary challenge for extension services.

2.5.4 Institutions providing services to small sugar cane planters in Mauritius

Several institutions are in operation to provide support and services to the small planters. The roles and functions of the major ones are summarized below.

2.5.4.1 Mauritius Sugar Industry Research Institute (MSIRI)

The MSIRI was created in 1953 *"to promote by means of research and investigation the technical progress of the sugar industry"*. Its mission is *"to carry out high quality research and development on sugar cane and other crops to meet the agricultural, commercial and societal needs of Mauritius"* (MSIRI, 1998, p 3). The major research themes at the Institute are in the fields of Crop Improvement (breeding and selection of better performing varieties), Crop Protection (Pathology, Entomology and Weed control), Biotechnology, Crop Management (Cultural Operations, Mechanization, Agricultural Chemistry and Irrigation) and Sugar Technology. The roles and functions of the MSIRI are discussed further in Chapter 3.

2.5.4.2 Farmers Service Corporation

The Corporation was initiated as a pilot project in 1987, with four 'Farmers Service Centres' (FSCs) established to provide advisory and support services to the small planters in each of four milling areas, in order to improve their efficiency and productivity. Later, after the positive appraisal of the pilot phase, the activities of the FSCs were expanded under the 1991 FSC Act (Farmers Service Corporation, 2012)**.** The roles and functions of the FSCs is further elaborated on in Chapter 3.

2.5.4.3 Sugar Insurance Fund Board

This agency is a statutory body set up under the Sugar Insurance Fund Act of 1974 to provide financial support for the sugar industry. Its objectives are to insure the sugar production of all sugar cane planters against losses in sugar production arising from inclement weather such as cyclones, drought, excessive rainfall and fire (Sugar Insurance Fund Board, 2013).

2.5.4.4 Cane Planters and Millers Arbitration and Control Board (Control Board)

Following the enactment of the Cane Planters and Sugar Millers Control Ordinance No. 27 in 1939, the Control Board was set up as a division within the Ministry of Agriculture to arbitrate disputes between planters and millers; to control the milling and weighing of canes; and to determine the quantity of sugar and by-products to be shared among the planters and the millers.

2.5.4.5 Sugar Planters Mechanical Pool Corporation (SPMPC)

This corporation keeps, maintains and operates a fleet of agricultural machinery for the timely provision of production-related services to the farming community, particularly the small planters, for the preparation of their land prior to replantation (per. comm. with SPMPC, July 2013).

2.5.4.6 The Mauritius Sugar Syndicate (MSS)

The MSS represents all sugar producers and is the sole sugar marketing organization in Mauritius. It is responsible for the sale of all sugar produced by its members and distribution of the sugar proceeds. It aims at optimizing producer income by seeking the highest obtainable sugar prices from markets abroad using various marketing strategies (MSS, 2012).

2.5.4.7 The Irrigation Authority (IA)

This authority provides irrigation facilities to the small planters, together with training to enable them to be independent, self-reliant and sustainable. Its main objectives are to study the development of irrigation, to implement and manage irrigation projects in each irrigation area and to ensure optimum use of available water (Irrigation Authority, 1981).

2.5.4.8 The Mauritius Sugar Authority (MSA)

Established as a corporate body under the Mauritius Sugar Authority Act No. 27 of 1984 (Government of Mauritius, 1984), the MSA is responsible for promoting and maintaining the development, efficiency and viability of the sugar industry. It operates under the aegis of the Ministry of Agriculture. Some of its main duties are to:

- formulate and promote the implementation of overall policies, plans and programmes for the development of the sugar industry;
- promote and facilitate the setting up of the sugar cane cluster in Mauritius and in the region;
- monitor and coordinate research, planting, milling, transport, bulk handling, marketing and other activities of the industry;
- advise government on measures necessary to ensure the viability of the industry, including the structure of taxation affecting the industry generally;

- coordinate the activities of various private and public organizations concerned with sugar; and

- regularly review the economic and financial performance and the problems and prospects of the industry and issue guidelines for the future development of the industry.

2.6 Expectations of the small sugar cane planters to remain competitive and stay in production

2.6.1 Contribution to the Mauritius sugar cane industry

The future of the sugar cane industry has been a subject of serious consideration by the Mauritian government, as well as by the larger cane producers. They have plotted a course based on the global changes influencing the sector. The fundamental assumption is that the challenge for the corporate sector is to pursue efforts to improve productivity through adoption of best management practices. This view is seen to apply to small-scale planters as well. Thus, if the small planters decide to continue their sugar cane business and reap benefits from it, they are left with no other alternatives than to follow the same path of adopting best management practices (Government of Mauritius, 2005).

A significant element of this is shifting the 'product' of sugar cane. As long ago as 2005, the Mauritian sugar industry was already converting itself into a sugar cane industry where the products and by-products will be value added; there is scope for the small planters to derive more livelihoods from activities related to this new industry. The active participation of the small planters needs to be ensured if Mauritius is to move towards increasing sustainability, as detailed in the Maurice Ile Durable Project (MID). Their contribution needs to be ensured through less sugar cane lands being abandoned, guaranteeing a critical mass of cane that will allow the sugar mills to remain active. The future of the cane industry itself will depend on the continued existence of the small-scale planters (Government of Mauritius, 2005).

2.6.2 Political asset / bargaining power

The overwhelming majority of the small planters are descendants of the migrants, indentured labour from India, and have very deep and strong roots in politics. A peculiar aspect of the relationship that they have with social, cultural, religious and political groups is that they belong to an intricate network that safeguards their interests on all fronts. It will take some time before the political establishment will let go of the massive vote bank that small planters represent. Therefore, it can be argued that to safeguard their interests, policy-makers will not hesitate to devise measures that are designed to keep small growers in production. A concrete example of this is the FORIP Project, mentioned earlier (Government of Mauritius, 2006).

2.7 Constraints to cost-effectiveness and sustainability of small-scale sugar farming systems

The FIRCOP study (MSIRI, 2010b) mentioned earlier has also shed light on the constraints that should be tackled to enable the small planters to remain in business. The major ones are reduced income due to increased production costs; scarcity and high costs of labour, transport and other inputs; and limited access to finance and credit facilities. The following are some of the potential solutions proposed by the cane grower respondents in the FIRCOP study.

- **Provision of subsidy to counteract increasing costs of inputs**

Fertilizers and herbicides are the inputs most commonly used in sugar cane cultivation either at plantation or for maintenance of ratoons. For years prior to the study, the prices of these inputs had been constantly on the increase. At the time of the study, they had more than doubled from 2007. To minimize the effect of this constraint, most of the respondents were of the opinion that the authorities, mainly the central government, should intervene through subsidy.

- **Recourse to mechanization and contractual services to counteract availability and high costs of labour and transport**

The availability and high costs of labour and transport were reported as being the second most important constraint to sugar cane production. In fact, this observation has also been made in

past studies. The labour and transport survey undertaken in 1990 revealed that more than 70% of the small planters interviewed were facing labour problems, especially during harvesting operations (MSIRI, 1990). Enabling the small planters to have recourse to mechanization for certain farm operations and the services from contractors were the main solutions proposed to minimize the effect of this constraint.

- **Greater access to finance and credit facilities**

The third problem in order of importance was low profitability resulting from high production costs, coupled with lack of finance and credit facilities. Low profitability limits production because if profit is constantly decreasing and there are few finance and credit facilities, there will be little investment in the business and this will affect productivity.

Contrary to the perception of the growers in that study, a range of facilities were available to assist sugar planters to stay in business, including government sponsored loans, subsidies and other soft loans offered by commercial banks. This suggests that these planters were either not aware of these facilities or that the requirements in terms of the application process and issues such as security requirements made these facilities 'inaccessible". This will require further investigation.

2.8 Summary

The local sugar industry has contributed significantly to the economic development of Mauritius in terms of foreign exchange earnings, provision of employment to rural families and environmental protection. It has been, and will continue to be, an important element of Mauritian socio-political dynamics. Thus the future of the sugar industry will have a substantial impact on a significant portion of the population – particularly those involved in cane production.

The conversion of the sugar industry into a sugar cane industry, where the whole cane biomass will be utilised, adds more value to the cane business. On the other hand, decreasing sugar

prices on the international scene and increasing costs of production are challenges that the sugar cane planting community will have to face. The small sugar cane planters forming part of that planting community are the most vulnerable and they will certainly need more attention from policy makers. Their cane lands are under pressure, they form an ageing population, they have very small farms and over the years they have not been able to achieve the same production levels as the large commercial planters. Yet their contribution to the Mauritian sugarcane industry is still acknowledged and will continue to be relied upon, especially in the context of improving the cost-effectiveness and sustainability of the industry. Thus, understanding in greater detail the context of these planters, and in particular the factors that contribute to the persistent productivity gap, is essential. Such a study required creating a clear framework for agricultural extension, research and technology development against which the situation of the small planters was interpreted, and provided the means for identifying strategies to address the multi-faceted issues that frame the dynamics of the sugar cane industry of Mauritius.

Chapter 3

Research and Development and Extension in Sugar cane

Sugar cane, a perennial grass of the genus *Saccharum* is of the family *Gramineae* (Daniels & Roach, 1987). It is cultivated for its juice from which sugar is manufactured. Most of the commercial sugar cane varieties that are cultivated worldwide are hybrids or offsprings of the species *Saccharum officinarum*, developed from wild canes species*, Saccharum robustom* and cultivated initially in the southern Pacific Islands. The main sugar cane growing areas are located in the subtropical and tropical areas of the world. The sugar cane plant is known to produce a number of stalks, three to seven metres in height and bearing long, sword-shaped leaves. The stalks comprise of segments, known as internodes and between each internode, at the joint, there is a bud. At maturity, the stalk may produce a flower at the top; this will depend on the variety as some varieties do not flower. The plant is normally propagated by using sections of the immature stalks, known as cuttings or cane setts, with each cutting having a minimum of three buds. The setts are planted in fields where the lands have been well prepared. Each bud will germinate and produce a primary shoot (Julien *et al*, 1989) and the root band around the bud will produce a large number of roots. Each shoot will also develop its own root system. Later, through a process of tillering and sprouting, a stool with a large number of growing canes is obtained and all the stools in a field form the plant or 'virgin' cane. After the tillering phase, the stalks will go through the process of elongation and finally will start the maturation phase, that is, the production and storage of sucrose. All these processes will last for a minimum of twelve months, after which, harvest may be contemplated. Being a perennial crop, after each harvest, the portions of stalks left underground will produce other shoots; this process is known as ratooning. Consequently, if the crop is well managed, a sugar cane crop cycle can be exploited over several years and harvested as plant cane and ratoons. Yield in ratoons eventually decreases and after a certain number of years, the yield becomes so low and uneconomical that the field will require a replantation. As a plant, sugar cane needs also to be 'nurtured' – it will require nutrients (those already present in the soil and those that need to be

added); water (this is dependent on rainfall regime, i.e. if the crop is planted in a rainfed area or whether it will require irrigation water if the regime is below the requirements of the plant); less competition with other grasses, known as weeds; and a proper pest and disease management programme.

All these aspects have subsequently justified the need for Research an Development (R&D) and the planter, as the one mostly concerned, needs to be kept informed, hence the role of extension. In this chapter, the organization of sugar cane research and extension in Mauritius with some reference to other sugar cane growing countries is described.

3.1 Sugar cane research

It cannot be said with certainty where and when research on sugar cane started, but it can be argued that it started the very first day when farmers attempted to select varieties. Sugar cane is known as one of the oldest cultivated plants in the world and has been intensely hybridized for its ability to accumulate sucrose (Alexander, 1973). This has resulted in very substantial increases in sugar yield with Purseglove (1972, in Mamet, 1992) claiming that sugar cane has benefitted from more research than any other tropical crop.

3.1.1 Historical development of sugar cane research in Mauritius

In Mauritius, it is reported that it was during meetings of the Chamber of Agriculture in 1877 that Sir Virgile Naz, a lawyer defending some planters against the Royal Commissions, proposed the setting up of an institution to conduct research in sugar cane (Rouillard, 1990). Later in 1885, Sir William Newton, who was chairing a committee to identify the possible causes of a sugar crisis, requested the setting up of a 'Station Agronomique'. Improvement of sugar cane through genetic manipulation has been carried out in Mauritius for over more than a century, after it was confirmed that the plant could produce viable seeds (Mamet, 1992). The first Mauritian seedlings were produced by Perromat in 1891 (North-Coombes, 1937). It was only in 1893 that the 'Station Agronomique' was created, in the form of an experimental station, for

organized research in sugar cane (Wiehe, 1968). It was financed by the sugar producers. Later, in 1913, it led to the foundation of a Department of Agriculture, within which a Sugar Cane Research Station came into operation in 1930. In 1948, an Economic Commission on the sugar industry recommended that '*sugar cane research work should be increased and intensified …… and that producers would be well advised to press on with measures for establishing their own research organization……' (Wiehe, 1968:2)* Consequently, the Mauritius Sugar industry Research Institute (MSIRI) was created by a government ordinance, No. 9 of 1953. It started operating in October 1953 to take over the functions of the Sugar Cane Research Station (Wiehe, 1968). It has the sole responsibility to conduct all research pertaining to the sugar industry. . According to Wiehe (1968: 5), the MSIRI was funded by a 'cess' or levy on sugar proceeds and at that time it was "Rs 3,50 per tonne of sugar exported, equivalent to 0.6% to 0.7% of the annual value of the sugar crop"; the amount was considered significantly lower when compared to what other countries like Australia, South Africa and Hawaii were devoting to research.

3.1.2 Organization of sugar cane research

Since its creation, the MSIRI has been administered as a statutory body by a Board of Directors. In 1953, the Board was comprised of eight members; one was a representative of government and the rest were representatives of the different sectors of the sugar industry. This has evolved over the years. Up until March 2012, the Board was still in place with nine members; two from government (Ministry of Agro-Industry and Food Security and Ministry of Finance and Economic Development); three representatives of miller planters; one representative of large planters; two of small planters; and one from the Chamber of Agriculture. In March 2012, with the enactment of the MCIA Act No. 40 of 2011, the MSIRI together with five other service-providing institutions: the Mauritius Sugar Authority; the Farmers Service Corporation; the Cane and Millers Arbitration and Control Board; the Sugar Planters Mechanical Pool Corporation; and the Bulk Sugar Terminal were merged under the Mauritius Cane Industry Authority (MCIA). While maintaining its technical autonomy, the MSIRI operates under a Research and Development (R&D) Committee answerable to the Board of Directors of the MCIA. The R&D Committee is comprised of a chairperson and eight members; one

representative each from the MCIA Board; the Ministry of Agro-Industry and Food Security; the Chamber of Agriculture; the millers; two representatives of sugar cane planters (one being a small planter); and one independent member having vast experience in the field of agro-industry. The chairman is appointed by the Cabinet of Ministers and the other members are nominated by the Minister of Agro-Industry and Food Security (Government of Mauritius, 2011).

3.1.3 Setting up the sugar research agenda in Mauritius

Since its creation, the MSIRI has had well planned procedures to develop its R&D programme. Its first programme was approved in December 1957 by a Research and Advisory Committee set in place for that function. The programme was expanded on by its senior officers, in consultation with the plant pathologist and entomologist of the Department of Agriculture (MSIRI, 1957).

Subsequently, the MSIRI has operated in programmes which are prepared in consultation with the stakeholders, each for a duration of 5 years. These programmes have always been flexible to be able to cater for the immediate needs of the growers and account for any unforeseen events, for example, a pest or disease outbreak or finding an alternative to an input not available on the market.

3.1.4 Major components of the sugar cane R&D programme at the MSIRI

Over the years, endeavours in sugar cane research and development in most of the sugar cane growing countries, including Mauritius, have provided growers with management practices that are aimed at optimizing productivity of sugar cane cultivation and minimizing environment pollution (MSIRI, 2004). These practices have continued to meet the immediate needs of the planters, but with new issues, like decreasing prices of sugar in the world market, increasing costs of production resulting from higher costs of labour and major inputs like fertilizers and herbicides, more efforts have to be devoted to address these issues.

If it is widely acknowledged that the sugar industry has played a vital role in the economic and social development of Mauritius and has contributed significantly to environment protection and the tourism industry, it is also acknowledged that R&D in sugar cane has been invaluable.

With the significant drop of 36% in sugar prices, resulting from the globalization of world trade and reform in the EU sugar regime, new objectives have been set for R&D to enable the Mauritian sugar industry to become a renewable biomass one, which will be economically viable and sustainable in the long term. These objectives, in addition to the on-going ones of improving sugar productivity and lowering production costs, are also aimed at the judicious use of resources and adherence to strict environmental and quality norms imposed by the foreign markets.

To remain sustainable, the Mauritian sugar cane industry is condemned to move towards lower production costs and higher productivity levels, both in terms of biomass and sugar output. It has to optimize the utilization of resources and at the same time comply '*with the strict environment and quality norms warranted in a small island and insisted upon by the developed world to whom its sugar and other products are sold*' (MSIRI, 2009: 1).

Most of the information concerning sugar cane research in Mauritius and the issues discussed in the remained of this section has been extracted from the MSIRI Research and Development Programme 2010-2014 (MSIRI, 2009).

The stakeholders in Mauritius have always recognized R&D in sugar cane as an investment for the future, but at the same time it should be emphasized that it requires 'state-of-the-art' technologies and equipment, as well as trained, dedicated and motivated personnel. It has to be cost effective and reliable to enable the sustainability and economic viability of the sugar cane industry. Currently the MSIRI is adopting a multi-disciplinary approach for R&D activities. These are grouped under four programmes which are illustrated Figure 3.1.

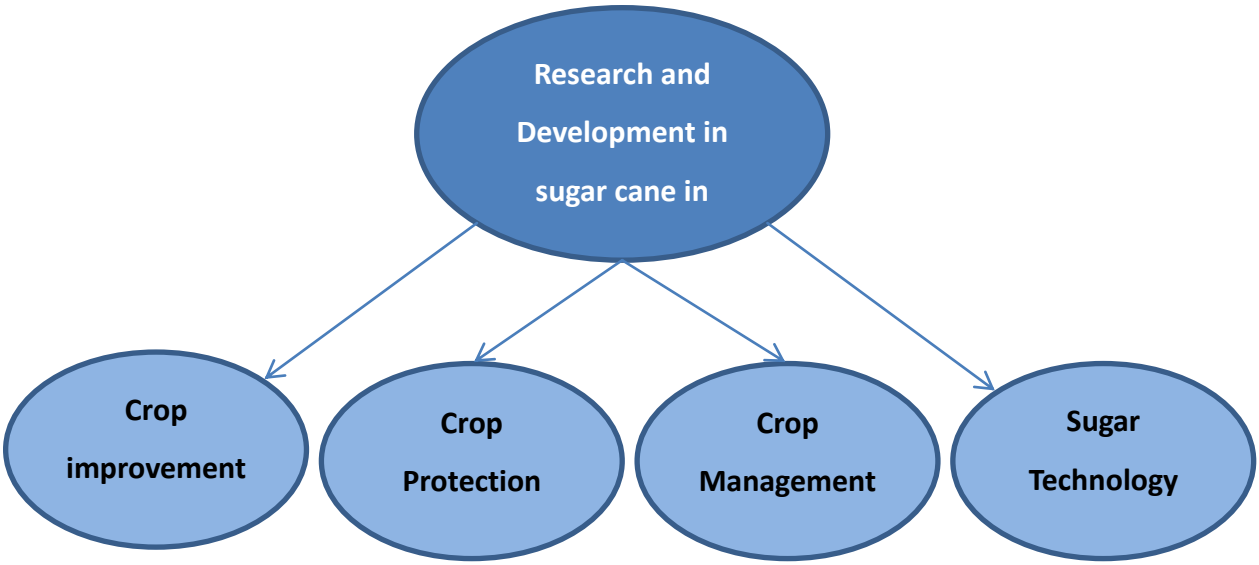


Figure 3.1: Organization of Sugar Cane Research and Development in Mauritius
Source: MSIRI, (2009)

The crop improvement programme includes the breeding and selection of varieties with high sucrose and fibre, as well as aspects relevant for their commercial exploitation, such as the harmonization of harvest dates with their agro-climatic conditions. Since it is argued that one of the means to improve planters' income and to attenuate the adverse impact of the global reform process and yield decline tendencies is to enhance sugar productivity per unit area, the development of new improved varieties adapted to local conditions is the main thrust of the R&D programme of the MSIRI.

Since its creation in 1953, the institute has released a total of 64 varieties, 52 have been created locally and 12 were imported and screened for suitability to local conditions. In 2012, 22 varieties were being recommended for planting in diverse environments and for harvesting at different periods of the crop season (MSIRI, 2012). Among these varieties, 10 have been widely adopted by the planting community and occupied nearly 91% of the cane area in 2012. Breeding and selection of new varieties are aimed at producing better varieties with enhanced cane yields and sucrose content, adapted to diverse agro-climatic conditions and soil types, resistant to pests and diseases and with good ratooning ability. The diverse agro-climatic conditions form three contrasting zones of the island: the sub-humid zone irrigated and rain fed

(<1600 mm rainfall per annum), the humid intermediate (>1600-2400 mm rainfall per year) and the very humid central upland zone (>2400 mm rainfall annually). The sugar cane lands also comprise five major soil groups and these are also considered in the selection of varieties; some varieties perform better in certain soil types. Emphasis is also placed on varieties adapted to mechanical harvest, with good germination and early canopy cover establishment, as well as being suitable for harvest across a wide range of environments and across the harvesting season. The centralization of sugar mills has added a new parameter in the breeding and selection programme; with only five sugar mills, as mentioned in Chapter 2, the harvest period has been extended (from early, instead of late, June to well over mid December, instead of late November) and this requires early-maturing and late-maturing varieties. With the conversion of the sugar industry into a sugar cane industry and with the view to utilize the sugar cane biomass more efficiently and as a renewable source of energy, the development of varieties with higher fibre content is also being contemplated. The contribution of biotechnology, an emerging technology, in the sugar cane variety programme is believed to shorten the selection process and offer new varieties earlier to the planting community, in a more timely fashion. It can also determine the susceptibility of the varieties to diseases. This technology enables the use of molecular markers for DNA fingerprinting of varieties, the application of molecular diagnostic tools for rapid disease screening and the use of tissue culture for rapid multiplication of new varieties.

The crop protection programme supports the sugar cane improvement programme with respect to disease diagnosis, disease epidemiology, evaluation of promising clones and the quality of planting material and the biological control of pests. It systematically tests major diseases in parents, new clones and varieties introduced from other countries. This programme aims at minimizing the risks of disease outbreaks. Mauritius, as other sugar cane growing countries, has to face a constant threat of introduction of new pests and diseases as well as the re-emergence of indigenous plant pathogens. Recrudescence of existing pests and diseases may happen in response to changes in climate and agricultural practices. Surveillance, precise diagnostic tools and reliance on various preventive measures are privileged to mitigate their propagation. A concrete preventive measure is the selection of resistant varieties. Mauritius

has a long standing tradition of having a sugar cane industry where use of chemicals to control pests and diseases is kept to a strict minimum. This has so far been possible through the exploitation of sugar cane varieties tolerating the common diseases and pests prevailing in the country.

Whilst the crop improvement and protection programmes are believed to improve productivity in terms of higher cane and sugar yields, it is expected that the crop management programme, over and above improving productivity, will also lower production costs. The development of new cropping systems; judicious use of fertilizers, particularly nitrogen fertilizers; conservation of soil organic matter; weed management; efficient use of irrigation and mechanization of field operations are the main aspects under investigation in the crop management programme. To discontinue with the practice of a sugar cane monoculture which is not sustainable to the industry and which contributes to yield decline, the programme is also considering the aspect of crop rotation to conserve soil biological fertility. The ultimate aim of the crop management programme is to be able to propose sound and improved agronomic management practices to the planters, in order to enable them to exploit the full potential of new varieties. In view of achieving a sustainable sugar cane farming system, the programme also caters for environment protection by proposing clean management practices to the farming community like sound and judicious use of agro-chemicals, especially fertilizers and herbicides and measures to control soil erosion and consolidate soil conservation.

Due to limited resources, the sugar technology and engineering programme is placing more emphasis on problem solving and advisory activities with the millers instead of research proper. With the measures outlined in MAAS, already described in Chapter 2, activities in this programme also attempts to attain the following objectives:

- to provide accredited laboratory analyses and advisory services in relation to direct consumption sugars;

- to conduct environmental evaluations of cane processing facilities and to provide advice on treatment measures to promote clean production in view of minimizing environmental pollution;

- to promote efficient energy utilisation and conservation measures in cane processing so as to enable maximum energy export to the national electricity grid;

- to evaluate treatment techniques and technologies for effluents from distilleries and to propose technologies for the safe disposal of the effluents; and

- to investigate the potential of cane biomass fractions, including sugar, for more value added products.

3.2 Theoretical framework for research in sugar cane

The main research question set in this study is why, despite efforts in R&D, the small sugar cane planters are still unable to close the productivity gap that exists between them and the large commercial planters. This study was set with the premise that improvements in sugar productivity on the part of the small sugar cane planters will depend on the appropriateness of the findings of research (production and farm business solutions).

The theoretical framework proposed for sugar cane research attempts to analyze the factors that may influence a research process relying on the total engagement of its stakeholders in the development of production and farm business solutions, instead of the conventional development of technology and improved farming practices. The different stages in the framework include: identification of gaps and needs; setting objectives and priorities; involvement of the stakeholders; elaboration, implementation and evaluation of research projects.

Figure 3.2 illustrates the existing framework. It shows the current articulation among the actors in the research and extension mix. The stakeholders include all sugar cane planters and their

organizations, the millers, the service-providing institutions (including extension) and the policy makers. For the purpose of this discussion, extension and planters are identified explicitly. As shown in this process, the corporate and non-corporate planters are involved to a certain extent in some stages, namely, identifying their research needs, setting objectives and priorities of the research agenda and in the evaluation and adoption of production solutions. The involvement of the corporate planters is more pronounced, either directly with the research specialists or the extension arm of the MSIRI. Indirectly, they also collaborate in the experimentation stage (provision of lands and other resources). The involvement of the non-corporate planters can be qualified to be more passive. Either through the FSCs, the PAUs or their representatives in the R&D committee and sub-committees, they have a say in the identification, objective setting and prioritization of projects and in the evaluation/adoption of production solutions. Here it must be stressed that they are not at all involved in the design and implementation of research projects.

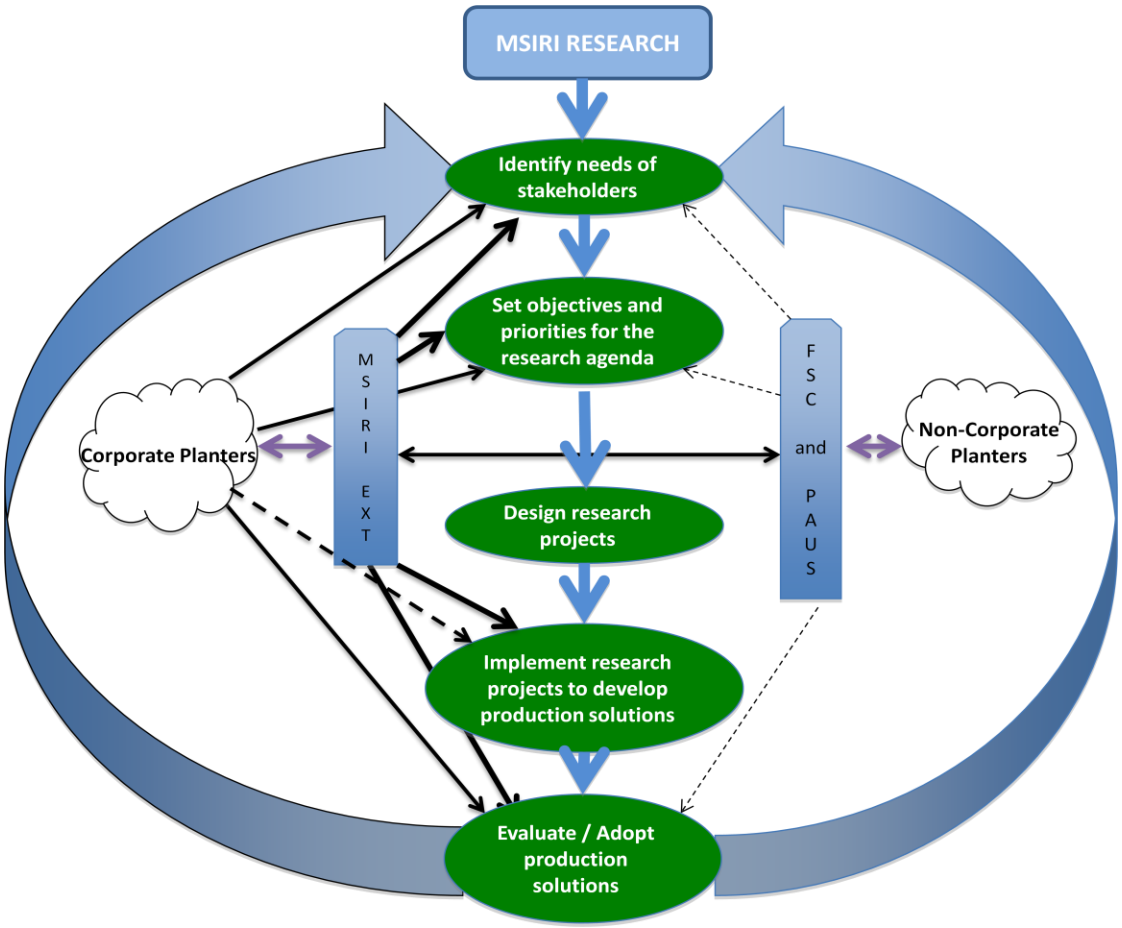


Figure 3.2: The existing framework showing the research and extension process.

The preparation of a R&D programme at the MSIRI normally comprises the following stages:

- A review of the major achievements of the out-going programme with representatives of the stakeholders, at the same time obtaining their views on the next R&D agenda.

- Organize regional seminars with representatives of the different categories of planters and organizations involved in sugar production to identify and prioritize their needs in terms of R&D. These exercises also enable revisiting the objectives of the R&D programme for the next five years.

- The information obtained in the above two consultations is processed by the senior officers of the MSIRI, who also bring their own input in terms of new breakthroughs in

sugar cane research elsewhere or from their own research. Research projects are proposed in the draft R&D programme. This is submitted for discussions among the members of the Research and Advisory Sub-committees (Agronomy, Biology and Sugar Technology) and for final presentation to the members of the Research and Advisory Committee. It is to be noted that these Committees are appointed by the MSIRI Board of Directors and are comprised of representatives of planters' organizations, University of Mauritius and the Ministry of Agro-Industry. Finally, the proposed R&D programme is submitted to the MSIRI Board of Directors for approval. An important aspect also considered at this stage is to ensure the financing of the R&D Programme and the allocation of resources in terms of manpower, equipment and infrastructure.

- Once the R&D Programme is approved, a research agenda for a five-year duration with over 150 specific research projects is established. The research projects are designed for implementation in the laboratories and the main Experiment Station at Réduit (where the Head office is located), the regional Experiment Station located in each of the three major agro-climatic zones of Mauritius and also on lands made available by the corporate planters. In the latter case, it can be questioned why these research projects are conducted only on lands of the corporate planters and not on lands of the non-corporate planters. This is because apart from lands which are already limited among the non-corporate planters, field experimentation requires other resources like labour, inputs (fertilizers, herbicides and irrigation water in rainfed and dry conditions) and equipment. These are either scarce or not easily and readily available. Also it should be stressed that field experimentation bears risks in terms of crop failures, for example and the non-corporate planters, especially the small ones, cannot afford this. The funding of sugar cane research is already being assumed by all the planters, through a 'cess' or levy on sugar which they produce and export. The collaboration of the corporate planters is essential for the establishment of trials to test new varieties and farming practices and to evaluate the impact on their sugar cane business.

Thus, in the existing framework, the role of the main stakeholders, that is the planters, is 'passive'. It is essentially limited to initial discussions in meetings and brainstorming sessions to establish the research agenda and in the provision of resources for experimentation. They are not at all engaged in the main research process. They are, however, engaged again at the 'end' of the process as potential recipients of the new technology.

This demonstrates that the research process is separate from or, at best, tenuously linked to extension and planters. Through some input from extension, the research accommodates and anticipates needs of planters, but largely sees them as end-users and adopters. This suggests that the dominant extension approach used with cane planters is akin to Blum's (2007) linear approach employing technology transfer extension methods.

Figure 3.2 applies this model to the situation in Mauritius at the time of the study. It shows the key stakeholders and their relationship with the research process. Drawing on the reviewed literature and the current framework for research and extension, Figure 3.3 presents a basic framework for the research extension mix that provides a more active role for stakeholders – in particular planters and extension.

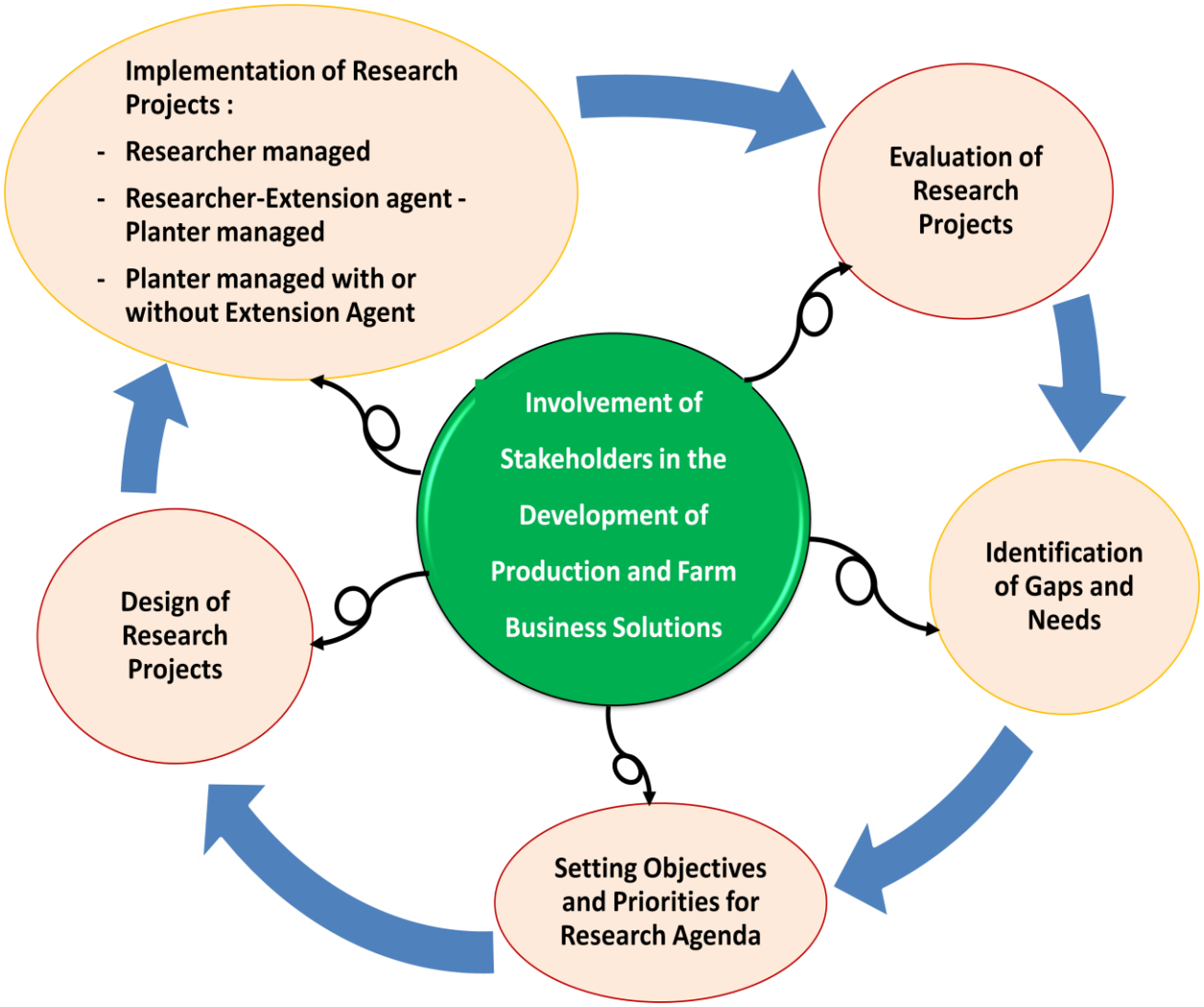


Figure 3.3: Basic framework for research and extension mix

The theoretical framework presented in Figure 3.3 can be compared to an innovation system. An innovation system comprises networks of actors (farmers, firms, research centres …), their actions and interactions, and the formal and informal rules that form the institutional framework in which the networks operate (Friedman, 1987; Lundvall, 1992; Nelson, 1993 in Ekboir *et al.*, 2009). The actions and interactions of these actors influence the enquiry and investigation into and the eventual output, diffusion and adoption of appropriate, relevant and economically useful knowledge, systems and technologies. According to Hall (2005: 614), "an innovation systems framework sees innovation in a more systematic, interactive and evolutionary way". In this framework, networks or organizations within their institutions and

policies that influence their innovative behaviors and performance bring new products and processes into economic and social use. Active interaction is encouraged among the different partners to enhance capacity building for continuous innovation to be able to respond and adapt to the changing socio-economic and environmental conditions. Appropriate policies are required to support and stimulate innovation.

This framework is premised on the sentiment that scientific research only has value if it improves production system and livelihoods, that is when it is used to satisfy social or economic needs or to take advantage of emerging opportunities.

The traditional approach for defining research priorities (as depicted in Figure 3.2) is often criticized because of the rigid definition of priorities by policy makers. Those directly concerned, that is the planters, are not given enough choice, nor are they given the opportunity to engage meaningfully along the research pathway. The process of prioritizing research, while looking for new opportunities, needs also to accommodate existing indigenous knowledge and capabilities and actively engage those who are ultimately the ones who will decide to use or not use the resulting technology. As noted by Drost *et al*. (1996, p. 6) *"increasing farmer participation in selecting and conducting appropriate research facilitates adoption of new and sustainable practices….Without grower participation in the design and implementation process, growers will be reluctant to adopt sustainable practices"*.

Thus the framework proposes some major innovations. Prior to the formulation of a research agenda, it will not limit itself in identifying the planters' needs in terms of technological solutions only. All activities earmarked in the research process are 'planter-centered'; the full engagement of the planters will result in a major paradigm shift in setting and prioritizing research objectives. It will also take on board any deficit or 'gaps', as well as opportunities in terms of their knowledge about new markets, new products, and alternatives to a sugar-based business that may no longer be profitable.

The framework depicted in Figure 3.3 is generic and needs to be adapted further. Further elucidation is needed on the nature of exchanges with stakeholders at the various stages of the cycle. It also needs to be applied to the specific context of the Mauritius sugar industry.

It can be argued that all investment in the sugar cane R&D programme is meaningless if the results are not made known to and adopted by the planters. Promoting awareness of sound agronomic practices and, more importantly, encouraging their adoption to enable the sugar cane planting community to achieve competitiveness and sustainability is a major objective of the R&D programme.

3.3 Sugar cane extension

This section reviews the origins and evolution of extension worldwide, the organization of sugar cane extension in Mauritius, its evolution, the extension approach adopted in Mauritius and the different methods of extension in use. A theoretical framework on research – extension linkage, based on a review of literature, is discussed in the following sections.

3.3.1 Origins of extension

In 1866, the term 'Extension' was first used in England in a system of university education started by Cambridge and Oxford Universities and this was later taken up by other educational institutions in England and Ireland. According to Jones (1982), agricultural advisory and instructional services started much earlier during the great potato famine in the mid 1800's in Ireland. It began as a small scheme in 1847 after proposals made by Earl of Clarendon, the then Lord Lieutenant of Ireland in a letter addressed to the President of the Royal Agricultural Improvement Society in Ireland. Itinerant practical instructors were appointed to advise small peasant farmers affected by the famine. *"Lord Clarendon's letter …… must be regarded as a classical document in the early history of agricultural extension" (Jones, 1982, p. 11).*

In the USA, a system of university extension was introduced through city libraries and later in 1892, the Universities of Chicago and Wisconsin started university extension programmes. This

influenced the land grant colleges to develop extension-type thrusts (Swanson, 1984). The term 'agricultural extension' was commonly used in the USA in the early 1900's when the Cooperative Extension Services were formed in association with the land grant colleges and where land was granted to each state to develop experiment stations and educational institutions or agricultural colleges.

Other countries have been using different terms, but with little differences in their meanings and following can be mentioned: *"Voorlitchting"* used by the Dutch to qualify the action of lighting the pathway ahead of people and helping them to find their way; *"Beratung"* is used by the Germans, meaning advisory work and implying provision of advice on the best alternatives, with the farmer finally deciding on the most appropriate one (Swanson, 1984).

A great deal of emphasis was placed on agricultural development during the colonization of tropical countries, to promote tropical crops like sugar cane, tea, tobacco and coffee. This led to the development of plantation economies, which in many third world countries not only dominated their agriculture, but also became the backbone of their economies. The crops mentioned above were mainly for exports. "Colonial governments sponsored research and extension type activities for export crops such as sugar cane, tea, … because they were interested in increasing the export of these crops" (Swanson, 1984, p. 6).

According to the same author, the development of agricultural extension organizations was, to a large extent, a post-independence phenomenon occurring mainly after the Second World War. However, extension-type activities were carried out in many countries in the early 1900s' (Swanson, 1984).

3.3.2 Definition of Agricultural extension

The World Bank defines agricultural extension as "the process of helping farmers to become aware of and adopt improved technology from any source to enhance their production efficiency, income and welfare" (Purcell, 1997, p. 55). According to Swanson *et al.* (1997), it is the act of extending relevant agricultural information to people or "the promotion of

agricultural technology to meet farmers' needs" (Moris, 1991, p. 17). According to Oakley and Garforth (1985), over and above offering technical advice on agriculture to farmers, agricultural extension also provides them with other necessary inputs and services to support their farming activities. The farmers are provided with information and new ideas developed by research specialists.

Extension has long played a role in the development of rural economies. This "extending" of relevant agricultural information to people (Swanson et al., 1997) has gone through many stages of evolution in various countries of the world. What can be observed in the above definitions is that the researchers have already anticipated the farmers' needs with no consideration given to their opinions, priorities and farming experience.

The following interrogations seem justified:

In the first instance, it is important to know whether feedback from farmers on performance and appropriateness of technology are being encouraged; secondly, if farms are being privileged instead of farmers; and finally, if capacity building and empowering farmers are considered as important extension goals.

It can be argued that the above definitions do not take into account these issues and this has probably prompted other authors to propose other visions for extension. According to Birner et al. (2006, in Davis, 2008), agricultural extension is defined as a whole set of organizations that support farmers in the process of solving problems and obtaining information, skills and technologies to improve their livelihoods and well being. Extension is defined as *"systems that facilitate access of farmers, their organizations and other market actors to knowledge, information and technologies; facilitate their interaction with partners in research, education, agri-business and other relevant institutions; and assist them to develop their own technical, organizational and management skills and practices"* (Christoplos, 2010, p. 3). In brief, according to Christoplos, agricultural extension should have a much broader role to include issues beyond agricultural practices and also offer services. Some of these issues are the dissemination of information about technology, research findings, markets, finance, weather

and climate; training and advice for individual farmers or their groups or organizations; on-farm testing and adaptation of new technologies; empowering small farmers in business management skills; facilitating linkages with other actors (market, finance, processing and trade); facilitating feedback from farmers which may contribute to the development of more appropriate policies and programmes; and improving awareness among farmers of new opportunities for certification of '*green*', '*fair-trade*' and other production methods.

3.3.3 Models or Approaches of Agricultural Extension

Over the years, agricultural extension has evolved from one extreme to the other, from the transfer of technology model or the top-down approach where emphasis was on the adoption of modern technology or farm practices developed on research stations to – human resource development, which aims at 'critical competence', where through learning and capacity building, farmers are capable of knowing "*what to ask for, can evaluate the appropriateness of technical information and are responsible decision makers*" (Nagel, 1997: p. 3).

The Farming Systems approach emerged to encourage farmers' participation in technology development. According to Farrington and Martin (1987) and Biggs (1989), it was aimed at better understanding the farmers' complex environment and the interdependencies among elements of farming systems in order to design technologies adapted to their conditions.

The 'Farmer First' concept was later introduced and posited approaches like Farmer-back-to-Farmer, Farmer-First-Farmer-Last, Farmer Participatory Research and Participatory Technology Development. The idea was to involve farmers in the process of generating, testing and evaluating technologies to promote sustainable agricultural production. According to Selener (1997), the concept was aimed at developing suitable technologies for small-scale and resource poor farmers and ensure their adoption to increase farm productivity and income.

The Agricultural Knowledge and Information Systems (AKIS) approach emerged in the 1990s to strengthen vertical and horizontal information flow in agricultural systems. According to Röling

(1992), an agricultural system is effective when information and technology are successfully accessed by the different actors in the system, essentially farmers, researchers and extensionists. Duncan (2011) argued that if agricultural research projects were to achieve social and economic change, more partners should be included in the value chain. According to Hall (2007), alternatives approaches to the linear approach should aim at looking for information and knowledge from farmers and enhance feedback loops.

Within this spectrum, Blum (2007) identified three broad approaches to extension: linear; advisory, facilitation. She examined these according to eight characteristics: Purpose; Source of Innovation; Promoter's Role; Farmer's Role; Assumptions; Supply/Demand; Orientation; and Target. Worth (2006) proposed learning as a fourth approach (closely related to but distinct from facilitation) which emphasised individual and collective learning as the focus of the extension engagement. Table 3.1 presents a comparison of extension models and approaches using Blum's framework.

Table 3.1: Comparison of extension models and approaches

Characteristics	EXTENSION MODELS/APPROACHES			
	Linear	**Advisory**	**Facilitation**	**Learning**
Purpose	Production increase through transfer of technology Government policy	Holistic approach to farm entrepreneurship	Empowerment and ownership	Awakening desire and building skills in learning for advancement as jointly defined by partners
Source of Innovation	Outside innovations	Outside innovations and by farm manager	Local knowledge and innovations	Synergistic partnership of farmers, researchers and extension
Promoter's Role	Extending knowledge	Providing advice	Facilitating	Promoting learning skills and facilitating partnerships for learning
Farmer's Role	Passive: others know what is best. Adopting recommended technologies	Active: problem solving. Asking for advice. Taking management decisions	Active: problem solving; owns the process. Learning by doing. Farmer-to-farmer learning	Considering all possibilities Contributing to own and others' learning; partner in learning
Assumptions	Research corresponds to farmer's problem	Farmer knows what advisory services he/she needs	Farmer willing to learn to interact and to take ownership	Farmer less powerful in learning relationship; needs support in developing desire and skill to learn
Supply/ Demand	Supply	Demand	Demand	Supply to evoke dynamic relationship of supply and demand
Orientation	Technology	Client	Process	Client and process and 'right' placement of technology
'Target'	Individuals Farmer organisations. Projects	Individuals Groups with common problems	Groups and organisations, interaction of stakeholders, networking	Farmers in context of a learning partnership Others in partnership in the context of facilitated learning

Adapted from Blum (2007) and Worth (2006)

The linear approach is essentially uni-directional technology transfer. While technology may be developed with the needs of farmers in mind, this approach generally excludes the farmer from the technology R&D process, assumes the research (and resulting technology) will correspond to farmers' problems and perceives the farmer as a passive recipient of technology. The orientation of this approach is based on the technology itself.

The advisory approach is also a form of technology transfer. Predetermined technology awaits a request from farmers. This approach assumes the farmer knows what he or she needs and will ask. Farmers are active participants in the sense that they request information and advice, but

remain disconnected from the R&D process. The orientation of this approach is on the client, but in the context of a predetermined technology.

In the facilitation model, Röling (1995) identified the need to reinforce individual learning among farmers, facilitated by agricultural professionals - both researchers and extension workers with emphasis on an agricultural knowledge and information system (AKIS). In this approach, the farmer is an active participant in the technology R&D process. There often is no predetermined technology, but clear principles of ecologically sound production. However, it largely assumes the farmer's willingness and ability to engage in a learning process. Its orientation is on the process.

In the ambit of the learning approach, which appears to be a refinement of the facilitation approach, Worth (2006, p. 180) proposed the 'Agriflection model' where farmers *'should be engaged in genuine partnerships with researchers, extension workers, funders and policy-makers for the purpose of learning. Learning starts with the farmers to know what they do, why they are doing it and how they improve the profitability and sustainability of their farming systems'*. According to the author, rendering the farmers full partners in research and innovation will impact directly on their profitability and sustainability. The following outcomes are expected from this model:

- knowledge of existing farming systems and what the farmers expect in order to enable them to improve their sustainability;

- making decisions together with the farmers about the available technological options that will improve their agricultural activities and which will positively impact on their livelihoods; and

- a more demand-driven approach where farmers will be continuously involved in technology development and innovation.

This will finally lead to the emergence of *'a cadre of innovative farmers'*, who will be capable to continue innovating and will be partners in instead of recipients of extension programmes (Worth, 2006, p 181). However, this approach assumes the farmer is less powerful in the desired learning relationship and needs support in developing both the desire and skill to learn. Its orientation is presented as a mix of client and process and 'right' placement of technology.

It is submitted that the approach ultimately adopted by research and extension depends on a number of factors. There may well be time when technology transfer (linear and advisory) is appropriate -- particularly in cases where there is well-documented research on the issues in question and ample evidence of the appropriateness of the 'pre-determined' technology. A choice between facilitation and learning approaches would be driven by a first-hand *in situ* assessment of farmer capacity and interest in learning. Effectively, it is argued that the 'assumptions' of each approach must be questioned in the field and, based on the outcome of that investigation, adopt the appropriate approach or mix of approaches relevant for the farmer(s) in question.

3.3.4 Extension with sugar cane planters in Mauritius

Having described the origin of extension and its evolution, an attempt is made in this section to review the development of extension in Mauritius, with particular reference to the organization of sugar cane extension. The model(s) adopted for sugar cane extension, the methods used and their major strengths and weaknesses are discussed.

3.3.4.1 Origin and evolution of extension in Mauritius

An acute need for food crops production in the 1940s' led to the setting up of a nucleus of advisory personnel in the Department of Agriculture to promote advisory services to the farming community in Mauritius (Mauree, 1979). This small body later assumed the responsibility of advising the small sugar cane planters and led to the creation of an Extension Service Division within the Department of Agriculture. The clientele of that Division were the small sugar cane planters, the small-scale vegetable growers and the livestock keepers. Since its

creation, the MSIRI has maintained direct contact with the large and miller sugar cane planters, either through an agronomist employed by the miller planters or directly with the large planters themselves. Contact with these two categories of planters were quite regular as the MSIRI depended on their support and close collaboration for the establishment of sugar cane variety trials and for testing and adapting new farming operations. These organizations had evolved over the years. Later, the FSC was set up to cater for advisory activities with the small sugar cane planters. For the non-sugar sector, the Agricultural Research and Extension Unit (AREU) was created to take over the major activities of the Directorate of Agricultural Research and Extension (DARE), which was established in 1994 within the Ministry of Agriculture to facilitate Government's goals of improving the productivity of the farming community and diversifying the production base. AREU was responsible to conduct research in food crops and livestock, and to provide extension services to all farmers in Mauritius, including its outer islands. It functions within the Food and Agricultural Research Council (FARC), a parastatal organization operating under the aegis of the Ministry of Agriculture and Natural Resources.

The following sections describe the organizational set up and functioning of all the institutions concerned with the provision of advisory services and training to sugar cane planters. These institutions are the Farmers Service Corporation (FSC), the Planters Advisory Units attached to some sugar mills and the Extension Department of the MSIRI. Their clientele and the extension approach and methods which they adopt for extension delivery are described. Figure 3.2 has illustrated the current framework of research and extension linkage in Mauritius. Results of research findings are shared with all the producer categories.

3.3.4.2 The Farmers Service Corporation

It was conceded in the 5-year Strategic Plan of the Sugar Industry (1985) that among the constraints limiting productivity among the small sugar cane planters were inadequate extension facilities and inaccessibility to inputs and services related to sugar cane cultivation. This had prompted the creation of Farmers Service Centres (FSCs) on a pilot project financed by the World Bank (Farmers Service Corporation, 2012). Started in 1986, the project covered four milling areas, Rose Belle and Saint Felix in the South, Solitude in the North and FUEL in the East.

The major objectives were to provide small planters access to information, inputs and services. The pilot project was administered by the Mauritius Sugar Authority and supervised by the Sugar Industry Development Fund. A Project Management Unit was responsible for the management of the FSCs and the training of their staff. The unit employed three technicians from Booker Agricultural International, a firm which engaged in agricultural consultancy assignments and land management contracts in the tropics and subtropics. Most of the staff members were recruited from the Extension Division of the Ministry of Agriculture.

Favourable feedback from the small planters encouraged the government to establish FSCs in other milling areas. In December 1991, the Farmers Service Corporation (FSC) was created as a parastatal body under the aegis of the Ministry of Agriculture and with the following as objectives:

- to set up and manage FSCs; and
- to devise and implement schemes and programmes aimed at enhancing the productivity and efficiency of the sugar cane planters.

The aim of the FSC was to modernize the small planter sector by providing them with necessary guidance and services that would ultimately improve their efficiency and productivity. This study provides some clues on how this has been achieved.

- Clientele and major functions of the Farmers Service Corporation

Until recently, that is prior to the setting up of the MCIA, the clientele of FSC included all the small sugar cane planters. Table 3.1 shows their distribution across each FSC and milling area, their number and total area occupied. Each FSC is in contact with some 2500 small planters and with a field staff of around four officers; the ratio of officer to planter stands at 1:600.

Table 3.2: Distribution of small sugar cane planters across FSC and milling areas

Farmers Service Centre	Milling area	Ex-milling areas (prior to centralization)	No. of planters	Total area occupied in 2012 (hectares)
Solitude	Terragri Ltd	Belle Vue, Mount, Beau Plan and Solitude	4309	3361
Riviere du Rempart		Mon Loisir and Saint Antoine		
L'Unité	Alteo (FUEL)	Constance	7553	6 119
Saint Pierre		Mon Désert Alma		
Beau Champ	Alteo (Beau Champ)	Beau Champ		
Saint Pierre	Médine		378	418
Rose Belle	Omnicane	Rose Belle, Riche en Eau and Mon Trésor	5199	3811
Saint Félix		Savannah, Britannia, Union, Saint Aubin, Saint Félix and Bel Ombre		

(Farmers Service Corporation, 2012)

The major functions of the Farmers Service Corporation include essentially advisory activities and provision of services and inputs. Each Centre is marketed as a one-stop shop for the planters; by coming there, besides being provided with technical advice, the planter also has the opportunity to purchase inputs like fertilizers and herbicides, to make arrangements for tractors to prepare land and to confirm the supply of seed cane for anew plantation. Organizing vocational training for the small planters is a major component in the activities of the FSCs. It can be argued that this activity has not been given due consideration over the past years as the FSC staff have limited resources and were fully engaged in the FORIP project, mentioned in Chapter 2.

Looking at the profile of the officers responsible of the FSCs (Farmers Service Corporation, 2012), some questions may arise as to what degree of importance is given to training for performing extension activities and working with adult farmers. This issue was also clearly identified during an extension workshop (focus group discussions) organized in Mauritius in 2011. The workshop report (unpublished) mentions *"…of greater concern was that almost none of the extensionists have any formal training in agricultural extension. Some have studied*

extension in post-graduate situations, but such training is rarely practically based in terms of a basic skill set in farmer engagement. This manifested itself most strikingly in the session to create visions for improving extension. The participants – farmers, researchers and extensionists – battled equally with basic extension concepts. --- it was one of the most valuable lessons learned as it highlighted one of the key areas of 'revisiting' extension to meet the needs of small-scale farmers".

The extension approach adopted by the FSCs is essentially a modified training and visit system, based on the concept of model farmers. At this stage, it cannot be said what has been its outcome, as no proper evaluation or assessment of the activities of the FSCs have been reported. The scope of this study does not include an evaluation of the activities of the FSCs, however, any issues coming out of this study and pertaining to their functioning are discussed.

3.3.4.3 The Millers' Advisory Units (or Planters' Advisory Units on sugar mills)

The five sugar mills currently in operation have each established a Planters' Advisory Unit (PAU) to assist small planters in the milling area with a view to maintain/improve their production potential and guarantee a supply of canes for processing. This approach is similar to the Commodity Based Extension, which according to Schulz (1973, in Nagel, 1997, p. 8) is common in many francophone countries in Africa where crops for commercial or export purposes predominate. In Mauritius, the crop concerned is sugar cane. The PAU acts a provider of certain facilities like contractual labour for farm operations, namely land preparation, planting and harvesting. It also proposes to planters a form of contractual management, where in agreement with the planter and against payment, the whole management of the farm is catered by the PAU. The contribution of the PAUs in improving small planters' productivity is yet to be assessed, but it can be argued that in facilitating access to certain services and inputs, they have an important role to play.

3.3.5 Technology transfer at the MSIRI

It is acknowledged that sugar cane research activities at the MSIRI would have no value if the results are not made known to and adopted by the planting community (Julien, 1996). It is believed that the promotion of sound agronomic practices developed by research and their adoption by the planters will enable them to achieve competitiveness and sustainability. It is also recognized that effective research-extension-farmer linkages to enable the development of appropriate technologies are critical in order to attain this objective. Targeted interventions towards the different planter categories are privileged, with emphasis also placed on the use of the modern techniques in Information Technology.

Since its creation in 1953, the MSIRI has maintained very close links with the millers and large commercial planters as it depended on them for resources and facilities to be able to implement its research programme. An Agronomist appointed by each miller planter has been the link or the contact person between the MSIRI and the miller and some large planters. In the 1970's, the MSIRI appointed a Liaison Officer to reinforce that link. At the same time there was a perception that the small planting community was being neglected by research and that all the fruits of the research were directed to and consumed by the large commercial planters. That perception was felt to be unwarranted as it was argued that the small planters were also benefitting from the research findings, from new varieties and improved field practices, for example. Even though it was felt that the perception was unwarranted, the MSIRI addressed the issue by setting up an Extension Division to be able to respond to the requests from the small planting community. It is to be stressed that the MSIRI was given the mandate for technology transfer to the miller-, corporate, large- and medium-planters, while extension support to the small planters was maintained at the level of the Ministry of Agriculture, through its Extension Division and later through the FSCs. As a result of persistent requests from representatives of small planters that the MSIRI should service the small planters directly, the MSIRI Board approved the setting up of a Small Planters' Desk in the premises of the Institute in 1996, together with a Soil Analysis Service, which was offered free-of-charge to the small planters. The Small Planters' Desk was in operation until 2012 and after that, with the creation

of the MCIA, all activities pertaining to extension support for non-miller planters were confined to the FSCs.

During its operation, the Extension arm of the MSIRI has been very much involved in implementing extension activities either directly with the miller, large and medium planters, or through the FSCs and the PAUs with the small planters. These activities, aimed at improving the productivity and competitiveness of all the sugar cane planters, were conducted through:

- provision of information and advice during scheduled field visits;
- establishment of large-scale trials and observation plots with promising sugar cane varieties;
- organization of Small-Planters' Days and conducted tours for planters and FSC officers;
- group discussions, seminars and brainstorming sessions on selected themes;
- use of Information Technology and development of decision-support tools; and
- targeted training to meet specific needs of the planting community.

A multitude of extension approaches was adopted by the MSIRI to execute its extension programme: transfer of technology, farming systems research and extension, farmer participatory research and training. Training of trainers, especially the officers of the FSCs, was achieved to a certain extent during the scheduled meetings organized at the MSIRI. Through the establishment of variety trials, large-scale observation plots of promising varieties and establishment of nurseries to ensure quality seed cane, planters are expected to adopt the best performing varieties to improve TCH and TSH.

Reducing production costs to enable the planters to remain competitive is another expectation of the extension programme. To achieve this, planters are encouraged to adopt cost-cutting strategies and good management practices. Among the practices promoted, are the following: minimum tillage and trash blanketing; rational use of fertilizers based on results of soil analysis;

judicious use of herbicides through adoption of appropriate weed management strategies and judicious use of irrigation water.

Specifically for the small planters, the MSIRI has conducted various socio-economic studies; the most recent one, the FIRCOP project, has opened avenues on the immediate concerns and needs of the small planters. The outcome of this project has also been instrumental in formulating the present study.

Special efforts have been devoted to assist the small-planters in the regrouping project (FORIP) and to develop group activities that will enable them to be more competitive and to benefit from economies of scale.

3.4 Toward an appropriate Extension and Research and Development approach for Mauritius small planters

The preceding section outlines the current situation prevailing in Mauritius. It indicates that the dominant extension approach for all cane planters is linear technology transfer, where the planters are largely removed from the R&D process. Their needs are assessed, but the technological answers are developed in their absence and then presented to them on the assumption that these are relevant to the situation of the end-user farmers. In such cases, the corporate planters appear to be more directly involved and engaged in line with the advisory approach. They are clearer about what they need to know and appear to have more immediate capacity (both personally and institutionally) to engage with the overall process.

The approach which appears to be shaped around the corporate planters is automatically applied to all planters – including the small planters. The theoretical framework presented in this study raises the question of the appropriateness of the current approach when applied to the small planters. Given the persistent productivity gap between small and large planters, it suggests that an amended approach is required.

Such an amended approach would have the following characteristics:

- Sugar cane planters being fully engaged in the research process as real partners who contribute in further strengthening the research-extension-planters linkages;

- The planters, corporate and non-corporate, are seen operating in full partnership with the extension organizations, thus giving a new dimension to their involvement in all the stages of the research process. There are fundamental differences when compared to the current process;

- Planters are not expected to be passive recipients of technologies developed by researchers, where their role is merely to express their needs when requested and remain dependent on others to develop solutions. Instead, they are involved, as partners in the whole process, in more crucial issues like identification of knowledge gaps and farm business opportunities rather than needs (technical) only;

- Extension and research are also engaged with the planters in learning; the learning process is defined as a process by which people and organizations create knowledge and acquire capabilities (Dodgson, 1993 in Ekboir, 2009).

It is accepted that the planters have been in the sugar cane business for years and they have undoubtedly acquired vast amounts of experience and knowledge which are not being currently exploited. They should no longer be considered as end-users of technology, but, should be seen to be at the same level as research and extension as 'developers' of production and farm business solutions, as mentioned in the basic framework for research and extension (Figure 3.3).

According to Peterson et al (2001, in Al-Rimawi, Tabieh, & Al-Qudah, 2013), interdependence and linkages between major institutional actors in an Agricultural Research and Extension System (ARES) are widely recognized as essential for an effective flow of technology and information between research, extension and the farmer. Extension is expected to have a broader vision of agriculture and should be no longer simply a channel for passing information,

but the role of extension includes those of consultants and facilitators for collective action and conduits of information flows (Alex, Zijp & Byerlee, 2002 in Ekboir, 2009).

Over and above production solutions, the research process is also expected to propose farm business solutions. To be able to address new challenges (Sulaiman, Hall & Raina, 2006), extension is required to play a wider role with a diversity of objectives, amongst which include linking farmers more effectively and responsively to markets; enhancing crop diversification; coupling technology transfer with other marketing services; improving livelihood; capacity building to enhance innovation and empowering farmers for more bargaining power. There are more opportunities for research and here it can be argued that with the general trend of decreasing resources for agricultural research worldwide, this may not be feasible. It is to be pointed out that if the planters can afford certain resources, they will also be doing some experimentation.

An innovation, which should be considered very crucial, is to create space in the research process for engaging the planters in the implementation/execution of certain projects. As it is currently the case in Mauritius, some planters, the corporate mainly, collaborate in this aspect by providing certain resources like lands, labour and inputs. This new process would need to accommodate and enhance farmer-managed innovation. Empowering planters to conduct experimentation is in itself recognition of their capacity/know-how in the sugar cane business. What appears also to be essential is that the research process offers the opportunity to all the planters and their extension partners to constantly interact with each other. This may be considered as another step forward in consolidating/improving relationships between large commercial and small scale sugar cane planters in Mauritius.

3.5 Summary

This literature review on research and extension provided clarity on the fact that business can no longer go on as usual. Research specialists can no longer claim that they alone can come up with solutions to the persisting problems that small scale sugar cane planters are facing.

Extension agents, instead of proposing ‘technical solutions’ received from research specialists and the impact of which they are hardly aware personally, need to accept that their clientele may be expecting something different. If their ultimate goals is to improve livelihood, both research and extension, need to engage the planters in the whole process of developing production and farm business solutions.

Chapter 4

Methodology

This chapter describes the two methods used to collect primary data for this study: focus group discussions and survey by questionnaire. It discusses the literature used to plan the research; the selection of research participants; the planning of focus group discussions; the design and testing of the questionnaire for the study; the design of the database for entry of data collected during the study; and finally the choice of the statistical package for processing and analysis of the data collected.

4.1 Theoretical Framework of the Research Design

This study was conducted using a qualitative research approach. Qualitative research is used when the aim of the study is to investigate whole processes and systems and to trace nuances and diversity of perspectives within the interlacing systems. In this instance, there is a long history of interaction between researchers, extension agents and planters, largely driven through institutional processes, policies and priorities. It was important to explore the nature of the relationships involved and the factors that influence those relationships from the perspective of the small planters, and, within that, from the variety of circumstances they represent (Hale & Astolfi, 2007).

As outlined by Hale and Astolfi (2007), modified analytic induction is appropriate to this study because it makes it possible to investigate many permutations of the situation being examined. It also allows for a certain amount of flexibility – using effective and iterative processes – that allow the researcher to revise both research questions and the understanding of the situation until the researcher "arrives at a suitable comprehensive, descriptively rich narrative" (Hale & Astolfi, 2007: 203). In keeping with the case study approach, results are communicated largely as a rich narrative based on qualitative statistics.

In this context, the study falls into two general research methods: Case study and Phenomenological Research. The case study is relevant because the Mauritian sugar cane industry is clearly definable, with specific institutions, processes and organization – including the small cane planters. Within the case study paradigm, interpretational analysis and reflective analysis were employed. The former was used to identify patterns and commonalities within the data. The latter was relevant because the researcher is highly qualified in the subject area and would be able to study the situation/phenomenon from an experienced perspective.

The case study approach is particularly relevant to agricultural extension. According to Leité and Marks (2005: 57) this approach is suitable because it reflects the reality of extension and "*takes place in real settings, requires an interdisciplinary approach, and calls for a properly portrayed context in order to allow the readers to make connections between the study and their own… experience*". Furthermore, it makes it possible to develop "a rich, deep, vigorous and complete description, that clearly illustrates the complexity of the case under study" (Leité & Marks, 2005: 58, citing Merriam, 1998).

The phenomenological approach was relevant to this study because it was important to try to understand the productivity issue from the point of view of the small planters and to establish the reality of the situation, as constructed by those who are meant to be the principal benefactors of research and extension. Although as will be seen, structured rather than semi-structured interviews were used and the resulting data was statistical, the data nonetheless provided descriptive perspectives of how the reality of the research and extension process is constructed by the small planters. It is also relevant because of the typical way in which phenomenological studies are communicated, i.e. "*through detailed narratives exploring themes and patterns which emerged from data analysis and reduction"* (Hale & Astolfi, 2007: 207)

4.2 Planning of the focus group discussions

To initiate the exploration for this study, focus group discussions were organised in the form of an Extension Workshop. More than 80 participants, comprising research specialists, extension officers and representatives of farmers' organizations and other service providing institutions explored current extension practices in Mauritius. The objective set was to gain insight into and to understand the perceptions concerning the extension and research and development approaches used particularly in the context of improving productivity.

As argued by Kitzinger (1995: 299) "Focus groups are a form of group interview that capitalises on communication between research participants in order to generate data…" This method is useful when a researcher wants to understand what, how and why the participants think about the issue under focus. Mwaijande et al., 2009: 60) found that focus group research is "particularly well-suited for investigating stakeholders' perceptions of specific agriculture-related problems or challenges in developing regions" which is the case in this study. Focus group discussions facilitate in-depth insight which is less easily obtained through individual interviews (Kiztinger, 1995; Mwaijande et al. 2009) and it is the dynamic of the group – the discussions, debates, bantering – that is the key to generating the depth and richness of the resulting data and is the primary reason for using the method (Smithson, 2009; Wilkinson, 2004). Wilkinson (2004:180) argues further that, perhaps counter-intuitively, rather than creating inhibitions around sensitive topics, focus groups actually create an environment that fosters "disclosure" that might not be forthcoming in an individual interview.

While the data from the focus groups discussions were reported as part of the primary research conducted in this study, they had another fundamental two-fold role. First, focus group research was used in this study because its findings were useful to inform the design of quantitative aspect of the study (Smithson 2009: 105 citing Vaughn et al. 1996). Second, the data were used in the process of interpreting, triangulating and/or confirming the findings of the questionnaire survey. As posited by Wolff et. al. (1991:133) focus group research can complement quantitative methods (e.g. questionnaires) because they provide "asymmetrical

but independent observations…that strengthen the ability to draw conclusions"

There are a number of limitations to focus group research. Three limitations potentially relevant to this study are: the tendency for participants to say what they think they are expected to say; the potential for a dominant voice(s) within the group skewing the 'group' view; and possible excessive influence on content by the group facilitator (Kidd & Parshall, 2000; Smithson, 2009).

To address the tendency for participants to say what they think they are expected to say, the research design acknowledged that it was important to ensure that each of the participants in the eight groups selected for the FGD were able to express their opinions freely during the different sessions. In the introductory session, the objectives of the FGD were clearly defined by the moderator. In the session where the objective was to assess the current situation of extension in Mauritius, each group member was given the opportunity to get more acquainted with the members in the group, by sharing information on his/her: background information (e.g. job titles, agencies); key functions and goals; primary and other clients and the key issues related to these clients; and the key challenges that each group member was facing. From observation by the researchers, this session resulted in creating a climate of trust and confidence among the members in the group and prepared each group member to express his/her opinions freely and also to listen and consider fellow group members' opinions in the sessions that followed.

To address the potential for a dominant voice(s) within the group skewing the 'group' view, before starting the whole process, members in each group were asked to choose democratically among them, a group leader/facilitator. The role/function of the latter was clearly defined and it was ensured that the following were adhered to: each group member should express his/her opinion; each opinion expressed, whether in or out of context should be recorded; any group member tending to be the dominant voice during the group discussions should be 'calmed down'; the leader/facilitator should, in no way, influence any member while

he/she was expressing his/her opinion(s); and the leader/facilitator was requested to be the last one in the group to give his opinion.

The possible potential excessive influence on content by the group facilitator was partly addressed by the process outlined above. It was also managed by the research team who circulated through the discussion groups to observe and provide guidance and direction as needed. Informal conversations were held with randomly selected members of each of the groups to measure the tenor and sense of 'fair play' in the groups. There were no major instances of undue influence detected.

Participants were organized in eight groups and were encouraged to brainstorm and report on three different themes, as described below. In accordance with Mwaijande et al. (2009:60), prior to holding the workshop, the research team developed a "clear, logical questioning route guided by concrete research objectives" which were, of course, the research objectives of the study. The focus group data were not analysed as if they were "naturally occuring discussions", but were analysed with the clear understanding that the discussions took place in a "specific, controlled setting" (Smithson, 2009: 104).

- Assessing the current situation of Extension in Mauritius

The participants in their groups had the opportunity to get more acquainted among themselves by reporting on their background information (e.g. job titles, agencies); their key functions and goals; their clients (primary and others); key issues related to these clients; and key challenges faced by group members.

- Developing a framework and using it to evaluate Extension

The group members were requested to list various extension objectives or goals, to describe what should be implemented to attain these goals and finally how achieving these goals could be measured. They were then requested to vote, in order to prioritize and select the most important extension objectives among those identified.

- Creating a vision for change and proposing practical steps for a way forward

The process of evaluation had enabled the participants to assess achievements in the different extension objectives that were selected. The groups were then assigned to create a vision for change and to determine how relationships between Farmer/Extension; Extension/Research; and Farmer/Research should look in terms of focus; collaboration and related issues. This activity was implemented at two levels; group and plenary.

The data gathered through this process was reviewed through content analysis to identify key issues and themes highlighting the status quo of extension and R&D. The data also provided insights into how extension and R&D processes could be strengthened to the benefit of the small scale planters.

4.2.1 Selecting the participants for the focus group discussions

Participants for the focus group discussions were selected through purposive sampling. The intention was to get as broad a spectrum of participants as possible, while keeping the total number of participants at a practicable size (Ritchie, Lewis & Elam, 2003). As a result of the more formal application of the method in the selection of the survey participants, purposive sampling is discussed in greater detail in the section discussing the survey. For the sake of brevity, it is not included here.

As noted above, 80 participants were invited to participate in the focus group discussions. Four categories of participants were involved: planters; researchers; extension workers; and service provider institutions. Planters were selected through their respective farmer organisations. Participants included both sugar cane and non-sugar cane producers of which there are nine (9) formally registered producer organisations representing approximately 1000 planters. Each farmer organisation was invited to send two representatives. In addition to this, the Mauritius Cooperative Agricultural Federation, which represents approximately 155 Cooperative Credit Societies with a total membership of approximately 9000 planters, was invited to send three

representatives. These organisations were given free latitude to determine who should represent them; the process was not influenced by the research design.

Researchers were invited from the MSIRI and from Agricultural Research and Extension Unit (AREU) – the latter of which provides research and extension in non-sugar agricultural production (including livestock production). The MSIRI was invited to send its five sugar cane production researchers, each of which was requested to bring one research assistant. The AREU was invited to send 12 researchers with the preference that each of the disciplines they work with were represented.

Extension workers were invited from the MSIRI, AREU, FSC and the Planters' Advisory Unit (PAU). Five MSIRI extension officers were selected to represent each of the key agro-climatic zones. Twelve (12) were invited from the FSC and seven (7) from the PAU. The seven service providing institutions were invited to send one representative each. Ultimately there were 65 participants in the focus group discussions. Table 4.1 provides the details of the range and numbers of participants from each participant base.

Table 4.1 Participant base for the focus group discussions

Participant base	Invited	Actually participated
Planters	20	16
MISIR Research	10	10
AREU Research	12	12
MSIRI Extension	5	5
AREU Extension	7	7
FSC Extension	12	8
PAU Extension	7	3
Service provider institutions	7	4
Total	80	65

4.2.2 Data analysis from the focus group discussions

The focus group discussions were designed and conducted with the assistance of the research supervisor. The results of these discussions were jointly reviewed with the aim of capturing key issues relevant to the extension/farmer, extension/research, and farmer/research relationships. The data was examined using spiral content analysis in which ideas are gradually grouped into coherent themes (Leedy & Ormrod, 2005).

4.3 Planning the questionnaire survey

The survey comprised the largest and most complex part of the study. This section presents the details relevant to planning the survey and handling the resulting data.

4.3.1 Criteria and parameters considered to establish the population sample for the survey

Given the diversity of characteristics prevailing among the small planter community in Mauritius, it was important that this diversity was reflected in the sample population. Therefore, non-probability sampling was used in which "units are deliberately selected to reflect particular features of or groups within the sampled population" (Ritchie, Lewis & Elam, 2003, p. 78). Within this framework, purposive sampling was used because it allowed the research to reflect the known variations in the population from which the sample would be chosen. It was intended that the study should understand the productivity issue filtered through specific criteria, but at the same time ensure that the known diversity is not lost to the study and that the influence of a given characteristic or factor can be observed (Ritchie, Lewis & Elam, 2003).

This approach facilitated the necessary 'detailed exploration and understanding' of the various facets of the research and extension dynamic affecting technology and other choices among small planters that are likely to affect productivity (Ritchie, Lewis & Elam, 2003). The particular sampling method used was a combination of heterogeneous sampling and stratified purposive

sampling. The former was used to maximize variation in the sample – that is to ensure that the widest possible permutations of factors were captured in the sample. Stratified purposive sampling was used because it was known that there is a fair degree of homogeneity – particularly around land sizes and economic status – and the study needed to be able to study sub-groups (Ritchie, Lewis & Elam, 2003).

In using purposive sampling there is always a concern about possible bias. In this instance, the selected criteria were based on previous studies of the small cane planters in Mauritius, which provided solid data about the kinds of characteristics that were prevalent amongst the population. An initial range of seven criteria was drafted. These, together with the proposed parameters, are summarized in Table 4.2 and are briefly discussed below.

Table 4.2: Proposed criteria and parameters to establish population sample

Criteria	Parameters
Sugar productivity	Equal to potential TSH, Just below potential, Very below potential
Milling area	Belle Vue, FUEL, Omnicane
Gender	Male; Female
Farm size	0.1 < 1 ha; 1 < 2 ha; 2 < 5 ha; 5 <= 10 ha
Biomass	Cane yield (TCH)
Age	< 20; 20 < 40; 40 < 60; >=60
Land suitability	Highly suitable; Moderately suitable; Marginally suitable

4.3.1.1 Sugar productivity (TSH) and biomass (TCH)

Sugar productivity is described here as the average annual sugar yield per hectare (TSH) of a planter and biomass as the cane yield per hectare (TCH). The potential TSH is the sugar yield that a planter can expect if all the conditions are favourable to cane growth and development. During discussions with the supervisor, it was pointed out that official figures available at the Sugar Insurance Fund Board do not necessarily reflect the exact cane or sugar yield of a particular field in a region, especially if a planter is exploiting several fields in the region or in different regions. The planter could have also kept part of his field for seed cane and not all the

canes in that field are sent to the mills. Hence these criteria were not considered in the sampling exercise.

4.3.1.2 Milling area

The development of sugar cane clusters discussed in section 2.1 will inevitably result in only four milling areas continuing to operate. For this study, three main milling areas were considered for establishing the population sample, namely Belle Vue sugar mill in the northern part of Mauritius, Flacq United Estates Limited (FUEL) in the central/eastern part and Omnicane in the southern part. These three milling areas were selected because they comprise the largest number of planters and they encompass a wide variety of agro-climatic conditions (major soil groups, the three major agro-climatic regions: subhumid, humid and superhumid). The fourth one, Médine Sugar Estate was not considered, due to its insignificant number of small planters and also in terms of agro-climatic conditions, it compares well to Belle Vue sugar mill. Milling area was retained as criteria for the sampling exercise. The milling areas selected are described in Boxes 1, 2 and 3.

Box 1: Belle Vue milling area

Belle Vue milling area, today known as Terra Milling Ltd, is located in the North of Mauritius. It is best known for its production of specialty sugars and is regarded as one of the most modern sugar factories in Mauritius, with a processing capacity of some 330 tonnes of cane per hour. Annually the mill processes some 725,000 tonnes of sugar cane and has the capacity to crush some 850,000 tonnes. Sugar production, presently around 77,500 tonnes, may reach some 90,000 tonnes of mostly specialty sugars for the international market. Terra has diversified its activities over the years, from an essentially sugar-oriented company to one with interests in energy and alcohol production, amongst others..

Box 2: Flacq United Estates Limited (FUEL)

Flacq United Estates Limited (FUEL), a public company incorporated is the largest sugar estate in Mauritius. It is located in the eastern part of Mauritius. The group sugar factories, FUEL Sugar Milling Company Limited (FSMC) and Compagnie Usinière de Mon Loisir Ltée (CUML) together mill some 1300000 tons of sugar cane annually to produce in excess of 125000 tonnes of sugar.

FUEL Steam and Power Company Limited and Compagnie Usinière de Mon Loisir Ltée jointly exports 210 Giga Watt hours of electricity to the national grid annually. FUEL Refinery Limited started operations in December 2009 and is expected to produce 175000 tonnes of refined sugar annually.

Box 3: Omnicane milling area

Omnicane was launched in July 2009 through a strategic re-branding of Mon-Trésor-Mon-Désert Ltd, a long established sugar cane group in Mauritius which origins can be traced back to the 1850s. Its agricultural activities are centered in the South of Mauritius although Omnicane owns lands in the Central part also. With the closure of five factories in the South of Mauritius; namely Rose Belle, Riche en Eau, Mon Trésor, Britannia and Saint Félix, their operations were centralized on two units owned by Omnicane Milling Operations Ltd. These include a flexi factory (described in Chapter 2) with a crushing capacity of 8,000 metric tonnes of cane per day and the only diffuser in operation in the island. It produces around 150,000 tonnes of refined or direct consumption sugar annually for the European market. The other unit is Omnicane Thermal Energy Operations (Saint Aubin) Limited and together with Omnicane Thermal Energy Operations (La Baraque) Limited, these two units contribute to about 28 % of exported electricity to the national grid, equivalent to about 740 210 Giga Watts hour (Omnicane Ltd, 2009).

Table 4.3 summarizes the main characteristics of these three milling areas. It also shows the number of small planters and their total area harvested for each of these milling areas.

Table 4.3: Characteristics of the three milling areas selected for the study

Milling area	Climate	Major soil types	Tonnes cane crushed annually	No. of small planters	Area cultivated by small planters
Belle Vue	Subhumid to humid	L, H, P	850000	4309	3361
FUEL	Humid to superhumid	L, H, F, P, B	1300000	7533	6119
Omnicane	Humid to superhumid	L, H, F, P, B	1250000	5199	3811

Source: compiled from MSIRI Annual Report (2010); Annual Report Mauritius Chamber of Agriculture (2012).
Note: The different soil types are described in Box 4.

Box 4: Description of major soil types

L – Low Humic Latosols:

They occur in zones receiving 800 mm to 2750 mm rainfall per year. They are deep to moderately deep, with good drainage, fairly high base and with low organic matter content. Occupied 23.5% of the total cane area in 2009.

H – Humic Latosols:

They occur in the humid and superhumid zones with a mean annual rainfall ranging from 1500 mm to 3750 mm.. They are dark brown to reddish brown silty clays and clays with a weak profile differentiation, with lower base and higher organic matter compared to L. Occupied 8.7% of the total cane area in 2009.

F – Humic Ferruginous Latosols:

They are the strongly weathered soils occurring in regions which receive between 2500 mm to over 5000 mm rainfall annually. Occupied 11.1% of the total cane area in 2009.

P - Latosolic Reddish Prairie:

They occur in the dry areas (same rainfall zone as the Low Humic Latosols) but are also slightly acid to neutral in reaction. They are quite rocky and rich in organic matter. Occupied 26.2% of the total cane area in 2009.

B - Latosolic Brown Forest:

They have been formed in the super-humid area where Humic Ferrigunous Latosols are also present. They are moderately to strongly weathered soils, acid to strongly acid and high in organic matter. Occupy 16.5% of the island. Occupied 18.3% of the total cane area in 2009.

(Parish & Feillafé, 1965; MSIRI Land Index database, 2010)

4.3.1.3 Farm size

As mentioned in Chapter 2 (Table 2.5), the SIFB database provides good insight into the distribution of the small planters and their farm sizes. The database shows that 79,1% of small farmers own up to one hectare, 13% own land between one and two hectares, 6,7% own between two and five hectares of land, with the remaining 1,2% own between five and ten hectares. Farm size was considered as a criterion for the sampling exercise. Thus the parameters were confirmed as presented in Table 4.1.

4.3.1.4 Land suitability

Land suitability is defined by Arlidge and Wong You Cheong (1975, p. 9) as the "*fitness of a given tract of land for a defined purpose. Differences in the degree of suitability are determined by the relationship, actual or anticipated, between benefits and required inputs associated with the use on the land in question*". Land suitability is classified in three categories: Suitable, Conditionally Suitable and Not Suitable. The category 'Suitable' refers mostly to agricultural lands and comprises three sub-categories: Highly suitable (S1); Moderately suitable (S2) and

Marginally suitable (S3). According to the same authors, S1 lands have no significant limitations that will reduce production levels; S2 lands have limitations that may impact on production levels and S3 lands have severe limitations that result in marginal production levels. Sugar cane and some other important crops like potato are cultivated on the Suitable lands. In absence of data on productivity, both in terms of TSH and TCH, land suitability was retained as a criterion for the sampling exercise.

4.3.2 Criteria and parameters selected for the survey

Based on the iterative process described above, the criteria and parameters selected for the sampling exercise were reduced from seven to three viable criteria. They were finalized as follows: Milling area; Farm size; and Land suitability. Table 4.4 captures the criteria in a framework used to determine the sampling.

Table 4.4: Criteria and parameters selected for the study

Milling area		Belle Vue			FUEL			Omnicane		
Suitability		High S1	Moderate S2	Marginal S3	High S1	Moderate S2	Marginal S3	High S1	Moderate S2	Marginal S3
Farm size	≤ 1									
	> 1 ≤ 2									
	> 2 ≤ 5									
	> 5 ≤ 10									

This framework resulted in a total of 36 combinations of criteria. The first permutation is based on milling area; this is followed by farm size, the number of planters varies within each farm size group, the (≤ 1) and (> 1 ≤ 2) groups with the highest number of planters and the (> 5 ≤ 10) group with the lowest number of planters; and then within these two criteria, soil suitability is factored in. The combinations are as follows:

Belle Vue – 12 (S1, ≤ 1 ha; S1, > 1 ≤ 2 ha; S1, > 2 ≤ 5; S1, > 5 ≤ 10; S2…….)
FUEL – 12 (S1, ≤ 1 ha, …….); and
Omnicane – 12 (S1, ≤ 1 ha, …….).

4.3.3 Determining the sample size

No minimum or maximum sample size was set; the design adhered as closely as possible to the intent of the concept of saturation, where more data collected during a qualitative research survey does not necessarily lead to more information (Mason, 2010). This also supports the reasoning that to enable judicious use of resources, labour, time and funds mainly, it is more appropriate to work with a realistic and practical sample. The concept is clearly articulated by Mason (2010:2):

> *"Qualitative samples must be large enough to assure that most or all of the perceptions that might be important are uncovered, but at the same time if the sample is too large data becomes repetitive and, eventually, superfluous. If a researcher remains faithful to the principles of qualitative research, sample size in the majority of qualitative studies should generally follow the concept of saturation (e.g. GLASER & STRAUSS, 1967)—when the collection of new data does not shed any further light on the issue under investigation".*

Within this framework, subsequently, to ensure capturing the full spectrum of permutations and variations (and the views that would come from them), at least two planters within each of the combination of the (> 5 ≤ 10) farm size group were interviewed for the study; with the number of planters gradually increasing in the other farm size groups to reach a maximum of nine planters in each of the combinations of the (≤ 1) group. Finally, in the 36 combinations, the provisional total number of planters sampled for the study is as shown in Table 4.5. Overall, the sample population comprised 189 small planters with equal numbers (63) from each milling area.

Table 4.5: Number of planters sampled per factory area

Milling area		Belle Vue			FUEL			Omnicane			
Suitability		High S1	Moderate S2	Marginal S3	High S1	Moderate S2	Marginal S3	High S1	Moderate S2	Marginal S3	Total
Farm size	≤ 1	9	9	9	9	9	9	9	9	9	81
	> 1 ≤ 2	6	6	6	6	6	6	6	6	6	54
	> 2 ≤ 5	4	4	4	4	4	4	4	4	4	36
	> 5 ≤ 10	2	2	2	2	2	2	2	2	2	18
	Totals	21	21	21	21	21	21	21	21	21	189
		63			63			63			

The list of the planters who were interviewed in each milling area, including their names, residential addresses and telephone numbers, are included in Appendix 3.

4.3.4 Development of the questionnaire

The aim of the questionnaire was to collect enough information among the sample population of the small planters to be able to answer the following interrogations:

- Experience in sugar cane farming;
- Main reasons for growing sugar cane;
- Is planter conscious of his/her contribution to the Mauritian economy;
- Purposes for which sugar cane is cultivated in Mauritius;
- Planter's contribution towards these purposes;
- Access to and affordability of information required for sugar cane cultivation;
- Planter's capacity to organize his farming operations;
- Implementation of farming operations – easy or difficult and major constraints;
- Production issues – capability to achieve production potential;
- Use of on-the-shelf new research findings, inputs, existing infrastructures/ institutions and credit facilities (source of information, access, financing and effectiveness);

- Planter's awareness of the main products of sugar cane and his/her opinion on their marketing;
- Contribution of income from sugar cane to planter's household income; and
- Planter's reliance on income from sugar cane

4.3.4.1 Pre-testing of the questionnaire

An eight-page questionnaire was finally developed and most of the questions were left open-ended to be able to record a maximum and a variety of responses. Following the principles outlined by Bowden (2002) the pre-testing of the questionnaire was undertaken by three FSC officers, four MSIRI Extension Officers and five small sugar cane planters. A valuable suggestion made during the pre-testing exercise was to devise a 'creole' (local dialect) version of the questionnaire in order to avoid misinterpretation of the questions during the interview with planters. A copy of the final questionnaire (English version) and the Consent form for the planter's interview are included in Appendices 1 and 2.

4.3.4.2 Assistance for the interviews of planters

Initially it was not planned to have assistance from other colleagues at the MSIRI and the FSCs for the purpose of interviewing the planters. However, with the MCIA coming into operation (as mentioned in Chapter 3), which resulted in the downsizing of the personnel at the MSIRI and the FSC who were solely responsible for extension with non-corporate planters, it would have been very difficult to pursue the study without the support of some colleagues at the FSC. In this context, they were provided with training on how to conduct the interviews (including practice) and also to better understand the aim of the study.

4.3.5 Design of a database to capture the information collected from planters' interviews

Data capture for the analytical processes was effected in a database developed through MS Access 2007; a popular Relational Database Management System. The database comprises ten distinct tables, as shown in Figure 4.1.

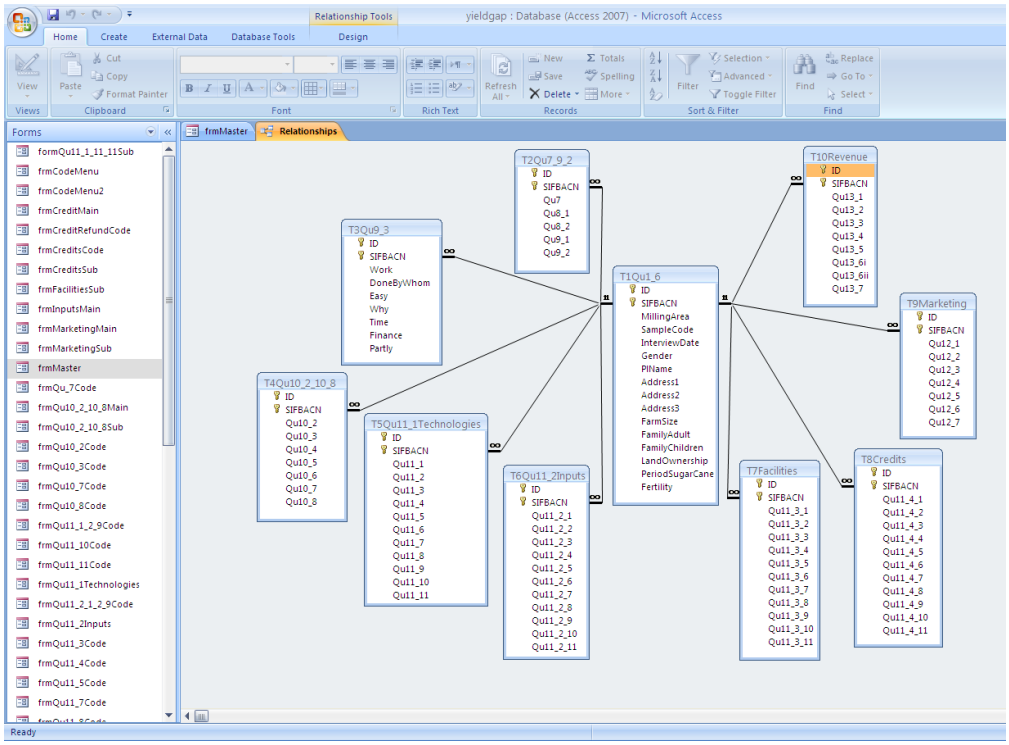


Figure 4.1: Database structure for data capture

Table T1Qu1_6 (Figure 4.2) is the central table to which all other tables are linked. It is structured to capture basic information on the planters interviewed in the sample population. It also includes information on the fertility status of the sugar cane fields of the respondents (Questions 1 to 6 and 10.1).

T1Qu1_6

Field Name	Data Type	Description
ID	AutoNumber	
SIFBACN	Text	SIFB Account Number of planter
MillingArea	Text	Factory area; display as combo box with 3 options
SampleCode	Text	Field potential code; display as combo box
InterviewDate	Date/Time	Medium date;dd-mm-yy
Gender	Text	Male or female; combo box
PlName	Text	Planter name
Address1	Text	
Address2	Text	
Address3	Text	
FarmSize	Number	Field size in arpent
FamilyAdult	Number	
FamilyChildren	Number	
LandOwnership	Text	Combo box; Self,Family or Leased
PeriodSugarCane	Text	Combo box;2 cols based on categories <5, 6-10 etc...
Fertility	Text	Qu 10.1; combo box

Figure 4.2: Description of Table1Qu1_6

As shown in Table 4.6, the remaining nine tables are structured as follows to capture other specific data from the survey questionnaire.

Table 4.6: Description of other tables in the database

Table	Data from survey questionnaire
T2Qu7_9_2	Questions 7, 8.1, 8.2, 9.1 and 9.2
T3Qu9_3	Question 9.3
T4Qu10_2_10_8	Questions 10.2, 10.3, 10.4, 10.5, 10.6, 10.7 and 10.8
T5Qu11_1Technologies	Different sections of question 11.1 related to technologies
T6Qu11_2Inputs	Different sections of question 11.2 related to inputs
T7Facilities	Different sections of question 11.3 related to facilities
T8Credits	Different sections of question 11.4 related to credits and other loan schemes
T9Marketing	Different sections of question 12 related to marketing of produce
T10Income	Different sections of question 13 related to incomes derived from produce

The questionnaire was finally reconstructed in a digital format by linking all tables through the Sugar Insurance Fund Board Account number of the planter (field SIFBACN in the database). Each open ended question was also accompanied with a digital code book with the possibility to add new responses. This facilitated the keying in of all the data in the database.

The end user interface consisted of 10 screens to allow entries related to each table in the database. An example of one screen is illustrated in Figure 4.3.

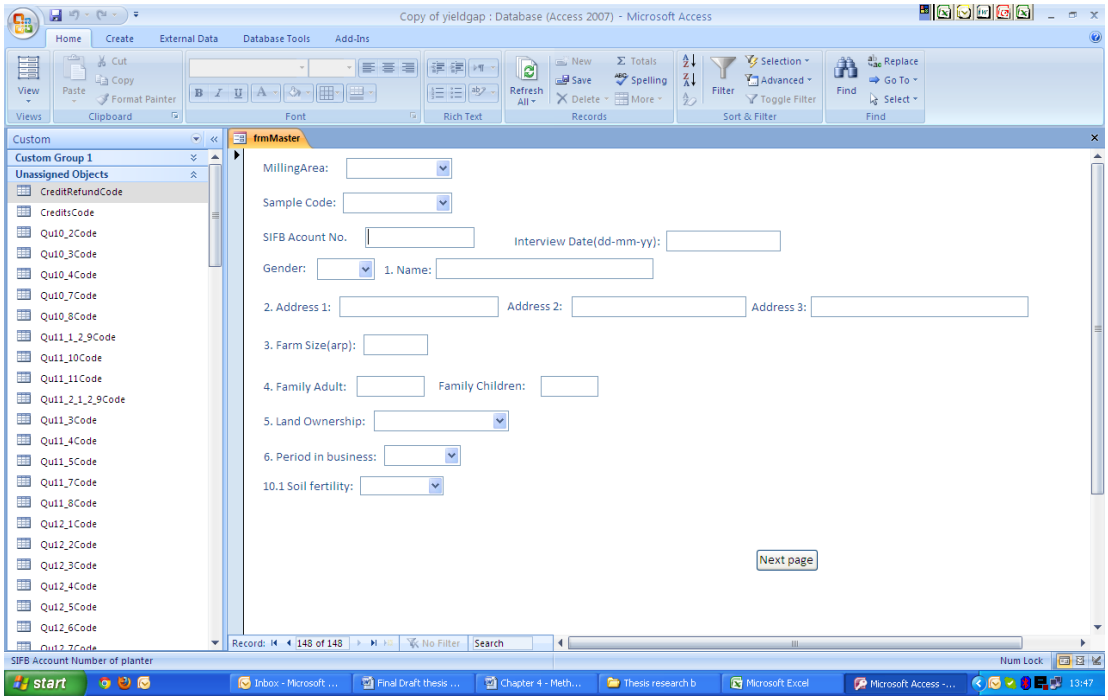


Figure 4.3: Screen 1 for data entry for Table1Qu1_6

4.3.6 Data analysis

The data were analyzed using SPSS (Statistical Product and Service Solutions). SPSS is a well established statistical and data analysis program with a range of facilities for data manipulation. The many features of SPSS Statistics are accessible via pull-down menus or can be programmed with a proprietary 4GL command syntax language. Command syntax programming has the benefits of reproducibility, simplifying repetitive tasks, and handling complex data manipulations and analyses (Saunders, 2009). SPSS enables analyses based on different frequencies and correlations of the different variables like milling area, gender, farm size and planter's experience in sugar cane cultivation. It is a powerful tool as it can perform many combinations and various permutations. A few queries were also performed using Microsoft Access and Microsoft Excel. The results are illustrated in Appendix IV.

Chapter 5

Research findings

The research findings are presented in two main sections and include those of the focus group discussions and the survey.

5.1 Findings of the focus group discussions

The objective of the focus group discussions was to explore the Farmer-Extension; Extension-Research; and Farmer-Research relationship in terms of focus (communication and research); collaboration; and related issues. As explained in Chapter 4 (Section 4.2.1), 65 planters, extension workers, researchers and other service providers participated in the focus group discussions. They were organised into eight groups of roughly homogenous members. The composition of the eight focus groups is captured in Appendix 5.

The focus groups were asked to discuss three main themes: Assessing the current situation of extension in Mauritius; Developing and applying a framework to evaluate Extension; and Creating a vision for change and proposing practical steps for a way forward. From this input, relationships among Extension, Research and Farmers were determined in terms of the *status quo* and the 'ideal'.

As a starting point, each group was asked to identify: the key functions and goals of the grouping they represented; the primary clients; the key issues related to these clients; other clients; and key challenges faced by the group members (see in Appendix 5).

This first session was then followed by three additional sessions, each one exploring in turn the three main themes listed above. The data for each of these sessions were as recorded by the groups themselves on pre-set data capturing sheets. The sections that follow summarise the findings of the focus group discussions following the plenary validation process outlined in

Chapter 4. Details of the findings for each focus group on each theme are captured in Appendices 6 - 8.

5.1.1 Assessing the current situation of extension in Mauritius

In their task of assessing the current situation of extension in Mauritius, the eight groups identified their primary and secondary clients (see Appendix 5). The primary clients are essentially the planters (corporate and non-corporate) in the sugar cane sector and the food crop growers and livestock keepers in the non-cane sector, the policy-makers, the service providing institutions, and the consumers. For these clients, the groups also identified some key issues that have a bearing on the functioning of extension: an ageing farming community, operating on a part-time basis with limited resources, and who is reluctant to change; increasing production costs and decreasing farm income; new marketing challenges; climate change; pest and disease management; low adoption of new technology and improved farm practices; and poor policy or 'imposed' decisions.

The secondary clients identified by the groups are the unemployed retrenched workers, new farmers (ex-sugar cane or ex-tea planters) coming into business, private and unskilled contractors, and marketing agencies and input suppliers. The key issues related to these clients identified by the groups included their limited knowledge and skills, farming on a part-time basis, and limited resources.

Finally in that session, the participants highlighted some key challenges that need to be addressed. These were an urgent need to improve profitability and sustainability, low adoption rate of new technology and improved farming practices, land abandonment, dealing with a clientele operating mostly on a part-time basis, and some administrative bottlenecks.

5.1.2 Developing and applying a framework to evaluate Extension

In an attempt to develop a framework for evaluating extension in Mauritius, the group members were requested to list various extension objectives or goals, to describe what should be implemented to attain these goals, and how achieving these goals could be measured (see Appendix 6). Each group listed at least two extension goals. Ultimately, 25 goals were discussed, among which were: producing crops for higher productivity and better quality, promoting integrated pest and disease management; successful dissemination of information on new technologies and improved farm practices through more effective methods of extension, such as group meetings, field demonstrations and training of farmers; and capacity building. For each goal, the group members brainstormed on the possible activities that should be implemented to achieve these goals. Among the activities listed were: 'traditional' extension activities like home and field visits to farmers, conducting group meetings on specific themes, and field demonstrations; and 'more modern' activities like establishing model farms and benchmarks, capacity building, and farmer-oriented research.

For the different activities listed, the group members also proposed some means on how to measure the achievement of these goals. The most cited means were the rate of adoption, the number of farmers who acquired new knowledge and skills, and improvement in productivity.
From among the extension goals identified in session 2, the groups prioritised the following five goals: Group formation; Participatory Research; Promotion of IPDM; Crop Productivity; and Clean Milk Production[1].

For each of these goals, the groups established specific key assessment indicators. Using these indicators, the groups made broad evaluations of each of the goals. The goals, indicators and evaluations are set out below.

- Group formation (bringing a group of farmers to work together for one or more activities): The specific indicators for group formation were the percentage farmers

[1] This specific goal was set by the livestock group. Although it is outside the intended scope of the exercise, it is included here as an accurate reflection of the data generated by the FGDs.

performing one or more activities together, and how effective extension has been at fostering this. The groups determined that collective action among farmers is generally low. The effectiveness of extension in this was found to vary from low for sugar cane, to moderate for non-sugar cane. Two groups pointed out that extension was successful in bringing some sugar cane planters together to benefit from the Field Operations and Regrouping and Irrigation Project (FORIP).

- Participatory research / Sharing among farmers (recognition of farmers' know how and capacity and encourage them to participate in research and to share resources among themselves): The key indicators for this extension goal were the percentage of acceptance of good practices by other farmers; the extent of trust and recognition of farmers' know-how; the level of farmers' participation in research and the methods used to enhance their participation; and the number of farmers sharing resources. The effectiveness of extension was found to vary from low to quite good. The extent of trust and recognition of farmer's know-how was more pronounced in the non-sugar sector. Farmers' participation in sugar cane research does exist to some extent in the corporate sector. Sharing of resources among farmers was found to be generally low due to little commitment of the farmers themselves.

- Promotion of Integrated Pest and Disease Management (IPDM: development of alternatives to chemicals and adapting them to farmers' conditions, and training of farmers): the indicators for promoting IPDM were the number of alternatives developed, the number of training sessions organized, the number of farmers trained and the rate of adoption. The effectiveness of research in the development of IPDM techniques was generally satisfactory in the non-sugar sector and extension was not really involved. Based on the number of meetings and training sessions organized to promote these techniques, extension was to a certain extent effective. Adoption rate of IPDM techniques was found to vary between low to average.

- Improving crop productivity (to help farmers increase cane and sugar yield at reduced costs in a sustainable way): The key indicators for improving productivity were the percentage increase in yield, the percentage increase in productivity and the percentage of farmers still in the cane business. Two of the five groups that brainstormed on this extension goal reported a yield decrease of nearly 10% to 15% and attributed this to the phenomenon of yield decline. The remaining three groups found a low to moderate increase in yield which they attributed it to the adoption of better management practices or adherence to the FORIP project mentioned earlier. The increase in productivity was reported to be poor due to decrease in sugar price. The number of farmers still in the cane business was found to be decreasing, but it was reported that extension was effective in mitigating the rate of land abandonment.

- Clean milk production (to help and train breeders to produce clean and quality milk through adoption of good animal husbandry): The specific indicators on which four groups brainstormed were chemical composition of the milk, the bacteriogical load and the number of breeders producing quality milk. The effectiveness of extension in achieving clean milk production was reported to be moderate due to lack of facilities for milk analyses. Cleaner milk production was noted among those few breeders who received training.

5.1.3 Creating a vision for change and proposing practical steps for a way forward

Having assessed the *status quo* of extension in Mauritius, using the framework they developed, the focus groups discussed extension in the 'ideal' and identified practical steps for the way forward.

The participants were assigned to create a vision for change and to determine how relationship between Farmer-Extension, Extension-Research and Farmer-Research should look in terms of focus; collaboration and related issues. This activity was implemented at two levels, firstly at group level and secondly in plenary. The group findings and outcomes of the plenary discussions are summarized in Appendix 8.

The intention of the FGDs was to examine extension support to small scale producers – especially cane growers – in the context of the rapidly changing social, economic and environmental landscape in the world in general and in Mauritius in particular. The issues raised through the various workshop sessions drew attention to some broad critical issues which provide directions to the way forward. These are discussed in the following sub-sections.

5.1.4 Farmer-Extension-Research relationships

The data from the focus group discussions shed considerable light on the tripartite and bilateral relationships among farmers, extension and research. The following sections describe the current relationships and identify key issues to be addressed to strengthen those relationships.

5.1.4.1 The Farmer-Extension and Farmer-Research relationships

The focus group discussions indicated that the farmer-extension and the farmer-research relationships are essentially two aspects of a larger farmer-extension-research collective relationship. Therefore, although the study sought to examine these separately, the results clearly indicated that they must be view holistically. The primary focus of the discussion centred on farmer access to and participation in the research process. The farmer-extension aspect of the collective relationship should enable more effective two-way communication to share knowledge between the farmer and research, to provide more relevant knowledge to the farmer, and to provide more timely feedback and regular follow-up by research. This is expected to enhance distinctive and meaningful conversation between research and the farmers and result in improved productivity, profitability and welfare of the farmer.

Another key issue was that the ensuing research should be more relevant to farmers' issues and should focus on solving problems and sharing of expertise. The process itself should be participative and the collaboration should ensure the development of two-way trust, with formal and informal partnerships and with increased levels of commitment from both sides. This relationship should also consider other related issues like non-sugar activities; financial viability; markets and farmers' and institutional resources.

5.1.4.2 The Extension-Research relationship

This part of the study found that a key element in the extension-research relationship is communication. The relationship should enable the extension officers to be more aware of the current research output and researchers should be more aware of farmers' issues. Common/ shared objectives need to be developed and extension fully involved in creating the research agenda.

In terms of collaboration, a formalised relationship should emerge, with appropriate structures to enhance sharing of knowledge. Research and extension should be mutually supportive with belief and trust in one another. Extension should be more involved in research and research more connected to the extension process.

Both should also consider other issues like economically viable technologies (farmers' perspective); market issues and non-sugar activities.

5.2 Findings of the survey

The findings of the survey cover the following key areas: Demographics of respondents; Farming systems; the Sugar cane business; and Adoption of technology and utilization of inputs, services and facilities. Each area presents the perceptions of the respondents with an initial analysis. A more detailed discussion of findings is recorded separately.

5.2.1 Demographics of respondents

The demographics of the respondents cover six aspects: the Milling area; Farm sizes; Land tenure; Age, Gender and Experience in sugar cane farming. Age was not asked in this study, the findings from FIRCOP (2010) are considered still valid. Each of these aspects is used later to analyze the findings to identify patterns that may help explain the productivity gap that persists among small-scale planters.

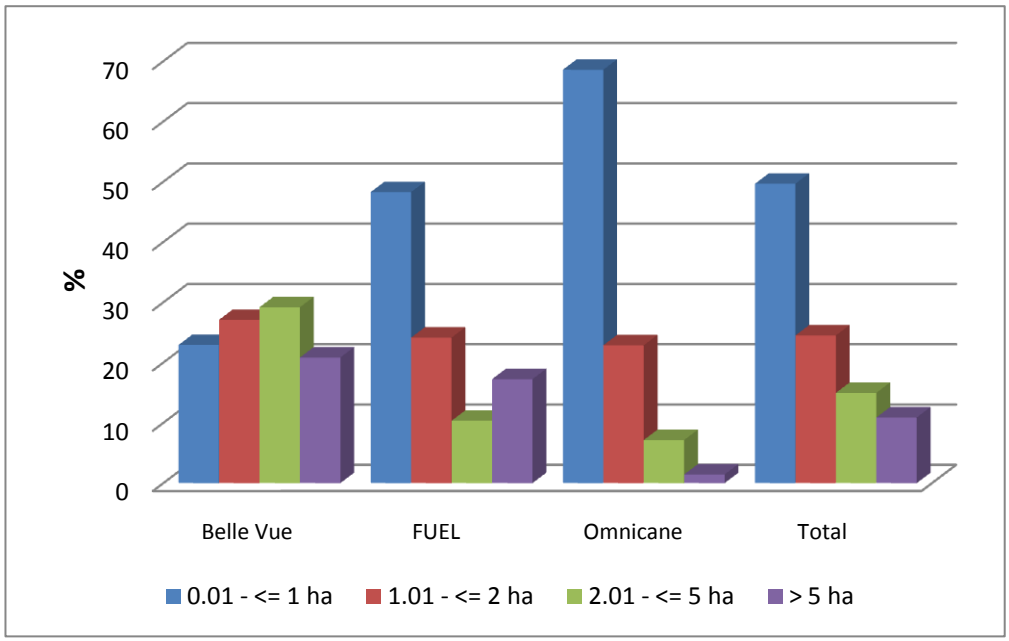
5.2.2 Milling area

The planters who participated in the study were from three different milling areas: Omnicane; Belle Vue and FUEL which have been described in Section 5. Of the 147 respondents, 70 (48%) of the respondents were from Omnicane, 48 (33%) were from Belle Vue and 29 (20%) were from FUEL.

5.2.3 Farm sizes

As shown in Figure 5.1, the majority of the respondents (74%) are operating on farm sizes ranging from 0.01 to 2.0 ha, with 50% operating on less than one hectare. With respect to milling areas, where $p<0.05$ at 95% probability, there is a significant difference among the milling areas in terms farm size. It is observed that the Omnicane milling area, compared to the other milling areas, has the highest percentage (69%) of respondents who have farms of less than one hectare as well the lowest percentage (<2%) of respondents who have farms of more than five hectares.

This is consistent with the FIRCOP study (MSIRI, 2010), conducted in Mauritius and South Africa, in which it was found that more than 80% of the fields were less than one hectare in size, with some 60% being less than half a hectare. Data from the Sugar Insurance Fund Board (SIFB) indicate that the average farm size per planter has fallen from 1.26 ha in 1969 to around 0.8 ha in 2011. This may be explained by prevailing inheritance laws which favour farm division, leading to smaller farm sizes per farmer (MSIRI-FSC, 1994). This may prove significant as studies done in other areas show that land size may affect technology adoption; findings in those studies are inconsistent and show that effect of farm size on adoption could either be positive, negative or neutral" (Akudugu, 2012).



p = 1.03E-05 (calculations are detailed in Appendix 9)

Figure 5.1: Distribution of farm size across milling areas

5.2.4 Land tenure

There are essentially three types of land ownership: self-ownership; family ownership; and leased. Self-ownership refers to land that is owned individually in the name of the farmer. Family ownership refers to land that, while being managed by a single farmer, is legally owned by a family. Leased land is land leased from another landowner which can either be a sugar estate, state lands or other planters. A farmer's land tenure may be through any one of these or in any combination of these. Table 5.1 shows the distribution of land tenure among the respondents in this study. The table shows that sugar cane fields are mainly owned by the planters themselves (69%) or their families (16%). Self ownership is lower for planters with farms in excess of five (5) hectares, compared to farmers with less than five (5) hectares, however the chi-square test does not indicate a significant difference in relationship between land tenure and farm size.

Table 5.1: Distribution of land tenure among small sugar cane planters in Mauritius

	% of respondents by land tenure						
Land size	No. of farms	Self-owned	Family owned	Leased	Self & Family	Family & Leased	Self & Leased
< 1 ha	73	37.4	8.2	2.7	0.0	0.7	0.7
1 < 2 ha	36	15.6	2.7	4.1	0.0	0.0	2.0
2 < 5 ha	22	10.2	3.4	0.7	0.0	0.0	0.7
> 5 ha	16	5.4	2.0	0.7	0.7	0.7	1.4

p = 5.33E-02 (calculations are detailed in Appendix 9)

These findings differ significantly from those found in the FIRCOP study, where some 50% of the farms were self-owned and nearly 30% family-owned. Fewer farms are self owned and nearly twice as many farms are family owned.

5.2.5 Experience in sugar cane production

The study shows that the vast majority of the respondents are very experienced sugar cane farmers; 85,7% have more than 10 years experience in sugar cane production, 79% have more than 15 years experience and 53,7% have more than 25 years of sugar cane farming. Only 2,7% of the respondents have less than 5 years of experience. As shown in Table 5.2, these findings are generally consistent with those obtained from the FIRCOP study where 83% of the respondents had 10 or more years experience in sugar cane farming and 11% had between five and 10 years of experience. One significant variation is that the number of farmers with less than five years of experience has reduced from 5,4% (FIRCOP study) to 2,7%, as found in this study. This suggests that the small-scale sugar cane planters in Mauritius are an ageing population, which again is consistent with the FIRCOP study which found that only 11% of small-scale sugar cane farmers were less than 40 years of age (i.e. 89% were over 40 years old). Twenty years before the FIRCOP study, a study conducted in the early 1990s indicated that 8% of the planters were below 30 years (MSIRI-FSC, 1994) (i.e. 92% were over 30 years old). This may prove significant as in other parts of the world, technology adoption is inversely affected by age – the older the farmer, the less likely he is to adopt new technology (Chi & Yamada, 2002; Akudugu, 2012)

Table 5.2: Comparison of years of experience in sugar cane planters in Mauritius

No of years of experience	This study	FIRCOP study
<5	2,7%	5,4%
5 -10	11,6%	11%
10 -15	6,8%	-
15 – 25	25,2%	-
>25	53,7%	-
>10	85,7%	83%
>15	78,9%	-

In relation to farm size, the present findings also showed that 93% of the planters at FUEL and 77% in Omnicane in the farm-size group of less than 1 ha have more than 15 years of experience in sugar cane, compared to only 45% at Belle Vue. It can be argued that younger planters are taking over sugar cane farming in Belle Vue milling area and this may be a subject for further research.

5.2.6 Gender

Mauritian small-scale sugar cane is populated predominantly by males. Out of the 147 planters interviewed, 28 (19%) were female and 119 (81%) were male. Again, these findings are consistent with those of the MSIRI-FSC study (80% male planters) and those of the FIRCOP study (74,4 % male planters).

5.2.7 Summary of demographics

Demographics of farmers are important when attempting to understand the reason for the productivity gap that persists among small-scale sugar cane farmers in Mauritius. Age, experience, gender and land size may all affect technology adoption. Given that this study found that the majority of the respondents own small-sized fields (< one hectare), are male and over 40 years old, and have more than 15 years of experience in sugar cane farming, it will be important to explore how these, individually and in various combinations, might affect technology adoption and use.

5.3 Farming systems

This study explored three aspects of the farming systems of the respondent small-scale sugar cane farmers: Organization of farming operations; Implementation of farm operations and factors influencing the implementation; and Productivity potential of small-planters' fields.

5.3.1 Organization of farming operations

The sugar cane farming systems used by the respondents involves three main groups of farming operations:

- Replantation: which includes land preparation, coarse and fine derocking, furrowing, preparation of planting material, planting, and in case of poor germination, recruiting to ensure a uniform crop establishment;

- Pre-harvest operations: including herbicide application, irrigation in dry areas, manual weeding and trashing prior to harvest; and

- Harvest and post-harvest activities: consisting of harvesting and transporting sugar cane to the mills, trash-lining, fertilizer and herbicide application, irrigation in dry areas and manual weeding.

All of the respondents perform all of these operations. The study examined the degree of difficulty of these operations. Table 5.3 presents the respondents' difficulty ratings in aggregate and by milling area.

Performing replantation was rated as being difficult by more respondents (61%) than any other operation. This was followed by post-harvest activities (48%) and pre-harvest operations (46%). That an operation is considered difficult does not imply that is not or cannot be completed; over 50% of those respondents who rated the different field operations as being difficult to implement also claimed that these operations were fully completed to their satisfaction.

Table 5.3: Degree of difficulty / ease of farm operations by milling areas

	% by milling area								
	Belle Vue		FUEL		Omnicane		Total		
Farming operations	Easy	Difficult	Easy	Difficult	Easy	Difficult	Easy	Difficult	*p values at 95% probability
Replantation	31	67	55	38	33	61	38	61	4.64E-02
Pre-harvest	42	54	45	48	57	40	52	46	2.66E-01
Harvest and post-harvest	33	54	45	55	56	40	47	48	1.02E-01

*Note: Calculations are detailed in Appendix 9

There was some variance according to milling areas. As shown in Table 5.3, with respect to replanting, where $p<0.05$, at 95% probability, there is a significant difference among the milling areas in terms of difficulty to implement replanting operations. However with respect to the difficulty of pre-planting operations and harvest and post-harvest operations (where $p>0.05$), there is no significant difference among the milling areas.

Table 5.4 shows that, across farm sizes, a higher percentage of the respondents with larger farms (above 1 hectare) rated the implementation of these farm operations as difficult, compared to those respondents with one hectare or less; 57% of the farmers with more than one hectare found replanting more difficult than those with one hectare or less (43%). Similarly, 55% found pre-harvest operations more difficult as compared to 45%, and 56% of the farmers with more than one hectare found harvest and post-harvest operations difficult compared to 44% of farmers with one hectare or less. However the chi-square test does not show a significant difference in the degree of difficulty in implementing the farm operations with respect to farm sizes.

Table 5.4: Degree of difficulty of farm operations across farm sizes

	% by farm size				
Farming operations	<= 1 ha	1.01 - <= 2 ha	2.01 - <= 5 ha	> 5 ha	> 1 ha
Replantation	43	28	16	13	57
Pre-harvest	45	28	15	12	55
Harvest and post-harvest	44	30	17	9	56

p = 9.83E-01 (calculations are detailed in Appendix 9)

As shown in Table 5.5, further analysis of the data indicated that the level of experience in sugar cane farming does seem to influence the implementation of the different farm operations. Generally, within an experience grouping, farmers were found to indicate the same or similar level of ease/difficulty across all three groups of operations. Just over half of the farmers (52-53%) with more than 25 years' experience consistently found all operations more difficult than those with less experience. Those with the least experience (i.e. less than five years) consistently find all operations equally easy, with only 2-3% finding the operations difficult. It is observed here that those with more experience, hence older planters, appear to be facing more difficulties. It is more likely that this is a function of age than of experience as those with more experience, tend to be older; those with more than 25 years experience are likely to be well over 40 years of age. However, the chi-square test does not reveal any significant difference in relationship between degree of difficulty in implementing farming operations and farmers' experience.

Table 5.5: Degree of difficulty of farm operations in relation to farmers' experience

	% by period of experience (no. of years of farming)				
Farming operations	< 5 yrs	> 5 - 10 yrs	> 10 - 15 yrs	> 15 - 25 yrs	> 25 yrs
Replantation	2	11	4	29	53
Pre-harvest practices	3	12	6	27	52
Harvest and post-harvest practices	3	10	7	27	53

p = 9.99E-01 (calculations are detailed in Appendix 9)

5.3.2 Implementation of and factors influencing the different farm operations

The study examined farmer perceptions of factors influencing the ease or difficulty of the three areas of their sugar cane farming systems. The factors investigated were labour, time and finance.

- **Labour**

An important aspect of farm systems is the use of labour. Two types of employment, full-time and part-time, were investigated. Table 5.6 summarizes the different responses obtained.

Table 5.6: Labour utilization by the respondents.

	Full-time employment		Part-time employment	
Type of labour	Frequency	%	Frequency	%
Self/family	29	19.7	36	24.5
Casual	0	0.0	86	58.5
Permanent	5	3.4	0	0.0
Contractor	2	1.4	10	6.8
No reply	111	75.5	15	10.2

Use of self/family-labour on a full-time basis was reported by 19.7% of the respondents and on a part-time basis by 24.5%. None of the farmers hire casual labour on a full-time basis and similarly, employing permanent labour full-time is practically non-existent; only 3.4% of the respondents do so. Use of hired labour on a part-time basis is most common among the respondents; 58,5% of them reported to use part-time labour. Use of the services of contractors on a part-time basis was reported by only 6,8% of the respondents.

In the FIRCOP study, some 60% - 85% of the respondents mentioned that they used hired labour for operations like land preparation and planting, application of herbicides and harvest – all operations which are quite labour demanding. In that study, it was also reported that 17% of the household/family labour was used for harvesting while 35% and 52% of that labour were devoted to land preparation and fertilizer application respectively. In the MSIRI-FSC study (1994), it was reported that nearly 75% of the planters interviewed benefitted from family

labour (including the respondents) for certain farming activities, but nevertheless, nearly 90% of them were hiring labour for the more labour demanding operations mentioned above. A notable difference with the present findings is the decreasing reliance on self/family-labour. These are summarized in Table 5.7.

Table 5.7: Comparison of labour use with past studies

	%		
Type of labour	This study	FIRCOP (2010)	MSIRI-FSC (1994)
Family labour	24.5	10.0 - 30.0	75.0
Hired labour	58.5	60.0 - 85.0	90.0

Furthermore, the present findings (Table 5.8) show that availability of labour is also a major factor influencing the implementation of the different farm operations and the perception of difficulty. Over 75% of the respondents claimed that labour constraints are key amongst reasons rendering the different field operations difficult. Conversely, for those stating that the field operations were easy to implement, the main reasons put forward are that they were being performed by the planters themselves (for over 45% of the respondents) or that labour was available (over 30% of the respondents) through casual labour or contractors.

Table 5.8: Reasons for perception of difficulty in the implementation of field operations

	% of respondents by reasons				
Field operations	Labour constraints	Unavailability of machinery	High costs	Old age	No reply
Replantation	76	6	13	4	0
Pre-harvest	75	0	13	6	6
Harvest and post-harvest	77	0	3	0	20

- Time and finance

The majority of the respondents indicated that time constraints and availability of finance did not have a significant influence on the execution of their farm operations. Time and money also did not affect the degree of perceived difficulty or ease.

5.3.3 Productivity potential of small planters' fields

In order to understand the cause of the productivity gap the study also investigated the productivity potential of small-planters' fields. The key factor was fertility status, including the reasons for the prevailing fertility status and for current productivity levels.

- Perceptions of soil fertility status

Soil fertility was determined solely on the basis of farmer perception based on yields; not on independent soil testing as this was beyond the scope of the study. As shown in Table 5.9, only 27% of the respondents indicated a high fertility status of their sugar cane fields; 59% indicated it was moderate; and 13% indicated it was low. Higher percentages of farmers with moderate fertility status are found in FUEL (69%) and Omnicane (63%) milling areas, whilst in those of Belle Vue, 50% of the respondents reported having fields with high fertility status, but none of the Belle Vue farmers indicated the perception that they had low soil fertility. The chi-square analysis reveals a significant difference among the milling areas in terms of perception of soil fertility.

Table 5.9: Perception of soil fertility in relation to milling areas

	% per milling area			
Status	Belle Vue	FUEL	Omnicane	Total
High	50	21	13	27
Moderate	48	69	63	59
Low	0	10	23	13

p = 8.84E-06 and is < 0.05 (calculations are detailed in Appendix 9)

Further analysis revealed that, among those respondents with high fertility status (n= 39), 69% operate in fields of more than 1 hectare and 32% have more than 25 years of experience in sugar cane farming. Among all the respondents (n=147), approximately one third (33%) have moderate soil fertility and are operating farms of less than 1 hectare. The majority of those with moderate (n=87; 55%) to poor (n= 19; 68%) fertility status, are operating on fields less than one hectare in size. Land ownership does not appear to influence soil fertility; there seems to be no significant difference whether the land is self-owned, family owned or leased.

Ninety-two percent (92%) of the farmers with high soil fertility attributed this to the adoption of good management and recommended cultural practices. Of those respondents with medium soil fertility (n=87), 32% also stated that it was due to the adoption of good management or recommended cultural practices and 18% claimed that it was due to personal know-how/experience. About 50% of the respondents did not give a reason. Among those with low soil fertility, 26% attributed this to rocky soils, 16% to old ratoons and 11% to keeping to their traditional practices.

- Perceptions regarding achieving field potential

Nearly 52% of all the respondents indicated that they were not achieving their field potential; that is, their sugar cane yields are lower than expected. However, among those respondents achieving their field potential (n=70), 78% have more than 15 years of experience in sugar cane farming, 71% are owners of their sugar cane lands and 46% are operating on land sizes of 1 ha or less. Furthermore, nearly all the respondents (94%) achieving their fields' potential attributed it to the adoption of good management practices including irrigation, where applicable, and rational fertilization.

Several reasons were reported by those not achieving potential yield. The most prominent reasons were inadequate irrigation water (22% of the respondents), poor land preparation prior to planting (18%), small-sized fields hindering adoption of good management practices (16%) and old ratoons (14%).

5.3.4 The sugar cane business

Other factors investigated to understand the persistent productivity gap were those related to their sugar cane farms as a business. This part of the study investigated the reasons why the farmers engage in sugar cane farming, the role of marketing in sugar cane production, the contribution of sugar proceeds to total income of the planter and the farmers' dependence on income from sugar cane and other sources of income for the household.

5.3.5 Reasons for farming sugar cane

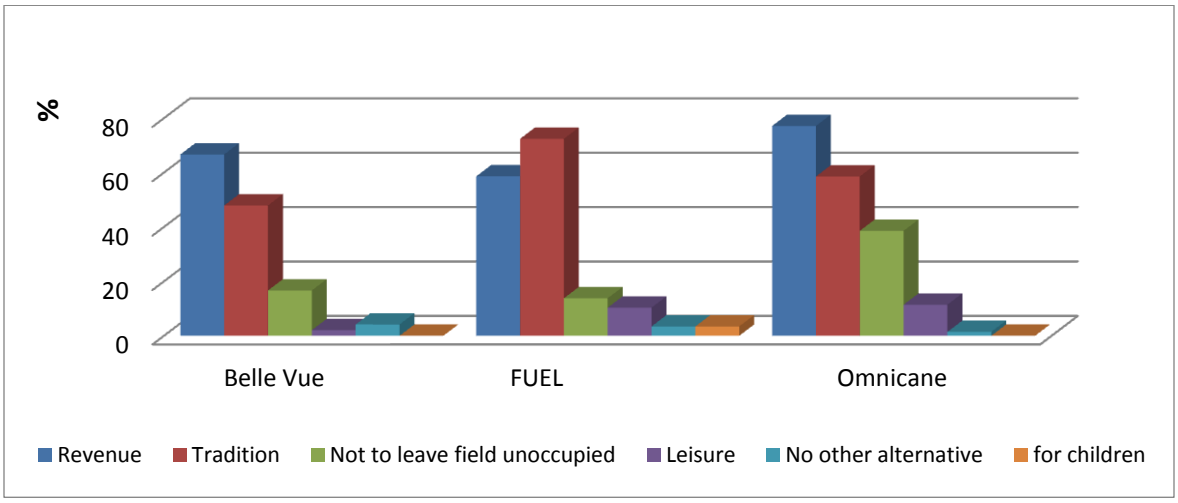
Income, family tradition, a sense of duty, leisure and 'no other alternative' were the reasons given by respondents for farming sugar cane. None of these reasons was held by the majority of respondents; most gave a combination of reasons. As shown in Table 5.10, 29% of the respondents stated that income from their sugar proceeds was their only reason for planting cane, and only 17 % of the respondents mentioned that their families' tradition of cultivating sugar cane was their only reason to be in the cane business. However, 70% of the respondents indicated that the major reasons for their sugar cane business were a combination of income, their family's tradition of sugar cane cultivation and their duty to keep their fields under cultivation.

Table 5.10: Reasons for planting cane

Reasons for planting cane	Frequency	% of respondents
Income	42	29
Tradition	25	17
Tradition + Income	34	23
Tradition +Income + Not to leave field unoccupied	10	7
Income + Not to leave field unoccupied	9	6
Not to leave field unoccupied	5	3
Tradition + Not to leave field unoccupied	5	3
Tradition +Income + Not to leave field unoccupied + Leisure	5	3
Tradition+Not to leave field unoccupied+ Leisure	4	3
No other alternative	3	2
For children	1	1
Tradition +Income + Leisure	1	1
Income + Not to leave field unoccupied+ Leisure	1	1
Tradition + No other alternative	1	1
Income + Leisure	1	1

The reasons given by the respondents do not seem to be influenced by farm size or gender, but as illustrated in Figure 5.2, tradition appears to be more important in FUEL (72%) than in the other 2 milling areas, Belle Vue (48%) and Omnicane (59%), where income is more important (77%) compared to Belle Vue (67%) and FUEL (59%). It is to be noted that the chi-square test

does not indicate any significant difference in relationship between milling areas and reasons for farming cane.



p = 2.163E-01 (calculations are detailed in Appendix 9)

Figure 5.2: Reasons for cultivating sugar cane by milling area

5.3.6 The role of marketing in sugar cane production

The study examined the farmers' perceptions and understandings about marketing in their sugar cane production. The vast majority of the respondents (96%) are aware that they are cultivating sugar cane mainly for production of sugar. They are also aware that other products obtained from their cane processed at the sugar mills are bagasse (76%) and molasses (77%). Very few mentioned the production of ethanol (2%). Furthermore, the majority of the respondents (75%) also reported that sugar is marketed through the Mauritius Sugar Syndicate (MSS). However, they do not seem to be aware of how the other products are marketed.

5.3.7 Contribution of sugar proceeds to total income of the planter

The study found that while sugar cane production is important to the respondents, it does not generally comprise a large percentage of the planters' income. As shown in Table 5.11, only 10% of the respondents indicated that income from sugar cane constitutes more than 50% of their total income. Nine percent (9%) reported that sugar cane income contributes between

26% and 50% of their total income. Another 16% reported it contributes between 11% and 25%. For 15% of the respondents, the contribution ranges from 6% to 10%.

Table 5.11: Contribution of income from sugar cane to planters' total income

% contribution	Frequency	% by respondents n=147
0	16	11
>=1 to =5	30	20
>=6 to =10	22	15
>=11 to =25	24	16
>=26 to =50	13	9
>= 51	15	10
No response	27	18

The study also found that sugar cane cultivation is a part-time activity for the majority of the respondents; only 19,7% indicated that they are full-time farmers, whilst 14% are full-time employees elsewhere, 31% own another business and 43% are old-age pensioners. It can be safely argued that all those respondents working full-time in their sugar cane fields are old age pensioners, which represents only 46% of the old-age pensioners in the total population surveyed.

These findings show a significant change from the findings of the MSIRI-FSC study (MSIRI-FSC, 1994) that determined that approximately 50% of the small-scale farmers were full-time growers and the 2010 FIRCOP study that determined only 15% were full-time growers and around 29% of the respondents were old-age.

These findings also indicate that the contribution of income generated from sugar cane cultivation to total income of the small-scale sugar cane planters is generally not significant. This sheds additional light on the earlier discussion around the reasons why the farmers engage in sugar cane production. Income is the main reason for 29% of the farmers, but it is more often accompanied by family tradition and a sense of duty.

These findings highlight the uncertainty about sugar cane farming among small-planters in Mauritius. For those farmers for whom income is their primary reason for sugar cane farming, it can be argued that the majority of them are not attaining that objective. This is consistent with the 2010 FIRCOP study that found that sugar cane production was profitable for less than one-third of the respondents, sometimes profitable for another 36% of the respondents and not at all profitable for the rest. The present findings thus confirm that the expectations of the small-scale planters in terms of income generation from sugar cane cultivation are not often met and are generally insignificant. This may also influence technology adoption, as many farmers will not adopt new ideas or technologies if they cannot see how it will benefit them (Chi & Yamada, 2002; Akudugu, 2012).

5.3.8 Adoption of technology and utilization of inputs, services and facilities

In this section, the findings of the study with respect to the farmer adoption and use of technologies were reviewed. The use of new technologies, including the adoption of new varieties, utilization of inputs, credit and other services and access thereto, the reasons for planters' choices and behavior and the impact on yields were also discussed. Finally, issues around the sources and access to information about technology options were discussed.

5.3.8.1 Knowledge and use of technologies promoted by extension

Among the technologies promoted by extension in Mauritius, three main ones are most cited: new sugar cane varieties; weed management practices; and soil analysis. The study investigated the planters' knowledge and use of these technologies. Table 5.12 presents the aggregated findings as well as the disaggregated findings relative to milling areas.

Table 5.12: Knowledge, use and adoption of technologies in relation to milling area

	% per milling area											
	Belle Vue			FUEL			Omnicane			Overall		
New technologies	Aware	Use	Rate of adoption	Aware	Use	Rate of adoption	Aware	Use	Rate of adoption	Aware	Use	Rate of adoption
New varieties	48	46	96	76	55	72	84	60	71	71	54	76
Weed management	40	40	100	48	38	79	87	76	87	64	56	88
Soil analysis	21	17	81	52	34	65	84	73	87	57	47	82
Average	***36***	***34***	***92***	***59***	***42***	***72***	***85***	***70***	***82***	***64***	***52***	***82***

Note: Rate of adoption calculated on the formula: (% Use / % Aware) x 100 = Adoption rate

P=7.077E-02 (calculations are detailed in Appendix 9)

In the aggregate, 71% of the respondents indicated that they were aware of new sugar cane varieties adapted to their respective farming systems that are promoted by extension. However, only 54% are currently exploiting them. Similarly, 64% are aware of new weed management practices, whilst 56% are currently adopting them. Similarly, soil analysis prior to plantation (a practice aimed at optimal and cost-effective fertilization in sugar cane) is known to 57% of the respondents and is being currently used by only 47% of the farmers.

In relation to milling areas, the study found that new sugar cane varieties are known by 48% of the respondents in Belle Vue, 55% in FUEL milling area and 60% in Omnicane; they are being currently exploited by 46% in Belle Vue, 55% in FUEL and 60% of those in Omnicane. A different pattern appears for the adoption of new weed management practices in relation to milling areas; 40% of the respondents in Belle Vue are aware and the same percentage implement the technology, 48% in FUEL milling area are aware and 38% implement, whilst in Omnicane, 87% know of the technology and 76% implement it. The chi-square test does not show any significant difference in relationship between use of technology and milling areas.

Performing soil analysis prior to replantation is known by 21% of the respondents in Belle Vue, by 52% in FUEL and by 84% in Omnicane. However, it is a current practice among only 19% in Belle Vue, 34% in FUEL, and among 73% in Omnicane.

Overall, the findings show that 85% of the planters in Omnicane indicated that they are aware of the three technologies. This is significantly more than in FUEL (59%) and Belle Vue (36%). This is reflected as well in the rate of adoption of new varieties, new weed management strategies and soil analysis which is also higher in Omnicane than in the other two milling areas.

In relation to farm size, as shown in Table 5.13, the study found that marginally higher percentages of respondents with farm sizes of one hectare or less know about new technologies than respondents with farms over one hectare. Whereas 74% of farmers with one hectare or less were aware of new cane varieties, 68% of farmers with more than one hectare were aware of this. Similarly, 68% and 63% of respondents with one hectare or less were aware of weed management practices and soil analysis respectively, compared to 58% for weed management and 50% soil analysis for those with farms over one hectare. In terms of adoption of innovations for weed management and soil analysis, the same pattern is observed between respondents, with farms of one hectare or less and those with farms over one hectare, 58% v/s 54% and 49% v/s 45% respectively. For different varieties, it seems that respondents with more than hectare adopt more than those with one hectare or less, 57% v/s 52%. However, the chi-square test does not show any significant relationship between use of technology and size of farm.

Table 5.13: Knowledge and use of technologies in relation to farm size

	% of respondents per farm size			
	<= 1 ha		> 1.01 ha	
New technologies	Aware	Use	Aware	Use
New varieties adapted to region	74	52	68	57
Weed management	68	58	58	54
Soil analysis	63	49	50	45

p = 8.426E-01 (calculations are detailed in Appendix 9)

Table 5.14 shows the findings in relation to planters' experience. The study found no significant difference in responses for knowledge and adoption of varieties and weed management. However, for soil analysis, it is observed that the respondents with less than 15 years'

experience are more aware of and more frequently adopt the practice of soil analysis prior to plantation. However, the chi-square test does not reveal any significant relationship between the use of technology and the planter's experience in cane farming.

Table 5.14: Knowledge and use of technologies in relation to years of experience

	% of respondents per years of experience			
	< 15 yrs n=31		> 15 n=116	
New technologies	Aware	Use	Aware	Use
New varieties adapted to region	71	55	71	54
New herbicides	65	61	63	54
Soil analysis	65	55	54	45

p = 8.66E-01 (calculations are detailed in Appendix 9)

In relation to gender, Table 5.15 shows that male planters seem to be more aware of and adopt more new varieties than female planters. The reverse is observed for weed management, where female planters appear to be more aware of these and more frequently adopt this practice. The chi-square test does not, however, indicate any significant diffrerence in relationship between gender and use of new technology.

Table 5.15: Knowledge and use of technologies in relation to gender

	% of respondents per gender			
	Female (n=29)		Male (n=118)	
New technologies	Aware	Use	Aware	Use
New varieties	66	45	72	57
Weed management	72	59	62	56
Soil analysis	59	41	57	48

p = 7.51E-01 (calculations are detailed in Appendix 9)

Tables 5.16 and 5.17 present the findings in relation to the contribution of sugar proceeds to household income. As has already been discussed, the overall percentage contribution of sugar proceeds to household income has declined. Respondents who indicate that sugar proceeds do not contribute at all to their household income show the lowest rates of awareness and use; and those for whom sugar proceeds are more than 5% of their household income show higher rates of knowledge and use. However, the chi-square test does not show a significant

difference in relationship between percentage contribution of sugar proceeds to the household income and use of technology.

Table 5.16: Knowledge and use of technologies in relation to contribution of sugar proceeds to household income

	% of sugar proceeds contribution											
		0%	> 0-< 5%		5< 10%		10< 25%		< 50%		> 50%	
New technologies	Aware (A)	Use (U)	A	U	A	U	A	U	A	U	A	U
New varieties	44	38	82	65	95	65	75	75	57	14	73	73
Weed management	38	25	71	65	75	70	75	75	71	71	60	60
Soil analysis	19	0	65	59	65	50	50	50	86	57	53	53

Table 5.17: Rate of adoption of technologies in relation to contribution of sugar proceeds to household income

	% of sugar proceeds contribution								
	< =5 % n=32			>5 to 10% n=20			>10% n=30		
New technologies	Aware	Use	Adoption rate	Aware	Use	Adoption rate	Aware	Use	Adoption rate
New varieties	66	53	81.0	95	65	68.4	64	59	91.1
Weed management	56	47	83.3	75	70	93.3	60	60	100.0
Soil analysis	44	31	71.4	65	50	76.9	51	48	92.6

Note: Rate of adoption calculated on the formula: (% Use / % Aware) x 100 = Adoption rate

p = 9.78E-01 (calculations are detailed in Appendix 9)

Table 5.18 presents the analysis of the respondents in relation to reasons for planting cane. These findings indicate that the reason for planting cane does not appear to be a significant factor either in awareness or use of the technologies studied. However, the adoption rate for weed management seems to higher (85%) for those who plant as a part of tradition compared to those planting for income (66%).

Table 5.18: Knowledge and use of technologies in relation to reasons for planting cane

	% of respondents by reasons for planting cane					
	Tradition (n=85)			Income (n=103)		
New technologies	Aware	Use	Adoption rate	Aware	Use	Adoption rate
New varieties	74	51	68	75	55	74
Weed management	64	54	85	68	45	66
Soil analysis	55	48	87	61	51	84

p = 5.66E-01 (calculations are detailed in Appendix 9)

5.3.8.2 Knowledge and utilization of inputs

As shown in Table 5.19, in the aggregate, a majority of the planters are aware of the major inputs required to establish a sugar cane crop and a somewhat smaller majority are utilizing these inputs. Ninety-seven percent (97%) of the respondents are aware of fertilizers, and 90% use them. Similarly, 90% of the respondents are aware of herbicides and 82% use them. A smaller majority (85%) is aware of planting material/cane setts, and 79% use them. Furthermore, 55% of the respondents are aware of scum and 37% use it – with the case that scum is not regularly available. Once again, the adoption rates were determined and the calculations show that the great majority of planters who are aware of these inputs utilize them, over 90% adoption rate for the major inputs, except for scum, which is not always available.

Table 5.19: Awareness and use of key inputs by small-scale Mauritian sugar cane producers

Input	Aware	Utilize	Rate of adoption
Fertilizers	97	90	93
Herbicides	90	82	91
Planting material/Cane Setts	85	79	93
Scum	55	37	67

Further analyses of the data indicated that farm size and period of experience do not seem to influence the planters' decisions to use these inputs. With respect to milling area, findings again show, as is the case in the adoption of soil analysis, that higher percentages of users of major

inputs (Table 5.20) were recorded in Omnicane, an average of 96% for fertilizers, herbicides and planting material/cane setts compared to an average of 77% for Belle Vue and 64% for FUEL.

Table 5.20: Use of key inputs by small-scale Mauritian sugar cane producers in relation to milling area

	% per milling area			
Inputs used	Belle Vue	FUEL	Omnicane	Total
Fertilizer	92	62	100	90
Herbicide	73	62	97	82
Planting material/Cane Setts	67	69	91	79
(Average)	77	64	96	84

5.3.9 Knowledge and utilization of services and facilities

On aggregate, the majority of the respondents indicated that they are aware of two main services: Farmers Service Centres (FSCs) for advisory services and training (81%) and Contracting services, including the Sugar Planters Mechanical Pool (SPMPC) for provision of machine/tractors for soil preparation prior to planting (58%). They are aware of two main facilities: Credit facilities (91%) and Government subsidized schemes (56%). However, the level of awareness, except for Credit, is significantly lower than the awareness of inputs discussed earlier. Furthermore, Table 5.21 shows that an even smaller percentage of planters indicated that they have access to or utilize these services.

Table 5.21: Awareness and use of key services / facilities by small-scale Mauritian sugar cane planters

	% of respondents	
Service / Facility	Aware	Access / Utilize
Farm Service Centres	81	73
Contracting services	58	48
Credit facilities	92	33
Government subsidized schemes	56	46

With respect to the milling areas, it is observed that access to services from the FSCs is lower in Belle Vue (56%) compared to that in FUEL (72%) and Omnicane (85%). As to farm size and planters' experience in sugar cane farming, no difference in access to services was observed.

Table 5.22 shows that the majority of respondents (91,8%) are aware of credit facilities available either from the private banks or through their Credit Cooperative Societies (CCS) from the Mauritius Post and Cooperative Bank (MPCB). However only 34% of them (n=50) use those credit providers and among them, 16,3% are from their CCS only.

Table 5.22: Knowledge and use of credit facilities in relation to milling area

	% by milling area							
	Belle Vue		FUEL		Omnicane		Total	
Credit facilities	Aware	Use	Aware	Use	Aware	Use	Aware	Use
Bank + CCS	66.7	4.2	55.2	6.9	61.4	10.0	61.9	7.5
CCS	8.3	10.4	17.2	13.8	34.3	21.4	22.4	16.3
Banks + Others	6.3	6.3	17.2	24.1	4.3	7.1	7.5	10.2
Total	81.3	20.8	89.7	44.8	100.0	38.6	91.8	34.0

With respect to farm sizes (Table 5.23), it seems that knowledge on credit facilities is not influenced by farm size, but 38% of the respondents above one hectare use credit, compared to 30% for those with farms below or equal to one hectare.

Table 5.23: Knowledge and use of credit facilities in relation to farm size

	% by farm Size									
	0.01 - <= 1 ha		1.01 -<= 2 ha		2.01 -<= 5 ha		> 5 ha		> 1 ha	
Credit facilities	Aware	Use	Aware	Use	Aware	Use	Aware	Use	Aware	Use
Bank +CCS	58	8	67	11	64	0	69	6	66	7
CCS	30	16	19	19	9	14	13	13	15	16
Banks + Others	4	5	8	11	9	18	19	19	11	15
Total	92	30	94	42	82	32	100	38	92	38

Experience in sugar cane production (Table 5.24) does not seem to impact on knowledge of credit facilities, however borrowing money is more among those respondents with over 15 years of experience (36%) compared to those with less than 15 years of experience (25%).

Table 5.24: Knowledge and use of credit facilities in relation to experience in sugar cane cultivation

	% by period of experience in sugar cane cultivation			
	< 15 yrs n=31		> 15 n=116	
Credit facilities	Aware	Use	Aware	Use
Bank +CCS	61	0	62	9
CCS	26	19	22	16
Banks + Others	6	6	8	11
Total	93	25	92	36

In relation to gender (Table 5.25), a slightly higher percentage of female planters (97%) are aware of credit facilities compared to male planters (90%) but no difference is observed in credit use, 34% in each case.

Table 5.25: Knowledge and use of credit facilities in relation to gender

	% by gender			
	Female (n=29)		Male (n=118)	
Credit facilities	Aware	Use	Aware	Use
Bank +CCS	66	10	61	7
CCS	24	14	22	17
Banks	7	10	7	10
Total	97	34	90	34

5.3.10 Reasons for adoption of technology and utilization of inputs, services and facilities

Having established the level of awareness and rate of utilization of technologies, input and services, the study also interrogated the reasons behind these levels. As shown in Table 5.26, while 44,2% and 27,2% gave no reasons for their decisions about technologies and inputs respectively, improved plant growth and increased yields emerged as the most common reason given. For example, some 67,3% of the respondents reported that they were using inputs like fertilizers, herbicides and cane setts to ensure plant growth and to improve yield. Similarly, 38,1% of the respondents declared that technologies and research findings like new sugar cane varieties, better weed management strategies and soil analysis prior to replantation are essential for cane growth and improvement in cane yields. Furthermore, 12,2% of the

respondents used technologies because they had been advised to do so by their extension officers.

Table 5.26: Reasons for adoption / non-adoption of technology inputs, services and facilities

	New technologies		Inputs		Services		Credit	
Responses	Frequency (F)	%	F	%	F	%	F	%
Improved plant growth and increased yields	56	38.1	99	67.3	12	8.2	5	3.4
As advised by extension officers	18	12.2	3	2.0	11	7.5	0	0.0
Currently used by other planters	2	1.4	2	0.4	11	0.5	3	0.0
To reduce costs	1	0.7	0	0.0	0	0.0	0	0.0
Readily available	0	0.0	2	1.4	23	15.6	22	15.0
Old ratoon/Not required/ Not to be indebted	5	3.4	1	0.7	17	11.6	55	37.4
No reply	65	44.2	40	27.2	73	49.7	62	42.2

Just over half (50,3%) of the respondents gave reasons for using the services discussed earlier. Three reasons emerged: they were readily available (15,6% of the respondents); advice from extension (7,5%); and following the example of other planters who were using these services (7,5%). The main reasons for not using these services were that they were not available when required or not required at all (11,6%). In this instance, 49,7% did not give any reasons.

Among all the respondents, 33% of respondents use credit facilities and 15% did so because credit was readily available but with no other justification. Only 3,4% of the respondents did so to improve their sugar cane crop and 2% because other planters used credit. Some 42,2% did not give any reason. The majority of the respondents (67%) do not use credit facilities (n=86). A significant percentage (37,4%) of the respondents stated that credit was not required or that they did not want to be indebted. These findings indicate credit aversion on the part of small planters. Such credit aversion is often linked to not wanting to expand and/or risk aversion which is driven by the perception of their farms as something other than merely a profit-making business (El-Osta et al., 2004; Colman and Harvey, 2003; Breen et al., 2005; Howley et al., 2011;

O'Donoghue and Howley, 2012 cited by Howley & Dillon, 2012). As credit is usually needed to invest in order to increase capacity (e.g. new varieties) these responses to credit suggest the rationale of the planters not adopting other technologies and/or using inputs.

In exploring the performance of adopted technologies, inputs, services and credit, a significant majority of the respondents currently using them perceived these as being quite useful; new technologies (66%), inputs (76%), services (62%) and credit (58%). They also said that these have a positive effect on the overall performance of their sugar cane cultivation; new technologies (72%), inputs (77%), services (67%) and credit (38%). These findings are shown in Table 5.27.

Table 5.27: Performance/impact of technologies, inputs, services and credit on the cane business

	% of respondents						
	Very good	Quite useful	Useless	Others*	Positive	No effect	Others*
	Performance[1]				Effect on yield[1]		
Research findings / Technologies	6	66	4	24	72	3	25
Inputs	5	76	0	19	77	1	22
Services	2	62	1	35	67	2	31
Credit facilities	0	58	0	42	38	2	60

[1]Responses only from those using technologies, inputs, services and facilities
*Others include no responses (mainly) and responses for dissatisfaction/below expectations

5.3.11 Source of and access to information for technology, inputs, services and credit facilities

Table 5.28 shows that extension alone via the FSCs is the main source of information for technology (51% of the respondents), inputs (50%) and services (43%). The other common source was other planters in the region; for technology (10%), inputs (14%) and services (12%). A similar percentage of the planters cited both extension and other planters as their sources of information; technology (12%), inputs (14%), and services (13%). Finally, relying on personal experience only was mentioned by 9% of the respondents.

Table 5.28: Source of information for technologies, inputs, services and credit facilities

	% of respondents			
Source of information	Technologies	Inputs	Services	Credit facilities
Extension	51	50	43	5
Other planters	10	14	12	9
Extension and other planters	12	14	13	0
Personal experience	9	11	9	15
Family	3	7	1	3
Family and Extension	2	3	1	0
CCS	1	2	2	15
Publications		1	0	1
No response	12	2	20	52

About half (48%) of the respondents explained where they obtained information on the availability of credit facilities. The most common was from the CCS (15%), followed by other planters (9%). Extension was cited as a source of information about credit by only 5% of the respondents.

Regarding access to technology, 65% of the respondents rely on extension services. Fifty-one percent (51%) access inputs through private service providers and cooperatives, while 48% access inputs through extension services.

5.3.12 Source of finance for technology, inputs and services and reimbursement of credit

In the light of the data on high levels of awareness, but general lack of use of credit, it is important to know how the use of technology, inputs, services and facilities are financed. Table 5.29 clearly demonstrates that the majority of the planters self-finance; 73% rely on their own finance to purchase the inputs. Only a small percentage uses other sources including credit; 12% use credit from CCSs for technologies and inputs and 7% use credit for services. In the case of services, the 48% of those respondents self-financing services indicated that those services are funded from 'cess' money to which they contribute. Cess money is a levy deducted from sugar sales and which represents 4% of the ex-Mauritius Sugar Syndicate price, i.e. the uniform average net price per tonne of sugar referred to in the Articles of Association (1967) of the Mauritius Sugar Syndicate.

Table 5.29: Financing the use of technologies, inputs, services and credit facilities

	%		
Method of financing	Technologies	Inputs	Services
Self	57	73	48
Loan from CCSs / banks	12	12	7
Self + Loan	5	7	2
Advance on crop	1	0	1
No reply	25	7	42

The planters indicated that reimbursement of loans obtained from the CCSs is made from their sugar proceeds. Reimbursement for loans from private banks is made through monthly installments paid to the bank, sometimes with assistance from the farmer's family.

The study also investigated issues surrounding other technology, inputs, services and facilities which planters are not using. Nearly half of the respondents (49%) were not aware of any other technologies, inputs, services or facilities. Fourteen percent (14%) were aware of a range of technologies and services, including new methods of planting cane, new fertilizers, planning and field layout for mechanization, and more efficient irrigation systems. When asked why these research findings/new technologies were not being used, the very few who responded mentioned costs and inaccessibility. They further added that if concerned authorities come forward with appropriate schemes such as subsidies, they may make use of these. Forty-five (45%) of the respondents were not aware of any other inputs, whilst 20% mentioned inputs including scum, poultry litter, cement and bio-fertilizers. However, these are not actually being used, either because of unavailability or high costs. Finally, the vast majority of respondents (90%) were not aware of other services and facilities that could be available.

5.4 Summary

Knowledge of the demographics of the small sugar planters in Mauritius is considered important to understand the reason of the persisting productivity gap among them. The majority of the planters own small-sized fields (each, less than one hectare), are males over 40

years of age and have more than 15 years of experience in sugar cane farming; these factors may influence adoption of technology.

Among the most important field operations, replantation is more difficult but is completed to their satisfaction for only half of the planters concerned. The degree of difficulty in performing replantation varies according to milling areas, easier in FUEL than in Belle Vue and Omnicane and according to farm sizes, more difficult for those planters with larger farms (over one hectare in size). The planters with more than 25 years' experience face more difficulties in implementing the operations than the least experienced planters. As those planters with more experience tend to be older, it is more likely that older planters are facing more difficulties. Labour constraints are noted as being the main reason rendering implementation of field operations difficult.

Just over half of the planters are not achieving their field potential in terms of cane yield. Among those doing so, are the more experienced planters (over 15 years of experience) and those with smaller farm sizes (less than one hectare). The planters achieving their field potential owe this to the adoption of good management practices.

For the majority of planters, cultivating sugar cane is not for income only, but also for perpetuating family tradition and showing a sense of duty, by not leaving sugar cane lands idle. Less than one third of the planters grow sugar cane for income only; the majority are found in Omnicane milling area, while a majority of planters in FUEL milling area do it to keep their family's tradition going. A vast majority of the planters are conscious that they grow sugar cane for producing sugar for export, but they also know that bagasse for energy production and molasses are important and valuable by-products.

Sugar cane, being essentially a part-time activity for the small planters, may explain their very slight to no dependence on its income; a little less than half of them are old-age pensioners. However, these low levels of dependence on income from sugar does not imply that an opportunity to improve income from their crop will not be considered by the planters; it

appears that it is simply their expectations for more income generation from sugar which are not being met.

New sugar cane varieties, weed management practices and the practice of soil analysis are the key technologies that a majority of the planters are aware of, but not all of them are using those technologies. Those planters using the technologies are aiming at better cane yields. It can be argued that the planters not using the technologies are either still not convinced of any yield improvement or cannot afford any further investment due to insignificant returns from the cane business. Higher rates of adoption of these technologies are observed in Omnicane milling area compared to the other two milling areas; this can probably be related to the finding that most of the planters growing cane for income are found in that particular area. The rate of adoption of new varieties tends to be higher among planters with larger farm sizes. More frequent and partial replantation of larger farms is common among those planters, as they cannot afford to replant the whole farm all at once.

Those planters with sugar proceeds contributing to more that 5% of their household income tend to show higher rates of technology adoption than those with less than 5%.

The great majority of planters who are aware of major inputs like fertilizers and herbicides utilize them, the rate of adoption being over 90%. Again, planters in Omnicane milling area are the highest users of those inputs.

More than 80% of the planters have a knowledge of the services provided by the FSCs, but their access to these services differs across the milling areas, but not according to farm size and planters' experience in sugar cane farming. In Omnicane milling area, FSC services seem to be more accessible. The finding that other planters in the region also represent a non-negligible source of information should not be overlooked when eventually devising a framework for extension.

More than 90% of the planters know about credit facilities, but only a little more than one-third make use of them. The main reason put forward by those not using these facilities is either they do not want to be indebted or simply that credit is not needed.

The FSCs remain the main source of information for technology, inputs and services, whilst the CCSs seem more important as a source of information for credit. This is understandable because CCSs also provide these facilities.

Most of the planters use their own funds to cater for expenses related to technology and the use of inputs. They are aware that they are already paying for the services provided by the FSCs, through their 'cess' contribution. For those using credit facilities, reimbursement is effected from sugar proceeds.

Finally, the planters are not very aware of other technologies, inputs, services and facilities which may be available and which they are not using.

Chapter 6

Discussions

In an attempt to shed light on the major question set for this study, that is, why, despite efforts made in research, development and technology transfer, there still exists a persisting productivity gap between large commercial sugar cane farmers and small-scale farmers, the findings in the preceding chapter are discussed and covers the following aspects:

- Appropriateness of sugar cane research and development (R&D) to small sugar cane planters;
- Adoption of the technologies most cited by the respondents, namely new varieties, weed management practices and soil analysis prior to replantation;
- Information on and accessibility to technology, inputs, services and facilities;
- Purposes and reasons for sugar cane farming;
- Achieving potential sugar cane yields; and
- Relationship between farmers and the extension services and research.

6.1 Appropriateness of sugar cane research and development (R&D) to small sugar cane planters

Sugar cane is a perennial crop; hence a good crop establishment at planting will guarantee its ratooning capability. The successful establishment of a sugar cane crop depends on various factors. Key among these are the time of planting, land preparation, soil nutrient status, the choice and availability of sugar cane variety , weed management, availability of irrigation facilities (in rainfed areas receiving less that 1500 mm rainfall), and management of insect pests and diseases (MSIRI, 2007).

To determine whether sugar cane R&D was appropriate for the small planters, this study interrogated the knowledge and adoption of research findings and technologies emerging from that R&D by small planters in Mauritius. The three technologies most cited by the respondents were new sugar cane varieties, weed management and soil analysis prior to replantation; thus these became the focus of the analysis.

If adoption of new technologies is considered as a measure of the appropriateness of these technologies, the study has shown that, for the three technologies, only a slight majority of the respondents adopted new varieties (54%) and weed management practices (56%), while conversely, a slight majority of the respondents (53%) did not adopt soil analysis (see Table 5.12: 108).

This is a simple percentage representing all the respondents, including those that were not aware of the technologies. For this study, adoption rate was determined based on knowledge of the technology or research information in question. Using this framework and the calculations which were described in Chapter 5 (see Table 5.12: 108), it is found that 76% of the respondents having knowledge of new varieties make use of them, 88% who are aware of weed management practices adopt them and 82% who have information on the benefits of soil analysis perform a soil test prior to replantation. This implies that the small planters will adopt a new technology or farm practice only if they are aware of it and are convinced that it will improve their productivity.

6.1.1 Adoption of a new sugar cane variety

One of the main thrusts in R&D programmes in Mauritius is the development of better performing sugar cane varieties, adapted to the different local agro-climatic environments, to enhance sugar productivity. The forecasts are that income of planters will improve and this will attenuate the adverse effect of the sugar reform discussed in Chapter 1 (Section 1.1) and the yield decline tendencies observed in the sugar cane fields (MSIRI, 2010). Since 1953, with the creation of organized research for sugar cane in Mauritius, a total of 64 varieties were released for commercial cultivation. Over the years, new and better performing varieties were proposed

to replace worse performing ones and in 2012, 22 varieties were available for commercial plantation. Among these varieties, ten were widely adopted by the planting community and occupied nearly 91% of the total cane area in that year.

It was not within the scope of this study to assess the number of new and better performing varieties which were proposed to the planters in general and to the small-planters in particular. However, during the past five years no new varieties were proposed, the last one released for commercial cultivation was in 2007 and was perceived as a variety with high fibre content, hence not really attractive for the planters for whom the main product from the cane they cultivate is sugar and not fibre. It can be argued that lack of better performing varieties cannot be the cause of the productivity gap, as it affects both the large commercial and the small-scale planters. The same varieties are recommended to the different producer groups (MSIRI, 2012).

Due to high costs of replantation, the planter will replant his field only if his current yield is poor and he is offered a variety superior in performance to the one he is exploiting. The moment he feels the need to renew his plantation, he will have to initiate various arrangements with service providers for machines for land preparation, other inputs like scum, fertilizers and herbicides and, last but not the least important, planting material of the sugar cane variety which is recommended for his region and which should outclass the one presently in his field.

The sugar cane variety should fit in the farming systems of the small planters; easy trashing, rapid canopy cover to check weed growth, good ratooning ability, including manageable maturity behaviour and harvesting period, i.e. the variety can be harvested at a time appropriate to the planter. These are the exigencies of every sugar cane planter and the small planter is no exception; these are also the challenges that research and extension have to face in fulfilling these exigencies.

Genetic improvement in sugar cane varieties is important to ensure the survival of the sugar industry. In Barbados, for example, Rao (2007: 4) reported that the sugar industry was *"… faced with a series of challenges including the onset of new diseases, changing cultivation practices, introduction of herbicides, mechanization, increased cost of production and reduced income."*

Furthermore, he stated that *"These conditions imposed the need for varieties to maintain sugar yield and ensure survival of the sugar industry."* He ultimately argued that *'Variety replacement proved its worth in increasing sugar production during a period of unprecedented changes in growing conditions '* (Rao, 2007: 5)

In other sugar cane producing countries, it is widely acknowledged that breeding for new varieties has impacted positively on production levels. In Edmé *et al* (2005), it was reported that Baver (1963) and Hogarth (1976) attributed 50 to 75% of the gains in sugar cane yields in Hawaii and Australia to genetics. Similarly, breeding for better varieties to improve production is also acknowledged in other crops. Edmé et al (2005:92), citing Fehr (1984), Duvick (1992b) and Frisvold et al., (1999) noted that *"Genetic improvements have contributed to about 50% of the yield gains attained in major U.S. crops".*

Due to the specific needs of the planter, not every new variety which is released will be deemed to be appropriate by every farmer. As discussed in Section 3.1.4, breeding and selection of new sugar cane varieties in Mauritius is conducted for the various agro-climatic environments and harvesting periods. When finally a variety is released for commercial exploitation, it may be adapted to a specific environment and harvested period which may not fit in the farming systems of each and every planter.

From the above, once farmers are aware that a new sugar cane variety has become available, that is better than the existing ones, it is clear the rate of adoption is improved. The lack of a better performing variety during the period of study may not have directly contributed to the productivity gap between the large commercial and the small planters, but it can be argued that such a variety, adapted to the small scale farming systems, made known to them and found by them to be suitable would have brought some relief to the present state of situation.

6.1.2 Adoption of weed management practices

The small planter replants his field on average every nine years (MSIRI, 1994); consequently choosing a variety for replantation will happen every nine years. Conscious of the fact that

varieties cannot reach their full potential without sound and improved agronomic management practices, R&D is also aimed at proposing improved field operations and recommendations for judicious use of inputs like fertilizers based on results of soil analysis, herbicides and irrigation water.

As mentioned earlier, the second technology most cited by the respondents is the practice of weed management. Weeds, if not kept under control, are in direct competition with the sugar cane crop for sunlight, soil nutrients and water, which are essential for the growth and development of the sugar cane. Hence, weed control is a must for the sugar cane business. Three methods of weed control are commonly used by the small planters in Mauritius; manual weeding, chemical weeding and a combination of both. The third method is most common, whereby a small planter normally practising chemical weed control may supplement with manual weeding if certain tough weeds have remained intact.

Herbicides are used for chemical control and their annual costs to the whole Mauritian sugar industry average some 500 million Mauritian rupees (MUR) (USD 16.7m). Seeruttun (2008) estimated that the average cost of herbicides was MUR 3500 per hectare and that the costs of weed control vary between 4% and 8% of the total production costs. To minimise the costs of this operation, R&D is aimed at developing weed management strategies to replace the practice of total weed control in use since the early 1960's. In 2005, improved weed management strategies based on the critical period of weed competition with the cane were recommended and this included the possibility of delaying the first application of herbicides until the onset of this critical period and the use of post-emergence herbicides to keep weeds under control until the end of that period (Seeruttun, 2008).

Numerous research works were conducted locally and abroad to look into the aspects of weed management and it has been confirmed that a sound weed management impacts positively on productivity, both in terms of higher cane yields and lower production costs. If weeds are in direct competition with the sugar cane plant, that is if they are not properly managed and kept under control, a reduction of up to 50% in cane yield may ensue. Marion *et al*. (1991) found

that weed competition in cane attaining two months' growth could impact severely on yield as from that age, a delay in weeding might cause yield losses up to 400 to 500 kg per hectare per day on a crop, with a potential of around 130 tonnes of cane per hectare.

What R&D has proposed to the planters as new are more efficient herbicides, coupled with improved spraying techniques for chemical weed control. This is considered as a necessary alternative to the tedious and highly labour-demanding method of manual weed control. As mentioned earlier (see Table 5.12: 108), 88% of those respondents having knowledge of the technology are adopting it, but only 64% are aware. Hence it can be argued that those farmers (36% of the respondents in this study) who are not aware of proper weed management practices are contributing to the overall production gap under investigation. This indicates that extension should make more efforts to improve awareness of the R&D proposals for weed management.

6.1.3 Adoption of soil analysis prior to replantation

The third technology most cited by the planters is the practice of soil analysis prior to replantation. The importance of soil fertility to the sugar cane crop is highlighted in many works. Most of the sugar cane soils in Mauritius have been under intensive cultivation for several decades and their nutrient status is expected to vary due to different fertilizer management practices among planters (STASM, 2003). Soil analysis is therefore useful in the assessment of the actual nutrient status of a sugar cane field to be able to determine its nutrient requirements. R&D recommends that each time a field is to be replanted, soil samples be taken for chemical analyses to determine its level of acidity (pH value), available phosphate (P_2O_5), potash (K_2O) and in highly leached soils, silicon (Si) (STASM, 2003). Aware of the complexity of this practice, the small planters are provided with necessary assistance by the officers of the FSCs for the soil sampling operations and the samples are analyzed at the MSIRI for eventual fertilizer recommendations (MSIRI, 1997).

In Mauritius, this technology is available for all sugar cane planters and especially, free of charge for the small planters to enable them to improve their production levels and reduce

their production costs. Substantial numbers of research studies have been conducted in many sugar cane growing countries to fine-tune the different methods of soil tests and establish threshold values for the major soil nutrients. Results of soil tests will identify the following:

- the pH value which will indicate the level of acidity. Sugar cane is known to favour soils which are not high in acidity and with pH values not less than 5.0. In soils with high acidity, some essential nutrients like phosphate are not available to the plant;

- the level of P_2O_5, if this exceeds 80 ppm (Cavalot et al, 1988), fertilizer phosphate application is unnecessary;

- the level of K_20; if this exceeds 0.50 m.e % K, no fertilizer potash is recommended; and

- the level of silicon; if less than 140 ppm, the soil is considered to be deficient in silicon and necessary amendment is warranted.

In Reunion Island, an expert system based on this technology has been developed for the small-scale farming systems to enable the small farmers to practice cost-effective fertilization in fields earmarked for replantation (Pouzet, Chabalier & Legier, 2003).

The above confirms that to enable optimal fertilization and to ensure good growth and development of the plant, a soil test prior to the establishment of the cane crop is essential. This will impact positively on productivity, be it production levels or production costs. Regarding the findings of the study on the practice of soil analysis prior to replantation (see Table 5.12: 108), it was found that only 57% of the respondents are aware of this technology. Given that the rate of adoption amongst those who are aware is high (82%), here again it can be inferred that non-adoption of the soil testing by a majority of Mauritian cane planters (53% of the respondents in this study), contributes to the productivity gap. Here again, extension may have a vital role to play to improve the level of awareness.

It is noted, however, that a significant percentage – although not the majority – of the respondents who were aware of these technologies did not adopt them. Therefore, while

awareness of technology options is an important factor to address the productivity gap, it is not the only answer. This theme is discussed later in this thesis (Section 7.5).

6.2 Information on and accessibility for technology, inputs, services and facilities

According to Rogers (2003), the innovation-decision process is one in which an individual once being aware of an innovation, will form an attitude towards it to arrive at a decision to either adopt or reject it, to use it and finally to evaluate it. He stressed on the point that the individual's decision to adopt an innovation is not immediate, but it occurs over time and follows through a process made up of sequences of actions and decisions. Information is a necessary pre-requisite in the decision-making process. This appears to be evidenced by the findings of this study where the majority of sugar cane planters who were aware of the three technologies promoting productivity adopted those technologies when they were aware of them. Conversely, those who were not aware, obviously, could not include such knowledge in their decisions.

Various sources of information exist for the small planters, namely extension, other planters, own experience, other organizations providing services and inputs. In the study (see Table 5.28: 118), it is found that approximately half of the respondents rely on extension via the FSCs for the provision of information for technology (51%) and inputs (50%). Under half (43%) of the respondents depend on extension for information on credit; over half (56%) do not. As noted in Chapter 5, Table 5.12 and Table 5.19, a majority of the respondents have knowledge of technology (an average of 64%; 71% for varieties, 64% for weed management and 57% for soil analysis) and of inputs (an average of 91% for fertilizers, herbicides and cane setts). This implies that other sources of information remain important. These other sources include other planters, knowledge developed with experience in farming, and knowledge acquired from parents or from other organizations or institutions providing services to the planters. This confirms that the small planters do not rely solely on information coming from extension and other sources for extension remain important; those engaged in extension should be aware of

this fact. It is known that extension cannot work in isolation if it is to achieve its primary goal of improving the knowledge base of its clientele. Oakley and Garforth (1985) submit that it is essential that the extension agent in the field knows and understands what his colleagues in other services and government departments are doing. According to these authors, close cooperation will avoid duplication of activities and provide opportunities for integrated farm programmes.

The findings (see Table 5.12: 108) also show that in Omnicane milling area, more planters have knowledge of technology than the other milling areas; 85% of the planters in Omnicane, compared to FUEL (59%) and Belle Vue (36%) (see in Table 5.12: 108). The rate of adoption of new varieties, new weed management strategies and soil analysis is also higher in Omnicane than in the other two milling areas. This study did not provide tangible evidence why higher percentages and rates of adoption are found in Omnicane and not in the other two milling areas, and further research is warranted to clarify issues like: whether there is more willingness from the planters in that specific milling area to invest in new technologies to improve their production levels; and whether extension should be more convincing in its approach to improve the knowledge base of the small planters in the other milling areas.

As indicated in Table 3.2 (Chapter 3), in Omnicane milling area, two main Centres and two sub-offices are in operation. In Belle Vue there is one main Centre and one sub-office (no longer operational) and at FUEL, only one main Centre. It can be argued that the proximity of extension to the small planters in Omnicane could have been an advantage. Based on the findings of the study, it can also be argued that the planters in Omnicane, with more small-sized fields (Section 5.2.3), with more experience (Section 5.25) and for whom field operations (at harvest and post-harvest) are easier (see in Table 5.3: 98), with higher percentages of fields with moderate fertility status and finally, for whom income is the more important reason for planting cane (77% of the planters in Omnicane compared to 67% in Belle Vue and 59% in FUEL) (see in Fig. 5.2: 105), may imply that they are more willing to adopt new technology in order to improve their productivity.

Presently, in the different milling areas of Mauritius, the Farmers Service Agency (FSA) with its current eight Farmers Service Centres, compared to 12, in 2011 when this study was initiated, and a staff of around 40 field officers, are solely responsible to service some 20000 small planters (described in Chapter 2). Traditional extension methods like farm visits, planters' vocational trainings and office calls are deployed to reach farmers. An assessment of how effective these methods are was not within the scope of this study, but based on the above findings, there is every reason to believe that such an exercise is warranted.

Related to this, when reviewing the results of the focus group discussions in Chapter 5 (Section 5.1), it was noted that regardless of the size of the work force, another 'revisiting' for extension is to change the way that the service perceives and engages farmers. The general tendency (not unique to Mauritius) is to see farmers as the end-users of extension services; as 'students' to be 'taught', as targets of an awareness or promotion campaign; the aim of which is technology adoption. If extension can shift this paradigm to one where farmers are seen as genuine partners in the research-extension mix, then the result is better, allowing for more relevant technologies and farmers who effectively take up some of the extension work. They become a practical part of the solution to the extension officer-planter ratio problem. However, this must be done genuinely and effectively; mere words will not suffice. Thus, one partnership is that embracing researchers, extensionists and farmers (S Worth, pers. comm., October, 2013). This theme will be explored more specifically in Chapter 7.

It is more or less confirmed that resources both in terms of finance and manpower will remain very limited. The ratio of extension worker to planters will not improve, at present there is one extension worker for every 600 to 700 small planters (FSA, pers. comm., November, 2013). The number of FSCs will definitely not improve and this implies that proximity with the small planters will be jeopardised. Therefore extension has to devise other ways and means to respond to this situation, to develop a new mindset and, as mentioned earlier, to accept that the small planters should be considered as genuine partners in the whole process from this point onwards.

6.3 Purposes and reasons for sugar cane farming

Another objective set in this present study was to identify the purposes perceived by the small planters for sugar cane farming in Mauritius and the reasons why they are involved in this specific business. As for the purposes, the respondents are conscious of their valuable contribution in the provision of cane to the sugar mills for processing into sugar and the production of other co-products like energy from bagasse and alcohol from molasses. They are also aware of providing casual employment to people living in the rural areas, as well as playing an important role in keeping Mauritius green (Government of Mauritius, 2006).

In 2012, some 18,000 small planters harvested an area of around 14,256 hectares and delivered a total of 892,000 tonnes of cane to the sugar mills, representing 22,7% of the total cane processed for sugar and other co-products in Mauritius for that year (Chamber of Agriculture, 2013). This contribution from the small planters is considered important and efforts to sustain that contribution are very apparent. The on-going project of regrouping small planters into larger units to improve production levels and reduce production costs, known as the Field Operations and Regrouping Project (FORIP) is a concrete example (Government of Mauritius, 2006).

Another purpose for sugar cane farming mentioned in the study is the provision of employment to rural people. Most of the field operations performed by the small planters are undertaken manually and in most cases not by the planters themselves, but by casual labourers. On average, it is estimated that one hectare of sugar cane will require 25 mandays for land preparation and planting (for an eight-year crop cycle) and annually around 50 mandays for pre-harvest, harvest and post-harvest operations. On this basis, it is assumed that the small planters are providing employment, annually on a casual basis, to nearly 5000 rural families. According to Statistics Mauritius (2011), the large commercial sugar cane planters employed annually on average 8800 labourers and on a permanent basis. It can be questioned why the small planters who are exploiting only 25% of the whole area under cane, are providing employment (even on a casual basis) to more people than the large establishments are able to.

This is explained by the fact that the large establishments are having recourse either to total or partial mechanization of their field operations. As described in Multi-Annual Strategy Plan 2006-2015, (MAAS) (Government of Mauritius, 2006), when the restructuring of the sugar industry started a few decades ago, and with the centralization of sugar mills into larger units, manual workers were encouraged to opt for voluntary retirement, better known as the Blue Print and later as Voluntary Retirement Scheme (VRS).

Hence, the contribution of the small-planters' sector in poverty alleviation through bringing additional income, even if minimal, to their households and to other rural families is significant and efforts to sustain this should not be neglected.

As to the preservation and protection of the environment, also mentioned by the respondents as a purpose for being in the cane business, it is recognized that sugar cane, being a perennial crop, has the potential to maintain the soil structure over a period of several years and is very effective in controlling soil erosion. If replaced by a less stable crop in the sloped marginal soils, this will result in accelerating soil erosion and washing off nutrients in the top soils, with disastrous effects on the reservoirs and lagoons. Over and above sugar, which is now manufactured using modern processing methods, the whole cane biomass and the by-products from sugar mills can be used in an environmentally friendly manner; bagasse for production of electricity; the scum or filter cake to improve soil fertility; and molasses for production of ethanol.

As described in MAAS (Government of Mauritius, 2006: 24),

> *"…the contribution of the sugar industry to the protection and preservation of the environment is multi-fold, it relates inter alia, to soil conservation, biological control of pests, minimal use of pesticides, the discharge of a minimal pollution load, carbon sequestration, avoidance of imports of fossil fuels and maintenance of a green landscape".*

"…The sustainability of the small planters (cultivating 10 hectares or less) and the reliability of the supply of their canes hold the key to the future viability of the sugar cane cluster".

The ability of the sugar cane plant to sequestrate carbon is known. According to Robbins (2011), rich countries are relying on poor countries to fight climate change, through the funding of projects to enhance carbon sinks, i.e. to sequestrate organic carbon in plants and soils instead of being present in the atmosphere as greenhouse gases.

As to the reasons for staying in the business, the main reasons identified by the majority (70%) of the respondents included a combination of income, family tradition and their duty to keep their field under sugar cane (see in Section 5.3.5 and Table 5.10: 104). Individually these reasons are not held by a majority of the respondents. Furthermore, for a majority of the respondents, the contribution of income from their sugar cane crop does not exceed 50% of their total household income (Section 5.37). It is possible that this may not be a significant problem for the respondents, as this activity is done on a part-time basis and their main income is derived from other sources. Making more use of existing credit facilities to further invest in this activity was also seen to be very minimal.

With increasing costs of labour and essential inputs like fertilizers and herbicides and with the continuing decrease in sugar prices in the world market, the threat of further erosion of net profits in the sugar cane business is real. It is clear that it can no longer be "business as usual" if the survival of the small planter sector is to be ensured. As discussed earlier, the contribution of this sector to the revisited Mauritian sugar cane industry is considered significant.

Determining whether it would be more convenient to redirect the small planters to other non-sugar activities was not within the scope of this study. It can be assumed that if it is agreed that the small planters' contribution to the sugar industry needs to be sustained, there will be no need to pursue that option. On the other hand, if the planters themselves decide to opt out of sugar cane planting and to reap more income from their agricultural lands by exploiting other non sugar activities, and if such opportunities exist, then it would be worthwhile to begin

moving in that direction. There are several issues which would need to be considered, however. These include:

- Most of the small planters are in the sugar cane business on a part-time basis;
- They are an ageing population and their children should be encouraged to take over these businesses and will require training; and
- As earmarked in the Strategic Programme, facilities exist for the non-sugar sector.

6.4 Achieving field potential

The last point, but definitely not the least important, is the issue of achieving productivity potential in small planters' fields. The key factor analysed was the fertility status, including the reasons for the prevailing fertility status and for current productivity levels (Section 5.3.3). In the three milling areas surveyed, it is worth noting that fertility statuses differ. For the majority of the small planters, the fertility status is not optimum and this implies that cane yields cannot be compared with those of the planters operating on fields with optimum fertility status. It is acknowledged that in the early days of the sugar industry, the small planters did not benefit from the best lands and that with limited resources, further investments to improve that situation had been possible only for the few who were able to afford this (Mundil, 1978). Their ancestors, who were among the indentured labourers brought from India after the abolition of slavery to replace the slaves who were working in the sugar cane fields, acquired some marginal lands. Over time and through hard work, they were able to buy land from the large planters and it is believed that in these cases, they were not offered the best quality land. The agro-climatic zones described in Chapter 3 (Section 3.14) have shown that the agricultural lands in Mauritius are heterogeneous, with different soil types, fertility statuses, degree of rockiness, varying rainfall regime and altitudes. This may explain the differential in responses in terms of the fertility statuses recorded in the three milling areas.

Despite long-held perceptions surrounding the root causes of lower productivity levels among the small planters, when compared to the large commercial planters, it is interesting to note

that in some way or the other, the small planters (92% of the respondents with high soil fertility) attributed high productivity to the adoption of good management and recommended cultural practices (Section 5.3.3). Good management practices generally include all those field operations and practices that are essential for the plant to grow and develop with minimum stress, etc. These operations / practices include, amongst others, appropriate timing of plantation, rational fertilization, judicious use of herbicides and irrigation water. These operations and practices may be an area which researchers and extensionists may wish to pursue in the future.

Several reasons were also reported by those not achieving potential yield. Research and extensions already have on-the-shelf solutions for identified problems such as inadequate irrigation water, poor land preparation prior to planting, small-sized fields hindering adoption of good management practices and old ratoons; it is only a matter of enabling the small sugar planters to believe in their benefits.

6.5 Relationship between farmers and the extension services and research

The participants in the focus group discussions unanimously shared a common vision of a healthy, collaborative and mutually beneficial relationship that leads to improved income and livelihood stability for producers, as well as job satisfaction for extensionists and researchers. It was argued that there was a disconnection between extension messages, farming realities and research; the knowledge and skills base of extensionists should be scrutinized in order to prevent service limitations and weak partnerships. An example of the disconnection between extension messages and their farming realities which was raised was that extension encourages cane producers to improve sugar content of their individual harvests in a context where their sugar content is, in most cases, averaged from an aggregate and hence shared with other planters. Although the planters understand the message, they have no incentive to adopt the necessary practices.

Another key factor that emerged from the focus group discussions is that the knowledge and skills base of the extensionists is not broad enough to enable them to provide holistic support to farmers. Some are trained specifically in cane production; some are trained in communications; some are trained in crop or animal production. As noted earlier, few were found to have any training in farm economics, business or marketing.

Of greater concern was that almost none of the extensionists have any formal training in agricultural extension. Some have studied extension in post-graduate situations, but such training is rarely practically based, in terms of helping to develop a basic skill set in farmer engagement. This manifested itself most strikingly in the session to create visions for improving extension. The participants – farmers, researchers and extensionists – struggled equally with basic extension concepts. While on the surface this hampered the discussion process, it was one of the most valuable lessons learned as it highlighted one of the key areas of 'revisiting' extension to meet the needs of small-scale farmers.

The disconnection also applies to research, where too often the fruits of excellent research fall beyond the reach of small-scale planters. Most of the technologies developed do not suit the small-scale farming systems, technologically, economically or practically. The participating researchers also acknowledged that their focus is on the technology itself and not on the economics or business aspects of it.

Finally it was recognized that there is little acknowledgment of the farmers' knowledge, expertise and experience. This does not only contribute to non-adoption of recommended technologies by the planters, but it deprives the research process of a wealth of knowledge that, if tapped, could both strengthen and speed up research.

Chapter 7

Summary, conclusions and recommendations

The local sugar industry has contributed significantly to the economic development of Mauritius in terms of foreign earnings and provision of employment in rural families. The whole biomass of the sugar cane plant, known to be the most efficient converter of solar energy, can be exploited. The sugar cane crop also contributes to environmental protection; due to its low, negative impact on soil conservation compared to other crops, it may protect the coastal areas and be a boost for the tourism industry. It has been, and will continue to be, an important element of Mauritian socio-political dynamics. Thus, the future of the sugar industry will have a substantial impact on a significant portion of the population – particularly those involved in cane production. The conversion of the sugar industry into a sugar cane industry, where the whole cane biomass will be utilized, adds more value to the cane business. On the other hand, decreasing international sugar prices and increasing costs of production are challenges that the sugar cane planting community will have to face. The small sugar cane planters forming part of that planting community are the most vulnerable and they will certainly need more attention from policy makers. Their cane lands are under pressure and over the years they have not been able to achieve the same production levels as the large commercial planters. However, their contribution to the Mauritian sugarcane industry is still acknowledged and will continue to be relied upon, especially in the context of improving the cost-effectiveness and sustainability of this industry. The development of rural areas is also, to a large extent, due to the determination of the small sugar cane planters to improve the living standards of their families.

This chapter summarizes the major findings of the study conducted among a sample of small sugar cane farmers in three major milling areas of Mauritius; it sheds some light on the main research question set and draws some conclusions based on the research conducted and the review of literature. It proposes a paradigm shift in the way research and extension are currently operating. It finally attempts to make some recommendations for the way forward in

view of improving the livelihood of the small sugar cane planters in Mauritius, while at the same time suggesting some areas for future research.

7.1 Clues to the cause of the persisting productivity gap between the large commercial and the small-scale sugar cane planters in Mauritius

Several factors have been identified from the findings of the study as being the causes of the productivity gap. Key among these are:

- Firstly, the small planter sector, being mostly an ageing population, is facing difficulties in implementing the major field operations that are essential to ensure a good sugar cane crop establishment;

- Most of the small planters perceived the fertility status of their fields as being low to moderate, hence not conducive for achieving optimum/potential yield;

- The rate of adoption of key technologies, especially new varieties, is below expectations; and

- Finally, low profitability of the sugar cane business is reported by a majority of the small planters, with this majority not relying on income from their cane as a main source of income. Hence, there is little to no investment at all on the part of the small planters to increase capacity and improve productivity of their sugar cane farms; this is a disincentive to take further risks and to adopt new technologies.

From the above, it can be noted that six key themes have emerged from the study: the demographics of the small sugar planters in Mauritius; factors affecting the implementation of their field operations; factors influencing the production potential of their fields; the importance of the income from their sugar cane business; factors affecting their adoption of key technologies; and their perceptions of the support services and credit facilities available to them. These were considered important to understand the reasons behind the persisting productivity gap among them, the main research question which this study has answered.

The primary research included in this study did not, by design, include corporate planters, thus no primary data concerning them is recorded. The factors leading to higher productivity among corporate planters are commonly understood to be access to better and more productive lands, greater resources, better managerial expertise, a closer relationship with research, and they can take greater risks than small planters, However, this knowledge is not empirically established or otherwise concisely documented in a credible source and therefore is beyond the scope of this thesis.

The following discussion of these six key themes addresses the objectives of the study to:

- identify the main reasons and purposes for the small planters to farm sugar cane;
- assess the small sugar cane planters' capacities to organize their farming operations;
- assess to what extent the small planters are reliant on their sugar cane income;
- identify the main constraints hampering productivity and profitability of the small planter sector; and
- assess the relevance and contribution of Research and Development (R&D) carried out in sugar cane farming and of the technology transfer effort to the small planter sector.

7.1.1 Planter demographics

A majority of the planters own small-sized fields (each less than one hectare), are male and are over 40 years old. Findings from previous studies that the small sugar cane planting community is getting older, with very few new entrants from the younger generation are thus confirmed. The majority of the small planters currently in the sugar cane business are part-time farmers, with more than 25 years of experience in farming. Among those farming sugar cane on a full time basis are essentially old age pensioners and retired persons.

While the foregoing captures a significant portion of the small planter population, it by no means accounts for all of them. The study showed that, perhaps contrary to persistent perceptions, cane planters cannot be simplistically dichotomized in large- and small-scale

planters. Neither can small scale planters be homogenized and viewed as possessing the same characteristics. The study confirmed that it is much more complex and is similar to the situation found in South Africa where agriculture is commonly viewed as dualistic, characterized by large-scale commercial farmers and small scale so-called subsistence farmers, but which characterization belies a *"more complex reality with a great diversity of agricultural systems and people – a continuum of farmers and farming"* (Worth, 2012: IX). While Mauritius does not perhaps present the same range of diversity, the study suggests there is sufficient diversity to warrant closer attention being paid by research and extension to the unique characteristics of farmers when designing extension and research programmes and interventions. As argued by Worth (2012: IX), *"while it is important to remove the realities of this duality, duality should not be the mainspring for planning agricultural transformation, development and extension; the danger of focussing on duality as the problem limits the scope, range and nature of responses required to ensure that South African farmers and its agriculture advance equitably into the future".*

Notwithstanding the diversity of planters, the older farmers comprise an important block within the spectrum; they also represent a particular challenge to research and extension. The study found that these older farmers are generally conservative, that is, they tend to stick to their traditional farming practices. They are reluctant to take risks – risks for further investments in their farming activities; risks for adopting new technology and farming operations; risks 'to follow' and be involved in new projects where they are not engaged as true partners; and especially risks 'to lead' change. A further review of literature on the risks that affect agricultural producers has revealed that much research has been conducted to identify the source of risk aversion. Two broad categories have been identified, namely, business and financial risk. Business risk is defined as being inherent in the farming operation, and is independent of the way in which the farm business is financed (Eidman, 1990; Hardaker *et al*., 2004 in (Mac Nicol, Ortmann, & Ferrer, 2007). The same authors define financial risk as "*the added variability of net returns to owner's equity that results from financial obligations associated with debt financing*" (Mac Nicol *et al.*, 2007, p. 357).

7.1.2 Factors affecting implementation of field operations

Among the most important field operations, replantation was deemed the most difficult, and is completed to their satisfaction for only half of the planters concerned. The degree of difficulty in performing replantation varies according to milling areas; easier in FUEL than in Belle Vue and Omnicane, and according to farm sizes; more difficult for those planters with larger farms (over one hectare in size).

The planters with more than 25 years' of experience face more difficulties in implementing all the operations than the least experienced planters. This is likely to be attributed to the fact that those planters with more than 25 years' of experience are also much more advanced in age, which limits their physical capacity and fosters a perception of greater difficulty.
More generally, labour constraints are the main reason rendering implementation of field operations difficult. This is supported by the fact that those planters reporting implementation of certain field operations as being easy attribute it to availability of self or family labour.

7.1.3 Factors influencing production potential

A majority of the small planters perceive that they are not achieving their field potential in terms of cane yields, due to the fertility status of their soils, which in turn is attributed to not adopting good management practices. Those planters who are able to meet their production potential are those who are more experienced (with over 15 years of experience) and those with smaller farm sizes (less than one hectare in size). The planters achieving their field potential owe this to the adoption of good management practices, as mentioned in Section 6.4.

In literature, several factors regularly identified as influencing the adoption of an agricultural innovation have been listed (Feder et al, 1985 in Zeller, Diagne, & Mataya, 1997). These are: farm size; risk exposure and capacity to bear risks; human capital; availability of labour; land tenure; and access to commodity markets. Some of these factors have been identified in this study – small-sized farms, unavailability of labour, lack of business profitability, no interest in further investment and unwillingness to be indebted by using credit facilities. All these

circumstances converge to a very crucial element in small-scale farming – reluctance to take risks or risk aversion.

7.1.4 The importance of income from cane farming

For the majority of planters, cultivating sugar cane is not for income only, but also for perpetuating their family tradition and showing a sense of duty by not leaving sugar cane lands idle. Less than a third of the planters grow sugar cane for income only; the majority of these planters are found in Omnicane milling area. The majority of planters in FUEL milling area farm cane to continue their family's tradition and are adopting better weed management practices to keep their fields clean. Keeping fields clean/weed-free may be related to tradition where despite the costs, certain small planters adamantly refuse to allow weeds to grow in their sugar cane fields.

For those planters farming for income, the majority is not achieving that objective; only one third declares that the sugar cane business is profitable. The very slight to no dependence of the small planters on income from sugar cane may be due to the fact that farming sugar cane is essentially a part-time activity for them; little less than half of them are old-age pensioners. However, this low level of dependence on income from sugar does not imply that an opportunity to improve income from their crop will not be considered by these planters; but simply that their expectations for more income generation from sugar are not being met.

7.1.5 Factors affecting the adoption of key technologies and inputs

The majority of the planters are aware of three key technologies related to productivity: new sugar cane varieties; better weed management practices; and the practice of soil analysis prior to replantation. However, not all of them are adopting these technologies. Those planters using the technologies appear to be motivated by the desire for better cane yields. This is evidenced by higher rates of adoption observed in Omnicane milling area than in the other two milling areas. This may be related to the finding that most of the planters growing cane for income are found in that particular area. The rate of adoption of new varieties tends to be higher among

planters with larger farm sizes and it is known that more frequent and partial replantation is common among those planters with large farms, as they cannot afford to replant the whole farm all at once. It can be argued that those planters not using the technologies are either still not convinced of any yield improvement or cannot afford any further investment due to insignificant returns from the cane business, which reinforces the prevalence of disincentives to invest and of risk aversion. Those planters with sugar proceeds contributing to more that 5% of their household income tend to show higher rates of technology adoption than those where income from sugar cane totals less than 5%.

The great majority of planters who are aware of major inputs like fertilizers and herbicides utilize them, with the rate of adoption being over 90%. Again, it is not surprising to see that planters in Omnicane milling area are the highest users of those inputs and the reason for this, as mentioned earlier, is to improve yield for higher income.

All these findings confirm the argument that in anticipation of better cane yields which will improve productivity and livelihood, small planters will willingly adopt new technologies and inputs. The findings have indicated that this is more prevalent in Omnicane milling area. This may be due either to extension being more present in that milling area, as suggested earlier in Chapters 5 and 6 or that the planters see a brighter future for their cane business in the rapid expansion of that particular mill. These are issues that need to be investigated and confirmed in future research.

7.1.6 Perceptions about support services and credit

Even though the majority of the small planters are aware of the services provided by the FSCs, access to these services differs across the milling areas. In Omnicane milling area, FSC services seem to be more accessible. Other planters in the region also represent a non-negligible source of information.

Despite having knowledge of credit facilities, a substantial majority of the small planters are not taking advantage of credit for the simple reason that they do not want to be indebted. As discussed in Chapter 5, this gives further evidence to the argument that the small sugar cane

planters in Mauritius see no further gains in taking credit to increase capacity, due to very low returns from their sugar cane business.

7.2 The primary causes of the productivity gap

The findings of this study outlined in the previous sections have shown that the cause of the productivity gap is not due to a single factor, but to several factors which fall into two broad categories: one related directly to the farmer profiles; the other related to the farmer-extension-research relationships.

With regard to the farmer profiles, the reflection on the six themes suggests that the outward cause for the productivity gap is the failure to adopt productivity improving technologies and practices. There are, however, motivators for this behaviour, and these appear to be relative to age, perceptions of soil fertility and income; each of these is directly related to issues of incentive and risk. The factors identified in the study all point to the lack of sufficient incentive to mitigate risk averse behaviour.

Age: The small planter sector, being mostly an ageing population, is facing difficulties to implement the major field operations that are essential to ensure the establishment of a good sugar cane crop.

Perceptions about fertility: Most of the small planters' fields are claimed to be of low to moderate fertility status, hence not perceived to be conducive for the planters to achieve optimum/potential yield.

Income: Low profitability of the sugar cane business is reported by the majority of the small planters; with this majority not relying on income from their cane as a main source of income. Hence, there is little to no investment at all on the part of the small planters to increase capacity and improve the productivity of their sugar cane farms; this represents a disincentive to take further risks and to adopt new technologies.

With regard to the farmer-extension-research relationship, as discussed earlier, the study showed that the small planters are generally not connected to the research process in any meaningful way. Such a disconnection further reduces incentives to consider technology options provided by research through extension. Thus, the nature of the farmer-extension-research relationship – the fact that it is a one-way, linear, technology transfer approach is clearly another significant contributor to the persisting productivity gap.

7.3 Implications of the study findings

The heterogeneity of the small planter sector in Mauritius in terms of farmers' ages, farm size, reason for farming sugar cane and performance in terms of achieving yield potential (as outlined in Section 7.2), suggests that a uniform, undifferentiated approach to extension and research (as well as other services) is not appropriate. The failure of extension and research to actively involve the planters in each step of the process is a result of the assumption that the approach which works in the main for the corporate farmers, will also work for the small planters. This study shows that this is not the case and that the unique circumstances of the small planters must be fully incorporated into the research process. Logically, this can only be done if the farmers are fully engaged with this process.

There is thus urgency to review and change the structure and process of engaging research and extension with one another, as well as both individually and collectively with the planters. Figure 7.1 adapts the theoretical framework for research and extension developed and proposed in Chapter 3, to address the specific needs of the small sugar cane planting community in Mauritius based on the findings of this study. In keeping with the principles of that framework, Figure 7.1 suggests a number of significant changes to the way in which research and extension engage with planters – both corporate and non-corporate.

As discussed in Chapter 3, the current approach which is used is one that has been fairly typical of large research organizations. It is driven largely by the scientists who determine research needs through various means, including interacting with extension and with the corporate planters. Non-corporate, small scale planters are generally not included in this process. Once

'needs' have been determined, researchers work in relative isolation. Planters and extension agents are not directly involved in the research process until the new technology is 'ready'. The primary change suggested by the proposed "Extension and Research Pathway" is to increase the frequency of participation of the planters in the research process. For the non-corporate farmers this means being engaged directly in the process instead of indirectly. For the corporate farmers, it means increasing engagement. The two categories of planters (corporate and non-corporate) are deliberately kept apart for administrative purposes of research and extension, but this is not meant to qualify their behaviour or define them in terms of their capacity to engage with extension and research processes. The dotted line linking them perfectly indicates that they will be in constant interaction. Planters are to be engaged at all stages in the cycle – not just at the beginning and the end.

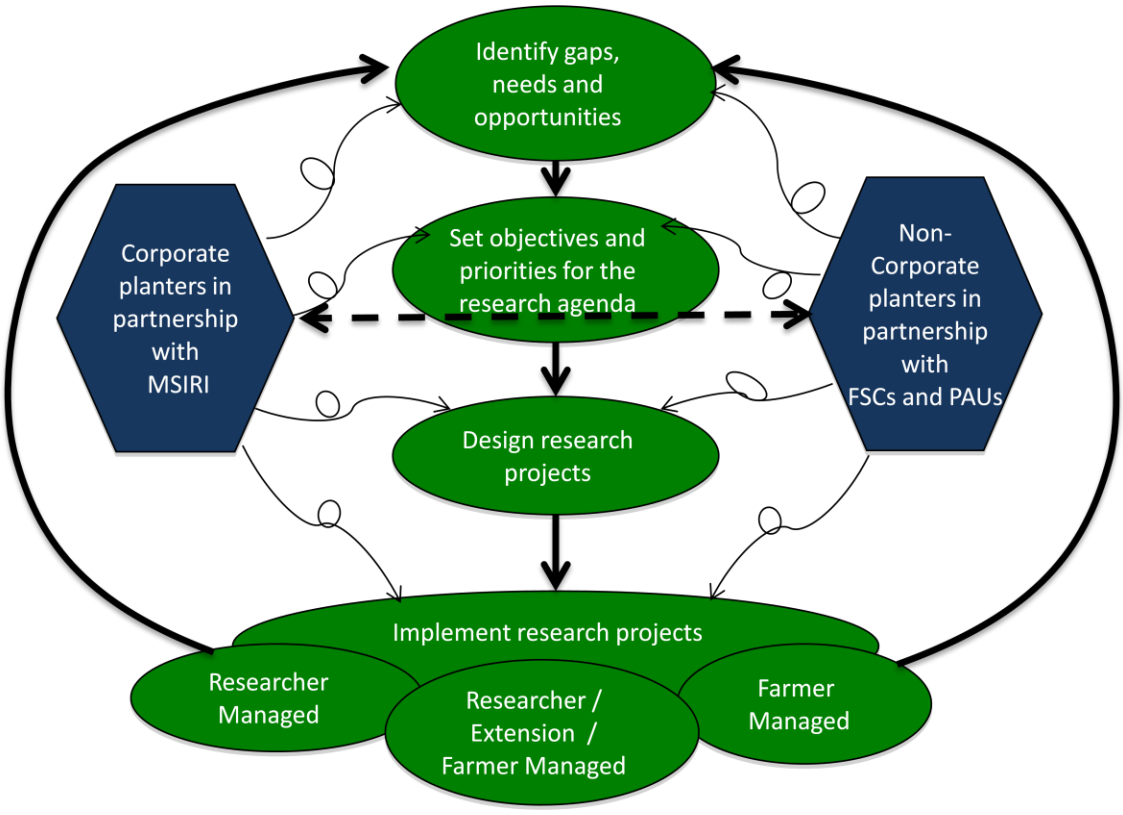


Figure 7.1: Proposed research & extension pathway for sugar cane in Mauritius

Secondly, the nature of the engagement changes. Denoted by looping lines, planters are engaged via an iterative process which is characterized by planning, acting and reflecting. At each stage in the process, planters, researchers and extension walk together along a pathway of learning. Together they identify gaps, needs and opportunities, set objectives and priorities for the research agenda and design research projects.

The third change suggested by the "Research and Extension Pathway" is giving institutional recognition and legitimacy to three distinct approaches to research projects: projects that are managed solely by researchers; projects that are managed jointly by research, extension and planters (or a combination thereof); and projects that are managed solely by planters. This depiction of the research process retains the space in which researcher-driven research can be conducted, but it also introduces the concept of jointly managed research projects. Perhaps, most significantly, it also suggests the introduction of farmer managed research projects.

Ultimately, of course, the results of the research have to be shared and the process resumed – and a new cycle commences.

The challenge which this approach presents is not inconsiderable. It requires the research institution to 'reverse' a number of its processes. As noted by Bang (1999), it requires a reversal of location of research from the research station to the farm; it requires a reversal of learning resulting in researchers learning from farmers; and it requires a reversal of the explanation of non-adoption where the relevance and appropriateness of the research/technology, and not the farmer, is questioned if it is not adopted by the farmer. If there is any transfer of technology, it will be from farmer to researcher.

However, as straightforward as this appears, implementing such a change requires more than just the researchers (and research institution) to change. It requires planters to engage as equal partners in the research and learning processes. After a long history of being excluded and viewed both by the researchers, themselves and peers as mere recipients of the findings of research, it will require deliberate effort by the planters themselves to engage in the proposed "pathway", as suggested. They will require accompaniment.

As the third partner in the research dynamic, accompaniment falls to extension. As argued by Worth (2006) to assist farmers to arise to meet the formidable challenge of participating as co-researchers, extension will need to actively support farmers in acquiring the skills, practice and confidence for active learning.

And finally, as mentioned earlier, the proposed "pathway" suggests the institutionalization of a range of research project management arrangements. This will require both the research institution and the extension service to actively support farmer managed research projects.

7.4 Future options for the Mauritian small sugar cane planters

In all aspects of the proposed "pathway", the FSA and the MSIRI will have to better understand the realities of the small planters in terms of realistic future options based on their reasons for farming cane and respond accordingly. Three somewhat sobering options emerged from this study: improving productivity to improve livelihoods; maintaining the status quo; and opting out of sugar cane as a source of livelihood. Figure 7.2 summarizes the salient factors derived from this study that lead to these three options for small cane growers in Mauritius.

According to MAAS (Government of Mauritius, 2006), the Mauritian sugar cane industry has to attain a critical mass of nearly five million metric tonnes of cane supplied by the different producer categories. Over the years, the contribution of the corporate planters has not exceeded 75% of this critical mass, despite massive investments in modernizing their farms and the adoption of the latest technologies and available good management and crop husbandry practices. This implies that, as discussed earlier, the 25% contribution from the non-corporate planters, which mainly comprise the small planters, will still need to be relied upon. Thus, their sustainability and the reliability of their input in that targeted critical mass are crucial for the viability the sugar cane cluster.

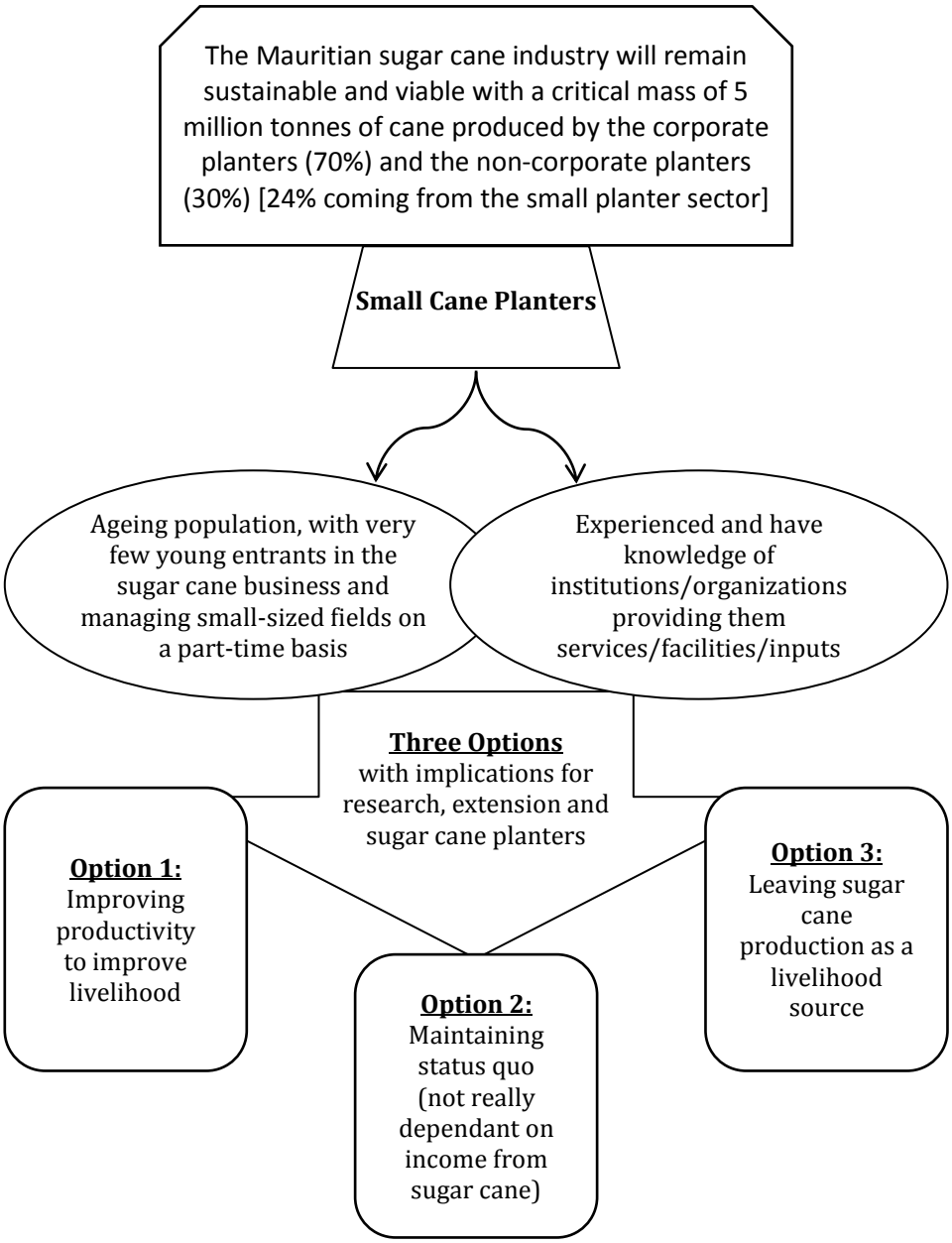


Figure 7.2: Future options for the small scale sugar cane farming systems in Mauritius.

The study has enabled an in-depth understanding of the context of the small sugar cane planters in Mauritius, and has also highlighted some of the factors that are contributing to the persistent productivity gap. With respect to the small sugar cane farming systems in Mauritius and the reasons which are keeping the small planters in the sugar cane business, the findings of

the study provide sufficient arguments to conclude that the three options need to be considered if Mauritius wants to improve the livelihood of the small sugar cane planters and their families. These options are discussed below.

Option 1 – Improving productivity to improve livelihood

Based on the discussion in Chapter 5 (sections 5.3.1 and 5.3.3), this option is most suited to those small planters who are farming sugar cane for income; those who are achieving their field potential which they attribute to the adoption of good management practices and those who see their sugar cane business as profitable. The study suggests that this category of small planters presents more opportunities for research and extension to intervene if the ultimate aim is productivity enhancement.

At the same time, as noted in the previous section, how these planters are engaged will need to change to ensure their maximum participation in all aspects of the research/extension process. While they are more motivated to adopt technologies and appear to be less risk averse, their engagement in the overall process of identifying and prioritising issues, and participating in the design, implementation and reflection on the outcome of research projects is still required.

This category of planters comprises approximately 70% of the small planter community. As discussed in Chapter 5 (section 5.3.1.), 70% of the small planters are farming cane for a combination of reasons – income, family tradition and sense of duty. They are making use of of nearly 11000 ha of land, with the potential of producing nearly a million tonnes of cane biomass annually. Thus this group provides a leverage point for improving productivity and narrowing the persistent productivity gap.

Option 2 – Small planters wanting to maintain status quo

Option 2 is for the category of planters who are essentially farming sugar cane to maintain family tradition. As also discussed in Chapter 5 (section 5.3.1), some may also be farming for income and others for the reason of not allowing their fields to be unoccupied or idle. However, the study suggests that neither of these reasons for planting act as sufficient drivers or

incentives to overcome risk aversion needed to invest in researching and adopting new technologies. This category of planters may see their sugar cane business not contributing significantly to their total household income; some may even have incomes that remove the necessity of relying on the income from their sugar/cane proceeds. However, this study does not suggest that engaging with these planters in the extension and research process should be abandoned entirely. It merely suggests that they lack sufficient incentive to be involved. It is possible that if these planters are engaged as per the proposed "pathway" they may find the incentive to adopt the necessarily more appropriate farming solutions that will emerge. This is based on the principle that participation tends to promote ownership and interest. In the generally difficult economic conditions prevailing worldwide and in Mauritius, it can be argued that once actively engaged, these planters will not reject the opportunity to earn additional income through participating in researching, developing and adopting productivity and income improving technologies.

Option 3 – Opting out of the sugar cane business

This option is suggested in the case of the stark reality that for some of the small planters, sugar cane farming presents a very different image – a business which is no longer profitable. This category of small planters may, in the eyes of some, represent a threat to the viability of the sugar cane industry in Mauritius by not contributing to the critical mass of cane discussed earlier. On the other hand, improving their livelihood is a challenge for research and extension, as these planters have the least incentive and greatest disincentive to engage in research and technology development. Rather, the study suggests that an exit strategy needs to be devised, where these planters are assisted to identify alternatives to sugar cane farming – whether this is on or off the farm. While this dynamic was beyond the scope of this study, and this particular finding will require further research, extension would still have a responsibility to work with these planters and to walk with them through the transition. It can be safely argued that engaging them in a manner similar to that outlined in the proposed "Pathway" would prove productive and helpful, as the principles of participation are applicable in this instance as well.

7.5 Implications for research and extension

This study is proposing a framework for agricultural extension, research and technology development against which the situation of the small planters has been interpreted. Hopefully, it will provide means to propose strategies that will address the multi-faceted issues that frame the dynamics of the sugar cane industry of Mauritius.

The literature reviewed on research and extension has opened avenues to different ways of functioning. Research specialists can no longer claim that they alone can come up with solutions to the persisting problems that small scale sugar cane planters are facing. Extension agents, instead of proposing 'technical solutions' received from research specialists need to accept that their clientele may be expecting a different service. If their ultimate goal is to improve livelihood, both research and extension need to engage the planters in the entire process of developing production and farm business solutions.

The study suggests that risk and risk aversion behaviour in relation to decision making among the small cane planters is a key element in understanding why the productivity gap persists. It further argues that this can be decreased by providing information that reduces the uncertainty of that decision and by more directly and completely involving the planters in the research process. More reliable and timely information will need to be made available to planters in forms that are relevant to their particular circumstances.

For the Mauritian sugar cane industry to remain competitive in a continually globalizing market environment, an enabling business environment that will help to reduce risk and uncertainty for producers and a process to reduce risk aversion will need to be created and implemented by policy makers. Small planters need to be assisted by extension to objectively identify risk and develop risk management strategies that will minimize constraints to improved productivity.

As discussed in Chapter 3 (section 3.2.4.7), interdependence and linkages between major institutional actors in an Agricultural Research an Extension System (ARES) are widely recognized as essential for an effective flow of technology and information between research,

extension and the farmer. Extension needs to have a broader vision of agriculture and should also act as consultants and facilitators for collective action. To be able to address new challenges, extension should play a wider role with a diversity of objectives, amongst which include linking farmers to markets more effectively and responsively; enhancing crop diversification; coupling technology transfer with other marketing services; improving livelihood; and capacity building to enhance innovation and empower farmers for increased bargaining power.

As noted earlier, to engage the planters in the proposed research process is a challenge. It cannot be imagined that it will be materialized without creating the right environment for it to happen. The same may be said for the research specialists and the extension agents. This research process includes an innovation where planters will be encouraged to 'learn by doing'. They will be responsible for managing some simple research projects either by themselves or in partnership with extension and research. Training and accompaniment will be required for all the participants in this revised approach – researchers, extension agents and planters – in order for them to acquire the knowledge, skills, attitudes and behaviours needed to implement and support such a fundamental change in the way that research is conducted. It is submitted that the development, implementation and improvement of the process itself will be an iterative process where the three key participants will be engaged in collective and mutual learning by doing, following a process of planning, acting and reflecting. Through this process, they will build the capacity, coherence, systems, institutions and processes that will inevitably be required to facilitate and maintain the transformation and to keep it responsive to the equally inevitable changes that the Mauritian sugar cane industry and its planters will face in the coming years.

It is essential for extension to assist the planters who will be exiting sugar cane farming with the intention of earning income from non-sugar cane activities on their agricultural lands. Many issues need to be addressed during the transition period:

- Most of the small planters are in the sugar cane business on a part-time basis, there is the challenge of how these planters cope if their new, non-sugar activities will require more of their time and attention;

- They form mostly an ageing population; therefore their children need to be encouraged to take over. They will require training and assistance; and

- The question of what will happen to these lands, located in remote and non-residential areas, if these planters decide to opt for non-agricultural activities.

These and many other questions that will arise from implementing this particular recommendation from this study highlight the need for extension staff to be trained with skills beyond agricultural production. They will need to be versed in other aspects of farm business, in particular, agricultural business management and agricultural economics, as outlined by Worth (2008).

This study has clearly shown that if it is intended to maintain the viability of the Mauritian sugar cane industry by keeping the small scale sugar cane planters on board and productive, specifically those who still see a future in the business, then Mauritian extension has to reinvent itself. Extension will have to learn how to accompany the planters in this challenging process to enhance capacity building and develop their ability to decide on what is more fitting for them to improve their livelihood. In addition to working with planters, extension will also have to help research specialists learn and understand that genuinely engaging the planters in the research process will avoid unnecessary claims from the latter of 'inappropriate' technologies being made available to them; it will, in fact, contribute to the adoption of technologies. The desired transformation will require all parties – extension, research and farmers – to come together and work with a common vision and mode of operation. The most likely leader of this transformative process will be the extension service.

7.6 Recommendation for further study

This study has discussed primarily the concern of the persistence of the productivity gap between large and small sugar cane planters in Mauritius. In addition to addressing that question, it has proposed fundamental changes in the ways that extension and research engage planters, and it has suggested three options that frame the nature of the overall extension engagement. In addition, it has raised a number of new issues that merit further research.

In order for the new research process to work effectively, all three participants – research specialists, extension and planters – will need to acquire the knowledge and skills needed to actively engage and genuinely participate in the quest for technologies and field practices that will result in improved productivity and livelihood.

Extension is best positioned to take the lead to determine the specific training needs of researchers and other stakeholders who will have the challenging role of accompanying the small planters as they assume their unaccustomed role of being engaged in the new research pathway and subsequently continue to fulfil their two-fold mission: meeting their own objectives for growing sugar cane; and contributing to the continued viability and sustainability of the Mauritian sugar cane industry.

While it was not the intention of this study to question the need for some of the sugar cane planters to exit the sugar cane business, the study clearly indicated that it is inevitable that some will, indeed, need to do so. Those planters who will be finally opting to do something other than sugar cane farming will need to be accompanied and be given the necessary support and incentives. Being beyond the delimitations of this study, the types of support and incentives that will be needed are still to be identified. Given the deeply entrenched consciousness of their contribution to the role which the sugar industry has played so far in the economic development of Mauritius, it is anticipated that the small scale farmers will be still very willing to continue contributing to the Mauritian economy. Policy makers, research, extension and planters will need to investigate suitable methods and means of making this happen.

The study has established that the uptake of credit facilities which are available to the small sugar cane planters is low but has not determined the reasons for this low uptake. It was also argued that uptake of credit is connected to risk. Further research to help understand the reasons for low uptake of credit is therefore warranted.

7.7 The Way forward

Establishing closer, practical working relationships between farmers, extension services and research in the identification, development and testing of technologies is an urgent priority. Emphasis is placed on the 'practical working relationship' where it is not a matter of simply identifying needs of farmers and developing technologies, but actively engaging farmers and extensionists in the research process at every step of the way. This is essentially a review of operational policy.

It is imperative to consider providing training of extensionists and researchers in Participatory Technology Development. Thereafter there will be a need to engage the extensionists in training farmers in the same, with a view to building capacity among farmers, to participate in scientific enquiry; looking for solutions to identified problems and responses to identified opportunities.

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Appendix 1: Consent form for respondents

Project Title

Exploring the cause of the persisting productivity gap of small scale sugar cane planters in Mauritius: new directions for research & development and agricultural extension.

Main research question

Why does a profitability gap between small scale sugar cane planters and large commercial sugar cane planters persist despite efforts made in research, development and extension?

Statement of the project aims and objectives

- To identify main constraints hampering productivity and profitability of the small planter sector; and
- To assess the relevance and contribution of Research and Development carried out in sugar cane and of the technology transfer effort to the small-planter sector.

Contact details of Investigator

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Selection of farmers for the study

Some 200 small-scale farmers, owning sugar cane fields of less than ten (10) hectares and operating in the sugar cane milling areas of *Terra* (ex - Belle Vue sugar estate in the North), *Flacq United Estates Limited* (FUEL in the East) and *Omnicane* (Savannah and Rose Belle in the South) growing sugar cane on areas have been randomly selected to participate in the study.

Contribution of the selected farmers in the study

The farmer will voluntarily participate in the study by providing information to better understand why they are not being able to improve their production levels despite efforts made in research and development. The exercise will be conducted through individual interviews using a questionnaire which has been prepared after informal discussions with research scientists, extension officers and some farmers.

Potential benefits to be derived from participating in the study

The study will attempt to identify the major factors that are limiting improved production levels among small-scale sugar cane farmers. The outcome of this study will certainly assist policy makers and relevant institutions providing services to this category of farmers to revisit and improve their approach for the betterment of the local sugar industry.

Requirements from farmers participating in the study

Participation will be voluntary

Apart from devoting around 1½ hours for the interview, there will be not any financial expenses on the part of the farmers.

Refusal on the part of any farmers to participate in the study will not result on any form of disadvantage or entail any sanctions.

Any farmers willing to withdraw from the study at any stage or for any reason will be free to do so and this will not result in any form of disadvantage or sanctions.

Use of data collected or any recordings (written, audio or video) made

The information will be treated as confidential and any inferences made after analyses carried out by the investigator will be solely used to formulate relevant recommendations to concerned authorities as mentioned in section 8.

Declaration by the participant

I, …… (full names of participant) hereby confirm that I understand the contents of the document attached and the nature of the research project, and I consent to participating in the research project.

I understand that I am at liberty to withdraw from the project at any time, should I so desire.

…… ……

SIGNATURE OF PARTICIPANT DATE

Appendix 2: Questionnaire for individual interviews

Milling area

Sample code

SIFB Acct Number of Planter: | | | | | | | | Date of interview: | | | | | | |

1. Name of farmer

2. Postal/Residential Address

3. Farm size

4. Family size

Adult	Children (< 18 years)

5. Type of land ownership (self, family or leased)

6. For how long how you been growing sugarcane? ____ years

7. What are your main reasons for growing sugar cane?

8. How farmer is conscious of his contribution to the Mauritian economy? (not to be asked)

8.1 For what purposes is sugar cane cultivated in Mauritius

1.
2.

8.2 How do you think you are contributing towards these purposes?

1.
2.

Access and affordability

9. Management issues

9.1 How do you evaluate your access to the information required for sugar cane cultivation?

(I want to know how easy/difficult it is for them to get information; is it in form that they can use (language, graphics)

9.2 Once the information is available, how do you afford to make use of it?

9.3 Evaluation of the farmer's capacity to organize his farming operations

List main farming operations,

What is easy, what is difficult? Why?
Capacity is in personal ability to do or manage the operation
Does he have enough labour?
Do you have the time to each of these things; which get compromised or short-changed?
Do you always have the money to do each of these operation; which ones get compromised or short-changed?
How do you decide?

Main farming operations on the farm	Easy or difficult to manage?	Why?	How do you afford to implement to your satisfaction the major farming practices required?		
			Enough time to do it?	Enough finance?	Done only partially

10. Production issues

10.1 How do you rate the fertility of your sugar cane lands?

High		Medium		Low	

10.2 On what basis are you giving this rating?

10.3 What did you do to get this rating?

10.4 Where did you learn to do that?

10.5 What is your production potential? …… t cane ha^{-1}

10.6 Are you achieving it? Yes…….. / No ……..

10.7 If yes, what are you doing to achieve it?

10.8 If no, why?

11. Use of on-the-shelf new research findings , inputs, existing infrastructures/institutions and credit facilities

11.1 New research findings

What are the new research findings available to sugar cane farmers?

What are the new research findings you are currently using?

Why?

How effective are they? ……

How do they affect productivity? ……

Where did you learn about them? ……

How do you access these technologies?

……

How do you finance them? (e.g. do you own them, borrow them, work with other farmers, etc)

……

What are the other new research findings available that can enable you achieving higher production levels and that you are not using?

Why do you not use them?

What can be done to make you use them?

11.2 Inputs

What are the major inputs required by sugar cane farmers?

What are the inputs you are currently using?

Why?

How effective are they? ……

How do they affect productivity? ……

Where did you learn about them? ……

How do you access these inputs? ……

How do you finance them? (e.g. do you own them, borrow them, work with other farmers, etc)

……

What are the other inputs available that can enable you achieving higher production levels and that you are not using?

Why do you not use them?

How can you access these inputs or do you manage to afford them?

11.3 Infrastructures / Institutions

What infrastructures / institutions are in place to support your sugar cane cultivation?

What are the infrastructures/ institutions you are currently getting access to?

Why?

How effective are they? ……

How do they affect productivity? ……

Where did you learn about them? ……

How do you access these infrastructures? ……

What are the implications in terms of time, costs involved, etc.? ……

What are the other infrastructures / institutions that are in place and can enable you achieving higher production levels and that you are not getting access to?

Why?

What can be done to access these infrastructures / institutions?

11.4 Credit facilities

What credit facilities are available to support your sugar cane cultivation?

What are the credit facilities you are currently using?

Why?

How efficient are they? ……

How do they affect productivity? ……

Where did you learn about them? ……

How do you access these credit facilities? ……

How do you manage to abide to the terms and conditions attached to these credit facilities?

What are the other credit facilities that are in place and can enable you achieving higher production levels and that you are not getting access to?

Why?

What can be done to access these credit facilities?

12. Marketing

What products are obtained from the canes that you are sending to the mill?

How are these products marketed?

What do you think of this marketing system?

What other systems can be used?

Why?

13. Income

What percentage does income from sugar cane contribute to your total income?

Do you have income from other activities on your farm?

What percentage your income from your sugar cane production contributes to your overall family income?

How reliant are you on your income from sugar?

What other sources of income for your family?

Who works full-time on the farm?

Who works part-time on the farm?

Full time	Part time

Who earns income off the farm?

Appendix 3: List of small planters interviewed per milling area

Belle Vue (48 planters)

SIFB Acc. No.	Sample Code	Name of planter	Address1	Address2	Date of Interview
0574953	0_1S1	Rajguru Bucktowar	Latapie Road	Brisée Verdière	16-Mar-12
0574840	0_1S1	Geeandan Soogary	Sewraj Road	Triolet	14-Mar-12
0572730	0_1S1	Soonduth Kumaree Naga	Royal Road	Brisée Verdière	02-May-12
0543636	0_1S1	Mawtea Jeewooth	Royal Road	8eme mile, Triolet	16-Aug-12
0574328	0_1S2	Dooheetah Lutchmun	M Gandhi Road	Mon Gout	29-Mar-12
0501543	0_1S2	Baldeo Dodah	Kallee Road	Fond du Sac	18-Apr-12
0575176	0_1S2	Mrs Bibi Nazimah Bhugaloo	Amaury Road	Mare d'Australia	30-Apr-12
0572875	0_1S2	Premchand Futtingah	Canton Nancy	Pamplemousses	08-May-12
0574727	0_1S2	Premchandur Jaunky	-	UK	06-Jul-12
0502236	0_1S3	Amjad Damree	Royal Road	Vale	15-Mar-12
0574691	0_1S3	Farook Joolia	Boodhun Road	Upper Vale	28-Mar-12
0572247	0_1S3	Shradanand Jugroop	Royal Road	Villebague	30-Mar-12
0573145	0_1S3	Sawoocoomar Behary	Royal Road	Congomah	11-Apr-12
0571819	0_1S3	Soliedewo Sobnauth	Jourence	D'Epinay	27-Apr-12
0571434	0_1S3	M Prasad Radhay	Royal Road	D'Epinay	28-Jun-12
05443229	1_2S1	Rooplall Ramguth	Royal Road	Upper Vale	21-Feb-12
0522503	1_2S1	Asgar Ally Auleear	Royal Road	Triolet	14-Mar-12
0575179	1_2S1	Shyam Meetun	Mahadeo Road	Mlle Jeannne, Goodlands	04-Jul-12
0574532	1_2S1	D & M Seebah	Queen Elizabeth St	Petit Raffray	27-Jun-12
0575033	1_2S1	Nundlall Dhunnoo	TBS Lane	Triolet	20-Jul-12
0575282	1_2S1	Ramalingum Moonsamy	8eme Mile	Triolet	20-Jul-12
0523142	1_2S1	Indulsingh Inderjeet	Indira Gandhi Road	Triolet	28-Jul-12

SIFB Acc. No.	Sample Code	Name of planter	Address1	Address2	Date of Interview
0517399	1_2S1	Vidwantee Babooa	8th Mile	Triolet	28-Jul-12
0502522	1_2S2	Deonarain Autar	Luna Street	Petit Raffray	03-May-12
0572902	1_2S2	Mrs Lutchmee Bachoo	Shivala Road	Mon Gout	12-Jun-12
0543358	1_2S2	S Aboo Mohamedally	Royal Road	Plaines des Papayes	28-Aug-12
0573176	1_2S3	Seeparsad Mohabeer	Royal Road	Grand Baie	09-Mar-12
0571510	1_2S3	Ramsamy Ponin	Melanie Road	D'Epinay	09-Mar-12
0575163	1_2S3	Ww Nundrany Kullen	Royal Road	D'Epinay	15-Mar-12
0574859/ 0502155	1_2S3	Mrs B R Kinoo and Hamad Mohanut	34, Louis Xavier Street	Port Louis	11-May-12
0575286	1_2S3	B Soormah Nuckchady	Royal Road	Morc. St Andre	24-Aug-12
0574722	1_2S3	Nilwantee Seechurn	Royal Road	Morc. St Andre	29-Aug-12
0502706	2_5S1	Ashokdewa Gooriah	Bon Air Road	Morc. St Andre	05-Apr-12
0574831	2_5S1	Jugdut Ramkhalawon	Royal Road	Fond du Sac	12-Apr-12
0521417	2_5S1	Sukai Noopnarain	8th Mile	Triolet	28-Jul-12
0522414	2_5S1	Premduth Faugoo	Derningham	Triolet	02-Sep-12
0573419	2_5S2	Krishnaduth Khoobarry	Royal Road	Congomah	24-Apr-12
0543263	2_5S2	Deywanand Dukhi	Ajodha Road	Cottage	09-May-12
0502866	2_5S2	Teznarayen Rughoo	Forbach Road	Poudre D'Or Hamlet	31-Jul-12
0543023	2_5S3	Abdool Imran Chowtee	Mosque Road	Upper vale	06-Mar-12
0575252	2_5S3	R Hemoo	Ruisseau Rose	Montagne Longue	07-Mar-12
0543481	2_5S3	Mrs S Ramsurrun	SSR Road	Goodlands	10-May-12
0502487	2_5S3	Kemraj Soowamber	Shakespear Road	Fond du Sac	23-May-12
0568234	2_5S3	Premdun Toofany	Tagore Road	Fond du Sac	31-May-12
0566025	2_5S3	Manilall Purgus	Tagore Road	Fond du Sac	21-Aug-12
0566778	5_10S1	Coomar Bachwa	Shakespeare Road	Fond du Sac	24-Feb-12
0502177	5_10S2	Kabeeraze Ramkissoon	Royal Road	Fond du Sac	08-Jun-12
0571668	5_10S3	Ww Deojanny Sunkur	Royal Road	Montagne longue	04-May-12

FUEL (29 planters)

SIFB Acc. No.	Sample Code	Name of planter	Address1	Address2	Date of Interview
2506827	0_1S1	Bhaye Assam Boodhoo	Bonne Veine Road	Quartier Militaire	19-Apr-12
2501885	0_1S1	Mrs Sharda Bodhonah	Royal Road	Providence	20-Apr-12
2507255	0_1S1	Megnath Rughoobur	Rughoobur Road	Laventure	23-Jun-12
1014310	0_1S1	Bhye Shumud Ramoo	Medine	Camp de Masque	08-Apr-13
2501874	0_1S2	Bibi Amina Peerun	Avenue Paille en Queue	Medine	20-Jun-12
2505780	0_1S2	Roopnarainsing Chatoorsing	Royal Road	Pellegrin, Sebastopol	04-Jul-12
2504185	0_1S2	C Seebaluck	Shivala Road	St Julien D'Hotman	28-Jun-12
2586345	0_1S2	Bhagiahwatee Meettoo	Royal Road	Quatre Cocos	28-Jun-12
1314723	0_1S2	Soodhoo Hossen	Bombay Road	Providence	09-Apr-13
2589911	0_1S2	Lutchmun Rajroop	Ave des Colombes	Mont Ida	03-Apr-13
2586062	0_1S2	Bhye K Azad Hosseny	Ave des Moineaux	Medine Camp de Masque	06-Apr-13
2586513	0_1S3	Beebee Mooneza Bessendyal	Royal Road	Providence	22-Jun-12
341459	0_1S3	Sarengum Pillay Samoo	Vullemin		09-Apr-13
2506201	1_2S1	Societe Belmont	Saint Julien		22-Jun-12
2505741	1_2S1	Arumoogum Soobrayen	Royal Road	Queen Victoria	22-Jun-12
00000	1_2S1	Paraseeven Samoo Pillay	New Road	Quartier Militaire	09-Apr-13
2502153	1_2S1	Jugduth Seewooram	Medine	Camp de Masque	09-Apr-13
2586591	1_2S2	A R Noorbaccus	Royal road	Brisee Verdiere	25-Jun-12
25-	1_2S2	Ramjeet Gungah	Royal Road	Providence	04-Apr-13
2586699	1_2S3	Ramjee	Royal Road	Dubreuil	28-Jun-12
2504117	1_2S3	Abdool Wahab Eathally	Royal Road	Mont Ida	09-Apr-13
2589515	2_5S1	Succ Bibi Fatmah Sohun	Royal Road	Mont Ida, Medine	21-Jun-12

SIFB Acc. No.	Sample Code	Name of planter	Address1	Address2	Date of Interview
2504250	2_5S1	Mahendranath Bhuruth	Royal Road	Saint Julien Village	02-Jul-12
2506122	2_5S1	D M Bissessur	Bissessur Lane	Camp de Masque	02-Jul-12
2581096	2_5S2	Succ Irana Jagesswarsingh	Tancrel Road	Montagne Blanche	04-Jul-12
2589462	5_10S1	Baboo D Ramdour	Royal Road	Bon Accueil	26-Jun-12
2505294	5_10S2	Preeyavrat Bundhoo	I Bouquet Road	Saint Croix	21-Jun-12
2587596	5_10S2	Mowlabacas R A and Muslim Moosbaly	Peeroo Lane	Camp de Masque	21-Jun-12
2587776	5_10S2	Krishna Kathapermall	Royal Road	Lalmatie	21-Jun-12

Omnicane (70 planters)

SIFB Acc. No.	Sample Code	Name of planter	Address1	Address2	Date of Interview
2152347	0_1S1	Manikon Mudali	SWC Road	Chemin Grenier	25-Jun-12
2153472	0_1S1	Balraj Greedharry	Jumbo Road	Chamouny	24-Jun-12
2153217	0_1S1	Poospavadee Permal	Surinam Road	Surinam	06-Jul-12
0710364	0_1S1	Chabeelall Rughoo	Chemin Puit	Union Park	02-Jul-12
2102525	0_1S1	Jankeesaw Dilleea	Royal Road	Surinam	01-Jul-12
2151341	0_1S1	B Zoolhajah S Doomon	Vishnu Mandir Road	Chemin Grenier	23-Jul-12
2101886	0_1S1	Aneerod Poontah	Royal Road	Trois Bras	19-Jul-12
2102017	0_1S1	Seeparsad Pitumbur	Royal Road	Surinam	19-Jul-12
2103061	0_1S1	Deoduth Jugmohunsing	Surinam Road	Surinam	19-Jul-12
2152932	0_1S1	Daivaiguy :Pauvaray	Martiniere Road	Surinam	19-Jul-12
2103069	0_1S1	Mira Kadharoo	Royal Road	Souillac	23-Jul-12
2102246	0_1S1	Rajagopal A Ramsamy	Martiniere Road	Surinam	30-Jun-12
2201465	0_1S2	Omdut Bhageerutty	Royal Road	Mare d'Albert	12-Apr-12
2202420	0_1S2	Booknath Ruggoo	Royal Road	Mare d'Albert	01-Mar-12
2152073	0_1S2	Hurrylall Peeay	Sawmill Lane	Chamouny	23-Jun-12
2153276	0_1S2	Sacheedanand Mahabir	Royal Road	Chamouny	28-Jun-12
2102008	0_1S2	Balmick Boodhun	Camp Goolbar	Chemin Grenier	09-Jul-12
2152769	0_1S2	Satiadeve Aurtaram	Jumbo Road	Chemin Grenier	23-Jul-12
2102620	0_1S2	Radicka Muddoo	Community Centre Road	Chamouny	22-Jul-12
2153447	0_1S2	Kiswanand Joyram	Tamarin Road	Chamouny	20-Jul-12
2151501	0_1S2	Keolee Sawaruth	Gujadhur Road	Chamouny	19-Jul-12
2152614	0_1S2	Narainduth Nundun	Satanah Road	Chemin Grenier	24-Jul-12
2102523	0_1S2	Sanjaye Ramooah	Jooloom Road	Chemin Grenier	20-Jul-12
2152356	0_1S2	Yousoof Rossaye	New Mosque Road	Chemin Grenier	20-Jul-12

SIFB Acc. No.	Sample Code	Name of planter	Address1	Address2	Date of Interview
0710553	0_1S3	Leelaprakash Matoo	Royal Road	La Flora	03-Jul-12
0711760	0_1S3	Lutchmeen Toory	Cooperative road	La Flora	27-Jun-12
0710580	0_1S3	Toolsylall Matoo	Mattoo Lane	La Flora	12-Jun-29
0701945	0_1S3	Roopnarain Matoo	Royal Road	La Flora	12-Jun-29
0702545	0_1S3	Hurrydutt Matoo	Matoo Street	La Flora	27-Jun-12
0702815	0_1S3	Hanund Gomanee	Royal Road	Pont Coville	08-Jul-12
2270308	1_2S1	Ahmud Sariff Khoosee	Royal Road	L'Escalier	12-Apr-12
2151959	1_2S1	J Ramnundun	Royal Road	Surinam	22-Jun-12
2153460	1_2S1	Manjulla Devi Kissoona	Tamil Temple Road	Surinam	21-Jun-12
2102131	1_2S1	Tamodarain Moodelly	Riambel	Surinam	09-Jul-12
2102042	1_2S1	Krishnaduth Ramdarshan	Royal Road	Surinam	28-Jun-12
2102915	1_2S1	Ashok Sampat	Martiniere Road	Surinam	27-Jun-12
2152459	1_2S1	Ramsamy Krishnah	Jumbo Road	Chemin Grenier	09-Jul-12
2152949	1_2S2	Porunjay Joyram	Chamouny Road	Chemin Grenier	18-Jun-12
2153502	1_2S2	Succ. Raouf Jugoo	Keenoo Road	Chemin Grenier	22-Jun-12
2153405	1_2S2	Bibi Mehnaz Jugoo	Keenoo Street	Chemin Grenier	26-Jun-12
2153025	1_2S2	Chandradthsing Gooransing	Lotus Road	Chemin Grenier	29-Jun-12
2102001	1_2S2	Ponama Chengubroyen	Camp Jeanette	Chemin Grenier	28-Jun-12
2102606	1_2S2	Soobarassen Coopen	Tamarin road	Chamouny	25-Jun-12
2152818	1_2S2	Apalsamy Yancadoo	Camp Jeannette	Chemin Grenier	07-Jul-12
0710241	1_2S3	Parbatee Moottyloll	College Lane	Grand Bois	28-Jun-12
0702587	1_2S3	Bhurroonsing Mathoorasing	15, Lees Street	Curepipe	13-Jun-12
0710475	1_2S3	Cossile Budhan	Morcellement VRS	Grand Bois	28-Jun-12
0701661	1_2S3	Soondur Matoo	Royal Road	Mare d'Albert	03-Jul-12

SIFB Acc. No.	Sample Code	Name of planter	Address1	Address2	Date of Interview
0702539	1_2S3	Parmessur Matoo	Royal road	La Flora	03-Jul-12
2102168	2_5S1	Juswantsing Gowardun	Martiniere Road	Surinam	24-Jun-12
2101564	2_5S1	George Louis Desire	Chemin Prunes	Surinam	24-Jun-12
2101642	2_5S1	Kylashsingh Dhunputh	Royal Road	Surinam	01-Jul-12
2152638	2_5S1	Permila Devi Dhunputh	35, Avenue Cossigny	Quatre Bornes	30-Jun-12
2152366	2_5S1	Vishal Sampat	Martiniere	Surinam	27-Jun-12
2101719	2_5S1	Hurryduth Sampat	Sampat Road	Surinam	27-Jun-12
2152540	2_5S1	Rudi Rughoonundun	1, avenue des Palmiers	Quatre Bornes	25-Jun-12
2101551	2_5S2	Zikaria Moosafeer	Jumbo Road	Chemin Grenier	24-Jun-12
2102024	2_5S2	Daramduth Unnuth	Unnuth Road	Chamouny	26-Jul-12
2152838	2_5S2	Rajanand Khadoo	Royal Road	Chamouny	24-Jul-12
2102639	2_5S2	Aslam Mohammad Moosafur	Jumbo Road	Chemin Grenier	22-Jul-12
2152359	2_5S2	Sundaresan Rungasamy	Royal Road	Chemin Grenier	21-Jul-12
0701855	2_5S3	Debha Ramcharrundass Mohall	Le Grand Rd	Grand Bois	28-Jun-12
0702059	2_5S3	Basdeosing Runglall	Morcellement VRS	Grand Bois	28-Jun-12
0701919	2_5S3	Bhoochandrasing Jagutpal	Royal Road	Grand Bois	04-Jul-12
21022508	5_10S1	Dropnath Hardas	Balance Road	Surinam	11-Jul-12
2102981	5_10S1	Parmanand Hardas	Martiniere Road	Surinam	10-Jul-12
2101588	5_10S1	Atteeyanun Hardas	Riambel	Surinam	09-Jul-12
2102780	5_10S1	Chandun Hardas	Balance Road	Surinam	07-Jul-12
2152329	5_10S1	Nikhil Rughoonundun	1, Avenue des Palmiers	Quatre Bornes	25-Jun-12
2102726	5_10S2	Ameer A Jaufuraully	Royal Road	Chemin Grenier	25-Jun-12

Appendix 4: Findings of study

1. Planters bio-data

1.1 Number of farmers interviewed / milling area

Milling area	Frequency	%
Belle Vue	48	33
FUEL	29	20
Omnicane	70	48
Total	147	100

1.2 Number of farmers interviewed / sample code

	Sample code											
	0_1 S1	0_1 S2	0_1 S3	1_2 S1	1_2 S2	1_2 S3	2_5 S1	2_5 S2	2_5 S3	5_10 S1	5_10 S2	5_10 S3
Frequency	19	24	14	19	13	13	14	9	9	7	5	1
%	13	16	10	13	9	9	10	6	6	5	3	1

1.3 Farm size/milling area

	% of respondents by milling area			
Farm size	Belle Vue (n=48)	FUEL (n=29)	Omnicane (n=70)	Total n=147
0.01 - <= 1 ha	23	48	69	50
1.01 - <= 2 ha	27	24	23	24
2.01 - <= 5 ha	29	10	7	15
> 5 ha	21	17	1	11
Total	100	100	100	100

1.4 % of ownership in relation to milling area

	% of respondents by milling area			
Land ownership	Belle Vue (n=48)	FUEL (n=29)	Omnicane (n=70)	Total n=147
Self	54	55	84	69
Family	23	17	11	16
Leased	6	28	1	8
Self / Leased	12	0	1	5
Family / Leased	2	0	1	1
Self / Family	2	0	0	1

1.5 Land ownership in relation to farm-size

	% of respondents in relation to farm size				
Land ownership	0.01 - <= 1 ha n=73	1.01 - <= 2 ha n=36	2.01 - <= 5 ha n=22	> 5 ha n=16	Total n=147
Self	75	64	68	50	69
Family	16	11	23	19	16
Leased	5	17	5	6	8
Self / Leased	1	8	5	13	5
Family / Leased	1	0	0	6	1
Self / Family	0	0	0	6	1
Total	100	100	100	100	100

1.6 Experience sugar cane production in relation to farm size and milling area

		% of respondents in relation to Period in sugarcane cultivation				
Farm size	Milling area	< 5 yrs n=4	> 5 - 10 yrs n=17	> 10 - 15 yrs n=10	> 15 - 25 yrs n=37	> 25 yrs n=79
0.01 - <= 1 ha n=73	Belle Vue	18	27	9	9	36
	FUEL	0	7	0	50	43
	Omnicane	0	13	10	27	50
	sub total	3	14	8	29	47
1.01 - <= 2 ha n=36	Belle Vue	0	8	0	23	69
	FUEL	0	14	29	29	29
	Omnicane	13	13	0	31	44
	sub total	6	11	6	28	50
2.01 - <= 5 ha n=22	Belle Vue	0	0	7	7	86
	FUEL	0	33	0	0	67
	Omnicane	0	0	0	40	60
	sub total	0	5	5	14	77
> 5 ha n=16	Belle Vue	0	20	0	30	50
	FUEL	0	0	20	0	80
	Omnicane	0	0	0	0	100
	sub total	0	13	6	19	63
	Total	3	12	7	25	54

2. Reasons for planting cane

2.1 Reasons for planting cane

Individual Responses				Grouping of responses		
Reasons for planting cane	Frequency	% by respondents		Reasons for planting cane	Frequency	% by respondents
Income	42	29		Income	103	70.1
Tradition	25	17		Tradition	85	57.8
Tradition + Income	34	23		To leave field occupied	39	26.5
Tradition +Income + Not to leave field unoccupied	10	7		Leisure	12	8.2
Income + Not to leave field unoccupied	9	6		No other alternative	4	2.7
Not to leave field unoccupied	5	3		For children	1	0.7
Tradition + Not to leave field unoccupied	5	3				
Tradition +Income + Not to leave field unoccupied + Leisure	5	3				
Tradition + Not to leave field unoccupied+ Leisure	4	3				
No other alternative	3	2				
For children	1	1				
Tradition +Income + Leisure	1	1				
Income + Not to leave field unoccupied+ Leisure	1	1				
Tradition + No other alternative	1	1				
Income + Leisure	1	1				
Total	147	100				

2.2 Reasons for planting cane in relation to farm size

	Reasons for cultivating sugar cane (% of respondents by farm size)					
Farm size	Income	Tradition	To leave field occupied	Leisure	No other alternative	for children
0.01 - <= 1 ha n=73	74	56	40	11	3	1
1.01 - <= 2 ha n=36	69	58	14	6	0	0
2.01 - <= 5 ha n=22	59	59	18	5	9	0
> 5 ha n=16	69	63	6	6	0	0

2.3 Reasons for planting cane in relation to milling area

	Reasons for cultivating sugar cane (% of respondents by milling area)					
Milling area	Income	Tradition	To leave field occupied	Leisure	No other alternative	for children
Belle Vue n=48	67	48	17	2	4	0
FUEL n=29	59	72	14	10	3	3
Omnicane n=70	77	59	39	11	1	0
Total	70	58	27	8	3	1

2.4 Reasons for planting cane in relation to gender

	Reasons for cultivating sugar cane (% of respondents)					
Gender	Income	Tradition	To leave field occupied	Leisure	No other alternative	for children
Female	64	54	21	11	7	4
Male	71	59	28	8	2	0

3. Is planter conscious of his contribution in the national economy

3.1 Why sugarcane is grown in Mauritius?

3.1 a Farmers response (s)				3.1 b Grouped response (s)		
Response (s)	Frequency n=147	% by respondents n=147		Reasons	Frequency n=147	% by respondents n=147
Foreign earnings	86	59		Foreign earnings	133	91
Foreign earnings + Providing employment	31	21		Providing employment	47	33
Foreign earnings + Providing employment + Environment Protection	10	7		Environment Protection	18	12
For sugar production	5	3		Sugar production	5	3
Providing employment	5	3				
Foreign earnings + Environment protection	5	3				
Environment Protection	2	1				
Providing employment + Environment Protection	1	1				

3.2 How is the planter contributing in the sugarcane industry in Mauritius?

3.2 a Farmers response (s)				3.2 b Grouping of responses		
Reasons	Frequency n=147	% by respondents		Reasons	Frequency	% of respondents
Providing cane to the mill	74	50		Providing cane to the mill	125	85
Providing cane to the mill and employment	35	24		Providing employment	59	40
Providing employment	11	7		Environment Protection	20	14
Providing cane to the mill, employment and environment protection	10	7		Cane fields properly maintained	1	1
Providing cane to the mill and environment protection	6	4		No reply	6	4
Providing employment and environment protection	3	2				
Environment protection	1	1				
Cane fields properly maintained	1	1				
No reply	6	4				

3.3 Why is sugarcane grown in Mauritius in relation to milling area?

	% of respondents per milling area		
Reasons	Belle Vue (n=48)	FUEL (n=29)	Omnicane (n=70)
Foreign earnings	85	100	91
Providing employment	19	34	41
Environment Protection	4	14	17
Sugar production	10	0	0
No response	4	0	0

3.4 How is the planter contributing in the sugarcane industry in Mauritius in relation to milling area?

	% of respondents per milling area		
Ways	Belle Vue	FUEL	Omnicane
Providing cane to the mill	88	97	79
Providing employment	31	38	47
Environment protection	4	21	16
Cane fields properly maintained	0	3	0
No reply	8	0	3

3.5 Why is sugarcane grown in Mauritius in relation to farm size?

	% of respondents per farm size			
Reasons	0.01 - <= 1 ha n=73	1.01 - <= 2 ha n=36	2.01 - <= 5 ha n=22	> 5 ha n=16
Foreign earnings	93	92	77	100
Providing employment	33	25	36	44
Environment Protection	16	3	18	6
Sugar production	1	3	14	0
No response	1	0	5	0

3.6 How is the planter contributing in the sugarcane industry in Mauritius in relation to farm size?

	% of respondents per farm size			
Ways	0.01 - <= 1 ha n=73	1.01 - <= 2 ha n=36	2.01 - <= 5 ha n=22	> 5 ha n=16
Providing cane to the mill	86	86	73	94
Providing employment	36	28	64	56
Environment protection	15	3	27	6
Cane fields properly maintained	0	0	5	0
No reply	4	3	9	0

3.7 Why is sugarcane grown in Mauritius in relation to experience in sugarcane?

	% of respondents per period of experience				
Reasons	< 5 yrs	> 5 - 10 yrs	> 10 - 15 yrs	> 15 - 25 yrs	> 25 yrs
Foreign earnings	100	76	90	97	91
Providing employment	0	47	30	32	32
Environment Protection	0	24	20	16	8
Sugar production	0	0	0	0	6

3.8 How is the planter contributing in the sugarcane industry in Mauritius in relation to experience in sugarcane?

	% of respondents per period of experience				
Ways	< 5 yrs	> 5 - 10 yrs	> 10 - 15 yrs	> 15 - 25 yrs	> 25 yrs
Providing cane to the mill	2	11	8	26	54
Environment protection	3	8	5	24	59
Providing employment	0	21	11	32	37
Cane fields properly maintained	0	0	0	0	100
No reply	0	0	17	17	67

3.9 Why is sugarcane grown in Mauritius in relation to gender?

	% by gender	
Reasons	Female n=29	Male n=118
Foreign earnings	90	92
Providing employment	31	33
Environment Protection	7	12
Sugar production	3	3
No response	3	1

3.10 How is the planter contributing in the sugarcane industry in Mauritius in relation to gender?

	% by gender	
Ways	Female n=29	Male n=118
Providing cane to the mill	83	86
Providing employment	45	39
Environment protection	10	14
Cane fields properly maintained	0	1
No reply	10	3

4. Access and affordability

4.1 Accessibility to information

	Frequency	% of respondents
Information easily available through extension, is easy to understand and is useful	101	69
Information easily available through extension and is difficult to understand	13	9
Information easily available through other planters	12	8
Personal experience or family	12	8
not easily available	11	7
Other sources, e.g CCS, Contractors, etc.	3	2
Not interested to have information	2	1
no response	3	2

4.2 Accessibility to information in relation to milling area

	% of respondents per milling area		
Response	Belle Vue	FUEL	Omnicane
Information easily available through extension, is easy to understand and is useful	58	72	74
Information easily available through extension and is difficult to understand	2	7	14
Information easily available through other planters	23	3	0
Personal experience or family	25	0	0
not easily available	2	17	7
Other sources, e.g CCS, Contractors, etc.	4	0	1
Not interested to have information	2	0	1
No response	4	0	1

4.3 Accessibility to information in relation to farm size

	Frequency per farm size			
Responses	0.01 - <= 1 ha	1.01 - <= 2 ha	2.01 - <= 5 ha	> 5 ha
Information easily available through extension, is easy to understand and is useful	68	69	68	69
Information easily available through extension and is difficult to understand	10	14	5	0
Information easily available through other planters	3	11	9	25
Personal experience or family	4	6	14	25
not easily available	11	6	5	0
Other sources, e.g CCS, Contractors, etc.	3	0	5	0
Not interested to have information	1	3	0	0
no response	3	0	5	0

4.4 Accessibility to information in relation to experience in sugar cane

	% of respondents by period of experience				
Responses	< 5 yrs	> 5 - 10	> 10 - 15	> 15 - 25	> 25 yrs
Information easily available through extension, is easy to understand and is useful	2	12	9	25	52
Information easily available through extension and is difficult to understand	0	23	0	31	46
Information easily available through other planters	0	17	0	0	83
Personal experience or family	8	8	8	25	50
not easily available	0	0	0	36	64
Other sources, e.g CCS, Contractors, etc.	33	0	0	0	67
Not interested to have information	0	0	0	50	50
no response	0	0	33	0	67

4.5 Accessibility to information in relation to gender

	Gender	
	% of respondents by gender	
Responses	Female	Male
Information easily available through extension, is easy to understand and is useful	69	69
Information easily available through extension and is difficult to understand	10	8
Information easily available through other planters	7	8
Personal experience or family	14	7
not easily available	3	8
Other sources, e.g CCS, Contractors, etc.	0	3
Not interested to have information	0	2
No response	3	2

4.6 Once the information is available, can you afford to use it?

Response	Frequency	% of respondents
Yes	119	81
No	13	9
Not applicable	3	2
No response	7	5
Easy but not accessible	5	3

4.7 Once the information is available, can you afford to use it (in relation to milling area)?

	% of respondents per milling area		
Response	Belle Vue	FUEL	Omnicane
Yes	88	72	80
No	2	24	7
Not applicable	6	0	0
No response	4	3	6
Easy but not accessible	0	0	7

4.8 Once the information is available, can you afford to use it (by gender)?

	% of respondents by gender	
Response	Female	Male
Yes	21	79
No	8	92
Not applicable	33	67
No response	14	86
Easy but not accessible	20	80

4.9 Once the information is available, can you afford to use it (in relation to experience acquired in sugar cane)?

	% of respondents by period of experience				
Response	< 5 yrs n=4	> 5 - 10 yrs n=17	> 10 - 15 yrs n=10	> 15 - 25 yrs n=37	> 25 yrs n=79
Yes	3	14	6	24	53
No	0	0	0	38	62
Not applicable	0	0	0	33	67
No response	14	0	14	14	57
Easy but not accessible	0	0	40	20	40

5. Organization of farming operations

5.1 Which operation is more easy / difficult to the farmer?

	Frequency			% of respondents		
Field operations	Difficult	Easy	No response	Difficult	Easy	No response
Replantation (including land preparation, coarse and fine derocking, furrowing, setts preparation, planting and recruiting)	89	56	2	61	38	1
Pre-harvest practices (including fertilizer and herbicide application, manual weeding and trashing)	67	77	3	46	52	2
Harvest and post-harvest practices (including harvesting, trash lining, etc.)	70	69	8	48	47	5

5.2 Which operation is more difficult to the farmer in relation to farm size?

	% respondents per farm size			
Field operations	0.01 - <= 1 ha n=73	1.01 - <= 2 ha n=36	2.01 - <= 5 ha n=22	> 5 ha n=16
Replantation (including land preparation, coarse and fine etc)	53	69	64	75
Pre-harvest practices (including fertilizer and herbicide application, etc.	41	53	45	50
Harvest and post-harvest practices (including harvesting, trash lining, etc.)	42	58	55	38

5.3 Which operation is easier to the farmer in relation to farm size?

	% respondents per farm size			
Field operations	0.01 - <= 1 ha n=73	1.01 - <= 2 ha n=36	2.01 - <= 5 ha n=22	> 5 ha n=16
Replantation (including land preparation, coarse and fine etc)	40	36	23	56
Pre-harvest practices (including fertilizer and herbicide application, etc.	62	42	32	63
Harvest and post-harvest practices (including harvesting, trash lining, etc.)	51	44	36	50

5.4 Which operation is more difficult to the farmer in relation to experience in sugar cane?

	% of respondents by period of experience				
Field operations	< 5 yrs n=4	> 5 - 10 yrs n=17	> 10 - 15 yrs n=10	> 15 - 25 yrs n=37	> 25 yrs n=79
Replantation (including land preparation, coarse and fine etc)	2	11	4	29	53
Pre-harvest practices (including fertilizer and herbicide application, etc.	3	12	6	27	52
Harvest and post-harvest practices (including harvesting, trash lining, etc.)	3	10	7	27	53

5.5 Which operation is easier to the farmer in relation to experience in sugar cane?

	% of respondents by period of experience				
Field operations	< 5 yrs n=4	> 5 - 10 yrs n=17	> 10 - 15 yrs n=10	> 15 - 25 yrs n=37	> 25 yrs n=79
Replantation (including land preparation, coarse and fine etc)	4	13	11	20	53
Pre-harvest practices (including fertilizer and herbicide application, etc.	3	11	5	24	58
Harvest and post-harvest practices (including harvesting, trash lining, etc.)	1	12	9	25	54

5.6 Which operation is more difficult to the farmer and why?

	Reasons for difficult - % by respondents stating field operations difficult				
Field operations	Labour constraint	Machine not available	Expensive	Old age	No reply
Replantation (including land preparation, coarse and fine etc)	76	6	13	4	0
Pre-harvest practices (including fertilizer and herbicide application, etc.	75	0	13	6	6
Harvest and post-harvest practices (including harvesting, trash lining, etc.)	77	0	3	0	20

5.7 Which operation is easier to the farmer and why?

	Reasons for difficult - % by respondents stating field operations difficult				
Field operations	Contractor	Done by planter	Labour available	Good planning	No reply
Replantation (including land preparation, coarse and fine etc)	21	45	18	7	9
Pre-harvest practices (including fertilizer and herbicide application, etc.	12	55	17	8	9
Harvest and post-harvest practices (including harvesting, trash lining, etc.)	13	55	17	9	6

5.8 Which operation is more easy / difficult to the farmer in relation to time constraint / availability?

	Difficult			Easy		
	Time constraints - % of respondents stating field operations difficult			Time constraints -% of respondents stating field operations easy		
Field operations	Yes	No	No response	Yes	No	No response
Replantation (including land preparation, coarse and fine etc)	62	36	2	89	5	5
Pre-harvest practices (including fertilizer and herbicide application, etc.	60	36	4	90	5	5
Harvest and post-harvest practices (including harvesting, trash lining, etc.)	61	30	9	84	4	12

5.9 Which operation is more easy / difficult to the farmer in relation to financial constraint / availability?

	Difficult			Easy		
	Financial constraints - % of respondents stating field operations difficult			Financial constraints -% of respondents stating field operations easy		
Field operations	Yes	No	No response	Yes	No	No response
Replantation (including land preparation, coarse and fine etc)	60	36	4	77	16	7
Pre-harvest practices (including fertilizer and herbicide application, etc.	51	42	7	83	12	5
Harvest and post-harvest practices (including harvesting, trash lining, etc.)	54	34	11	80	10	10

5.10 Which operation, qualified as difficult is very often completed partly?

	Operations partly completed			
	% of respondents stating field operations difficult			
Field operations	Yes	No	No response	No of respondents
Replantation (including land preparation, coarse and fine etc)	36	51	13	100
Pre-harvest practices (including fertilizer and herbicide application, etc.	37	52	10	100
Harvest and post-harvest practices (including harvesting, trash lining, etc.)	31	53	16	100

5.11 List major operations and done by whom

	Operations done by whom?					
	% of respondents					
Field operations	Casual labour	Self	Contractor	Self + Casual labour	No reply	Total
Replantation (including land preparation, coarse and fine etc)	65	22	11	1	1	100
Pre-harvest practices (including fertilizer and herbicide application, etc.	57	33	8	0	2	100
Harvest and post-harvest practices (including harvesting, trash lining, etc.)	57	29	7	0	7	100

5.12 Which operation is more easy / difficult to the farmer in relation to milling area?

	Belle Vue			FUEL			Omnicane		
	Easy (E)	Difficult (D)	No response (NR)	E	D	NR	E	D	NR
Replantation (including land preparation, coarse and fine etc)	31	67	2	55	38	7	33	61	31
Pre-harvest practices (including fertilizer and herbicide application, etc.	42	54	4	45	48	7	57	40	42
Harvest and post-harvest practices (including harvesting, trash lining, etc.)	33	54	13	45	55	0	56	40	33

6. Production issues

6.1 Fertility status of farmers' fields

Status	Frequency	% of respondents
High	39	27
Moderate	87	59
Low	19	13
No response	2	1
Total	147	100

6.2 Fertility of soil in relation to milling area

	% of respondents per milling area			
Status	Belle Vue (n=48)	FUEL (n=29)	Omnicane (n=70)	Total n=147
High	50	21	13	27
Moderate	48	69	63	59
Low	0	10	23	13

6.3 Fertility of soil in relation to farm size

	% of respondents per farm size			
Status	0.01 - <= 1 ha n=73	1.01 - <= 2 ha n=36	2.01 - <= 5 ha n=22	> 5 ha n=16
High	16	31	41	44
Moderate	66	58	50	44
Low	18	11	9	0

6.4 Fertility of soil in relation to land ownership

	% of respondents in relation to type of ownership						
Status	Self n=101	Family n=24	Leased n=12	Self/Leased n=7	Family/Leased n=2	Self/Family n=1	Total n=147
High	24	33	17	57	50	0	27
Moderate	65	50	50	29	50	0	59
Low	11	17	25	14	0	0	13

6.5 Fertility of soil in relation to experience in sugar cane

	% of respondents per period of experience in sugarcane cultivation				
Status	< 5 yrs n=4	> 5 - 10 yrs n=17	> 10 - 15 yrs n=10	> 15 - 25 yrs n=37	> 25 yrs n=79
High	25	41	30	16	28
Moderate	50	47	50	59	63
Low	25	12	20	22	8

6.6 Qualification of fertility of soil based on?

	Judgement based on					
Status	Better yield in neighbours' fields	Yield better than neighbours	Better yield in neighbours' field + Soil less fertile	Better yield than neighbours + Irrigation available + Derocking completed	Soil more fertile	Same as neighbours
High	10	72	3	13	3	0
Moderate	62	18	5	0	2	13
Poor	100	0	0	0	0	0

6.7 Reasons for current fertility status

	How fertility status achieved? - % of respondents per fertility status					
Status	Good management	Adoption of recommended practices	Personal know-how	Very rocky	Old ratoon	No reply
High	69	23	8	0	0	0
Moderate	18	14	18	0	0	49
Poor	0	0	11	26	16	47

6.8 Achieving / not achieving field potential yield

Response	Frequency	% of respondents
Yes	70	47.6
No	76	51.7
Sometimes	1	0.7

6.9 Achieving field potential yield in relation to farm size

Farm size	Frequency	% of respondents per farm size	% of respondents achieving potential n=70
0.01 - <= 1 ha n=73	32	44	46
1.01 - <= 2 ha n=36	21	58	30
2.01 - <= 5 ha n=22	8	36	11
> 5 ha n=16	9	56	13

6.10 Achieving field potential yield in relation to experience in sugar cane?

Experience in Sugar cane	Frequency	% of respondents per period of experience	% of respondents achieving potential n=70
< 5 yrs n=4	2	50	3
> 5 - 10 yrs n=17	9	53	13
> 10 - 15 yrs n=10	4	40	6
> 15 - 25 yrs n=37	12	32	17
> 25 yrs n=79	43	54	61

6.11 Achieving field potential yield in relation to land ownership?

Land Ownership	No of respondents achieving potential yield	% of respondents per period of experience	% of respondents achieving potential
Family n=24	10	42	14
Family and leased n=2	1	50	1
Leased n=12	5	42	7
Self n=101	50	50	71
Self and leased n=7	4	57	6

6.12 Major reasons for achieving field potential yield

Reasons for achieving field potential yield	Frequency	% of respondents achieving potential n=70
Good management practices	54	77
Good management practices + Irrigation available	10	14
Good management practices + Rational fertilization	2	3
Planting of good varieties	1	1
No reply	3	4

6.13 List major reasons for not achieving field potential yield

Reasons for not achieving field potential yield	Frequency	% of respondents not achieving potential n=76
Inadequate irrigation	17	22
soil not well prepared	14	18
needs better management - smallsized field	12	16
old ratoon	11	14
Cane fires	8	11
Inappropriate variety	5	7
low fertilizer rate due to high price	4	5
Water logging	3	4
high labour cost	2	3

7. Use of new technologies/research findings

7.1 Main research findings / new technologies farmers are aware of and are currently using by milling area

	% of respondents by milling area					
	Belle Vue		FUEL		Omnicane	
New technologies	Aware	Currently using	Aware	Currently using	Aware	Currently using
New varieties adapted to region	48	46	76	55	84	60
New herbicides	40	40	48	38	87	76
Soil analysis	21	17	52	34	84	73
Mechanization including mechanical loading	19	13	45	14	39	21
As informed by extension or other planters	17	8	0	0	0	0
New planting methods/fertilizers	8	8	0	3	3	6

7.2 Main research findings / new technologies farmers are actually using in relation to farm size

	% of respondents per farm size			
New technologies	0.01 - <= 1 ha n=73	1.01 - <= 2 ha n=36	2.01 - <= 5 ha n=22	> 5 ha n=16
New varieties adapted to region	52	69	41	50
New herbicides	58	64	55	38
Soil analysis	49	58	32	31
Mechanization including mechanical loading	15	25	14	13
As informed by extension or other planters	0	6	0	13
New planting methods/fertilizers	5	6	5	13

7.3 Main research findings/new technologies farmers are actually using in relation to experience in sugar cane

	% of respondents per period of experience				
New technologies	< 5 yrs n=4	> 5 - 10 yrs n=17	> 10 - 15 yrs n=10	> 15 - 25 yrs n=37	> 25 yrs n=79
New varieties adapted to region	25	71	40	51	56
New herbicides	50	71	60	68	48
Soil analysis	50	59	50	51	42
Mechanization including mechanical loading	50	24	10	16	15
As informed by extension or other planters	0	6	0	0	4
New planting methods/fertilizers	0	0	0	3	10

7.4 Reasons for main research findings / new technologies farmers are actually using

Responses	Frequency	% of respondents n=147
To improve yield	43	29
As advised by extension officers	18	12
Necessary for growth	13	9
old ratoon	5	3
Currently used by other farmers and or readily available	2	1
to reduce costs	1	1

7.5 Performance of main research findings / new technologies farmers are actually using

Responses	Frequency	% of respondents n=147
Very good	9	6
Quite useful	97	66
Useless / below expectation	6	4
Satisfactory but not easily available	1	1
Not very satisfied	5	3
No reply	29	20

7.6 Effect of main research findings / new technologies farmers are actually using on sugar cane yield

Responses	Frequency	% of respondents
Positive	106	72
No effect	5	3
Improvement not observed due to lack of irrigation	9	6
No reply	27	18

7.7 Source of information for main research findings / new technologies farmers are using

Source of information	Frequency	% of respondents n=147
Extension	75	51
Other planters	14	10
Extension and other planters	18	12
Personal experience	13	9
Family	5	3
Family and Extension	3	2
CCS	1	1
No response	18	12

7.8 Access of information for main research findings / new technologies farmers are using

Response	Frequency	% of respondents n=147
Extension services	95	65
Media	3	2
Other planters	11	7
Service providers	5	3
Aware of formalities	4	3
Not available	1	1
No reply	28	19

7.9 Source of financing for main research findings / new technologies farmers are using

Response	Frequency	% of respondents n=147
Self	84	57
Loan from banks	17	12
Self + Loan	8	5
Advance on crop	1	1
Noreply	37	25

7.10 Other research findings / new technologies which are available and not being used by farmers and why?

Response	Frequency	% of respondents n=147
No idea	72	49
New planting methods	4	3
New fertilizers	4	3
New varieties adapted to region	1	1
derocking	4	3
Better irrigation system	4	3
Mechanization	2	1
Mechanical loading	1	1
No response	55	37

7.11 Why are other research findings / new technologies which are available not being used by farmers?

Response	Frequency	% of respondents n=147
Expensive	9	6
Not available	8	5
Field not appropriate	1	1
No reply/not applicable	129	88

7.12 What can be done for other research findings / new technologies which are available and not being used by farmers

Response	Frequency	% of respondents n=147
Putting appropriate schemes	17	12
Nothing	1	1
No reply	129	88

8. Use of inputs

8.1 Main inputs farmers are aware of and are currently using

	Aware		Currently using	
Inputs farmers are aware of	Frequency	% of respondents n=147	Frequency	% of respondents n=147
Fertilizer	143	97	132	90
Herbicide	133	90	121	82
Cane setts	125	85	116	79
Scum	81	55	55	37
Labour	15	10	11	7
Machines	6	4	6	4
poultry litter	1	1	1	1
No reply	4	3	15	10

8.2 Main inputs farmers are actually using in relation to farm size

	% of respondents per farm size				
Inputs used	0.01 - <= 1 ha n=73	1.01 - <= 2 ha n=36	2.01 - <= 5 ha n=22	> 5 ha n=16	Total n=147
Fertilizer	89	89	86	100	90
Herbicide	89	78	73	75	82
Cane setts	84	78	59	88	79
Scum	30	44	45	44	37
Labour	7	3	5	25	7
Machines	0	0	9	25	4
poultry litter	1	0	0	0	1
No reply	11	11	14	0	10

8.3 Main inputs farmers are actually using in relation to milling area

Inputs used	% of respondents per milling area			
	Belle Vue n=48	FUEL n=29	Omnicane n=70	Total n=147
Fertilizer	92	62	100	90
Herbicide	73	62	97	82
Cane setts	67	69	91	79
Scum	48	28	34	37
Labour	19	0	3	7
Machines	8	0	3	4
poultry litter	0	0	1	1
No reply	8	38	0	10

8.4 Main inputs farmers are actually using in relation to experience in sugar cane

Inputs used	% of respondents in relation to period of experience in sugarcane cultivation (years)				
	< 5 yrs n=4	> 5 - 10 yrs n=17	> 10 - 15 yrs n=10	> 15 - 25 yrs n=37	> 25 yrs n=79
Fertilizer	3	12	6	24	55
Herbicide	3	12	7	29	49
Cane setts	3	11	8	27	52
Scum	5	9	4	25	56
Labour	9	27	0	0	64
Machines	0	0	17	17	67
poultry litter	0	0	0	0	100

8.5 Reasons for using inputs reported by the planters

Responses	Frequency	% of respondents n=147
Necessary for growth	75	51
To improve yield	24	16
As advised by extension officers	3	2
Currently used by other farmers	2	1
Readily available	2	1
Old ratoon	1	1
No reply	40	27

8.6 Responses on the performance of inputs used

Response	Frequency	% of respondents n=147
Quite useful	112	76
Very good	7	5
No reply	28	19
Total	147	100

8.7 Effect of inputs used on yield

Response	Frequency	% of respondents n=147
Positive	113	77
No effect	1	1
No yield improvement (inadequate irrigation)	1	1
No reply	32	22

8.8 Source of information for inputs used

Source of information	Frequency	% of respondents n=147
Extension	74	50
Other planters	21	14
Extension and other planters	20	14
Personal experience	16	11
Family	11	7
Contractors, CCS, etc.	4	3
Family + FSC	3	2
Publications	1	1
No response	3	2

8.9 Access for inputs used

Access of inputs	Frequency	% of respondents n=147
Service providers, Cooperatives, etc	75	51
Extension services	70	48
Other planters	3	2
No reply	4	3

8.10 Source of financing for inputs used

Source of financing	Frequency	% of respondents n=147
Self	108	73
Loan from banks	17	12
Self + loan	11	7
No reply	11	7

8.11 Other inputs which are available and not being used by farmers and why?

Inputs	Frequency	% of respondents n=147
No idea	66	45
Scum	6	4
Poultry litter	6	4
Cement	5	3
Other fertilizers	4	3
Vinasse	4	3
Biofertilizers	4	3
No reply	52	35

8.12 Why other inputs which are available and are not being used by farmers?

Responses	Frequency	% of respondents n=147
Not available	15	10
Expensive	8	5
Field not appropriate	2	1
not better	1	1
No reply / not applicable	121	82

8.13 What can be done for 8.12

Responses	Frequency	% of respondents n=147
Putting appropriate schemes	18	12
No reply / not applicable	129	88

9. Use of facilities/services

9.1 Main facilities/services farmers are aware of and which are easily accessible

	Aware of		Easily accessible	
	Frequency	% of respondents	Frequency	% of respondents
Farmers Service Centres	119	81	108	73
Government subsidized schemes	82	56	68	46
Contracting services	67	46	53	36
Sugar Planters Mechanical Pool	18	12	17	12
MSIRI	3	2	4	3
Irrigation authority	3	2	3	2
Cooperatives	3	2	2	1
Sugar Insurance Fund Board	1	1	2	1
Suppliers	1	1		0
none, rely on own experience	1	1	12	8
no idea	11	7	7	5

9.2 Main facilities/services accessible to farmers in relation to farm size

	% of respondents across farm size			
Facilities/services	0.01 - <= 1 ha n=73	1.01 - <= 2 ha n=36	2.01 - <= 5 ha n=22	> 5 ha n=16
Farmers Service Centres	74	75	68	75
Government subsidized schemes	45	56	41	38
Contracting services	33	44	32	38
Sugar Planters Mechanical Pool	5	6	27	31
MSIRI	3	0	9	0
Irrigation authority	0	0	5	6
Cooperatives	1	0	0	6
Sugar Insurance Fund Board	0	0	5	0
none, rely on own experience	7	8	9	13
no idea	4	8	0	6

9.3 Main facilities/services accessible to farmers in relation to milling area

Facilities/services	% of respondents per milling area			
	Belle Vue n=48	FUEL n=29	Omnicane n=70	Total n=147
Farmers Service Centres	56	72	86	73
Government subsidized schemes	38	41	54	46
Contracting services	31	28	43	36
Sugar Planters Mechanical Pool	29	3	3	12
MSIRI	4	0	3	3
Irrigation authority	4	0	0	1
Cooperatives	2	3	0	1
Sugar Insurance Fund Board	2	3	0	1
none, rely on own experience	10	10	6	8
no idea	10	3	1	5

9.4 Main facilities/services accessible to farmers in relation to period of experience in sugar cane

Facilities/services	% of respondents per period				
	< 5 yrs n=4	> 5 - 10 yrs n=17	> 10 - 15 yrs n=10	> 15 - 25 yrs n=37	> 25 yrs n=79
Farmers Service Centres	50	71	60	68	80
Government subsidized schemes	25	59	50	51	42
Contracting services	25	35	30	49	32
Sugar Planters Mechanical Pool	25	12	10	3	15
MSIRI	0	12	0	0	4
Irrigation authority	0	0	0	0	4
Cooperatives	0	0	0	3	1
Sugar Insurance Fund Board	0	0	10	0	1
none, rely on own experience	0	6	20	14	5
no idea	0	12	0	3	5

9.5 Reasons why these facilities/services are used or not used

Reasons for using / not using facilities	Frequency	% of responses
Using	n=108	
Readily available	23	21
As advised by extension officers	11	10
Currently used by other farmers	11	10
Necessary for growth and to improve yield	12	11
No reply	51	47
Not using	n=39	
Not available in time	9	23
Not required	4	10
Not aware	3	8
No time	1	3
No reply / not applicable	22	56

9.6 Performance of the facilities farmers are using

Performance	Frequency	% of responses n=108
Very good	2	2
Quite useful	67	62
Useless	1	1
satisfactory but not easily available	9	8
No reply / not applicable	65	60

9.7 Effect of the facilities farmers are using on yield

Effect on yield	Frequency	% of responses n=108
Positive	67	62
No effect	2	2
Operations delayed leading to abandonment	1	1
No reply / not applicable	38	35

9.8 Source of information for facilities/services farmers are aware of

Source of information	Frequency	% of responses n=147
Extension	63	43
Other planters	17	12
Extension and other planters	19	13
personal experience	13	9
CCS, Contractors, etc.	3	2
Family	2	1
Family + FSC	1	1
No response	29	20

9.9 Access to the facilities/services farmers are farmers are aware of

Access to the facilities available to farmers	Frequency	% of responses n=147
Extension services	66	45
Personal experience / aware of formalities	26	18
Service providers	5	3
Not available	3	2
No reply	47	32

9.10 Source of financing for 9.2

Financing of facilities	Frequency	% of responses n=147
Self	70	48
Loan from banks	11	7
Self + loan	3	2
Advance on crop	1	1
No reply	62	42

9.11 Other facilities/services which are available and not being used by farmers and why?

Facilities not used	Frequency	% of responses n=147
No idea / no response	132	90
Fine derocking	7	5
Contracting services	4	3
None, rely on own experience	1	1
Subsidy on fertilizers, cane setts, etc	1	1
FORIP project	1	1
Mechanical loading	1	1

9.12 Why farmers not using available facilities?

Responses	Frequency	% of responses n=147
No reply/not applicable	134	91
Field not appropriate	1	1
Field already occupied	4	3
not better	7	5
expensive	1	1

9.13 What can be done to encourage farmers for ?

Responses	Frequency	% of responses n=147
No reply / not applicable	132	90
Putting appropriate schemes	14	10
Nothing	1	1

10. Use of credit facilities

10.1 Main credit facilities farmers are aware of

Credit facilities	Frequency	% by respondents n=147
Bank +CCS	91	62
CCS	33	22
Banks	10	7
Others	1	1
No idea	5	3
None	1	1
no reply	6	4

10.2 Main credit facilities actually used by farmers

Credit facilities	Frequency	% by respondents n=147
CCS	24	16
Banks	14	10
Bank +CCS	11	7
Others	1	1
No idea	2	1
None	86	59
no reply	9	6

10.3 Why using / not using credit facilities?

Using	Frequency	% by respondents n=50		Not using	Frequency	% by respondents n=86
Readily available	22	44		Not required	35	41
to improve yield	5	10		Not to be indebted	20	23
Currently used by other farmers	3	6		No reply	31	36
for harvest	1	2				
No reply	19	38				

10.4 Main credit facilities actually used by farmers in relation to farm size

	Frequency per farm size				
Credit facilities used	0.01 - <= 1 ha n=73	1.01 - <= 2 ha n=36	2.01 - <= 5 ha n=22	> 5 ha n=16	Total n=147
CCS	16	19	14	13	16
Banks	5	8	18	19	10
Bank +CCS	8	11	0	6	7
Others	0	3	0	0	1
no reply	5	6	14	0	6

10.5 Main credit facilities actually used by farmers in relation to milling area

	% of respondents per milling area			
Credit facilities used	Belle Vue n=48	FUEL n=29	Omnicane n=70	Total n=147
CCS	10	14	21	16
Banks	6	21	7	10
Bank +CCS	4	7	10	7
Others	0	3	0	1
no reply	13	7	1	6
no idea	4	0	0	1
none	63	48	60	59

10.6 Main credit facilities farmers are aware of and are actually used by in relation to milling area

	% of respondents per milling area							
	Belle Vue n=48		FUEL n=29		Omnicane n=70		Total n=147	
Credit facilities	Aware	Use	Aware	Use	Aware	Use	Aware	Use
Bank +CCS	66.7	4.2	55.2	6.9	61.4	10.0	61.9	7.5
CCS	8.3	10.4	17.2	13.8	34.3	21.4	22.4	16.3
Banks + Others	6.3	6.3	17.2	24.1	4.3	7.1	7.5	10.2

10.7 Main credit facilities actually used by farmers in relation to experience in sugar cane

Credit facilities	% of respondents per period of experience				
	< 5 yrs n=4	> 5 - 10 yrs n=17	> 10 - 15 yrs n=10	> 15 - 25 yrs n=37	> 25 yrs n=79
CCS	50	6	30	16	15
Banks	0	0	20	11	10
Bank +CCS	0	0	0	14	8
Others	0	0	0	0	1
no reply	25	0	0	3	9
no idea	0	0	10	3	0
none	25	94	50	51	57

10.8 Responses on the efficiency / performance of credit facilities

Responses	Frequency	% by respondents n=50
Quite useful	29	58
satisfactory but not easily available	4	8
Not very satisfied	3	6
No reply	14	28

10.9 Responses on the effect of credit facilities on yield

Responses	Frequency	% by respondents n=50
Positive	19	38
No effect	1	2
No reply	30	60

10.10 Source of information for credit facilities

Responses	Frequency	% by respondents n=147
Cooperative Societies	22	15
Personal experience	22	15
Other planters	13	9
Extension	8	5
Family	4	3
Publications	1	1
No response	77	52

10.11 Access to credit facilities

Responses	Frequency	% by respondents n=147
Cooperative Societies	19	13
Aware of formalities	18	12
Extension services	5	3
Media	2	1
Other planters	1	1
Service providers	1	1
No reply	101	69

10.12 How are credit facilities used by farmers reimbursed?

Responses	Frequency	% by respondents n=50
Advance on crop	4	8
Loan from banks	34	68
Loan from family	50	100

10.13 Other credit facilities which are available and not being used by farmers

Responses	Frequency	% by respondents n=147
None	11	7
No idea	40	27
No reply	96	65

10.14 Why other available credit facilities are not being used?

Responses	Frequency	% by respondents n=147
Reimbursement expensive	2	1
Not better	1	1
Not available	1	1
No reply	143	97

10.15 What can be done for other available credit facilities which are not being used by farmers

Responses	Frequency	% by respondents n=147
Putting appropriate schemes	5	3
No reply	142	97

11. Marketing

11.1 Main products of sugar cane

Products	Frequency	% by respondents n =147
Sugar	141	96
Bagasse	112	76
Molasses	113	77
Scum	3	2
Alcohol	3	2
No response	6	4

11.2 Main products of sugar cane by milling area

	% of respondents Milling area			
Products	Belle Vue n=48	FUEL n=29	Omnicane n=70	Total n=147
Sugar	96	93	97	96
Bagasse	77	55	84	76
Molasses	79	55	84	77
Scum	4	0	1	2
Alcohol	4	0	1	2
No response	4	7	3	4

11.3 Responses on their marketing system?

Products	% of respondents				
	Mauritius Sugar Syndicate	Private Companies	Sugar Mills	No idea	No reply
Sugar	75	2	1	21	1
Bagasse	69	4	2	23	3
Molasses	68	3	0	23	6
Alcohol	33	0	0	0	67

11.4 Farmers' opinion on the marketing systems

Responses	Frequency	% by respondents n=141
Good	8	6
Quite good	30	21
Not good	21	15
No response	82	58

11.5 Reasons for such opinion

Responses	Frequency	% by respondents n=141
Media	7	5
Personal experience	34	24
No transparency	3	2
No response	97	69

11.6 Other marketing system proposed by the farmers

Responses	Frequency	% by respondents n=141
Not aware	33	23
Government intervention	3	2
no response	105	74

11.7 Why farmers are proposing other marketing systems

Responses	Frequency	% by respondents n=141
Not applicable	33	23
Better distribution of income	3	2
No response	105	74

11.8 How are they aware of these new systems?

Responses	Frequency	% by respondents n=141
Not applicable	33	23
Own judgement	3	2
No response	105	74

12. Income

12.1 % of contribution of income from sugar cane to total income of the farmer

% contribution	Frequency	% by respondents n=147
0	16	11
1	3	2
2	7	5
3	1	1
4	2	1
5	17	12
8	2	1
10	20	14
15	6	4
18	1	1
20	9	6
25	8	5
30	2	1
35	1	1
40	3	2
50	7	5
60	2	1
70	1	1
75	3	2
80	2	1
90	1	1
100	6	4
No response	27	18

% contribution	Frequency	% by respondents n=147
0	16	11
>=1 to =5	30	20
>=6 to =10	22	15
>=11 to =25	24	16
>=26 to =50	13	9
>= 51	15	10
No response	27	18

12.2 Responses on other crops contributing to total income of the household

Response	Frequency	% by respondents n=147
No	126	85.7
Yes	11	7.5
No response	10	6.8

12.3 % of contribution of income from sugar cane to total income of the household

% contribution	Frequency	% by respondents n=147	% contribution	Frequency	% by respondents n=147
0	16	11	0	16	11
1	5	3	> 0 - 5	33	22
2	7	5	>5 - 10	23	16
3	2	1	> 10 - 25	20	14
4	2	1	> 25 - 50	11	7
5	17	12	> 50 - 90	5	3
7	1	1	> 90 - 100	6	4
10	22	15	No response	33	22
15	6	4			
18	1	1			
20	4	3			
25	9	6			
30	1	1			
35	1	1			
40	2	1			
50	7	5			
60	1	1			
70	1	1			
75	1	1			
80	2	1			
100	6	4			
No response	33	22			

12.4 How much is the farmer dependant on sugarcane income?

Extent of dependence	Frequency	% by respondents n=147
High	19	13
Average	17	12
Low	29	20
Very low	24	16
Negligible	50	34
No response	8	5

12.5 What are the other sources of income for the household?

Response	Frequency	% by respondents n=147
Farmer is a full-time employee	21	14
Farmer is a part time employee	2	1
Farmer is self employed	46	31
Farmer is an old age pensioner	63	43
Family members are employed	25	17

12.6 Use of labour by the respondents

	Full-time employment		Part-time employment	
Type of labour	Frequency	% by respondents	Frequency	% by respondents
Self	29	19.7	36	24.5
Casual	0	0.0	86	58.5
Permanent	5	3.4	0	0.0
Contractor	2	1.4	10	6.8
None/no reply	111	75.5	15	10.2

12.7 Responses on family members bringing income outside sugar

Family member	Frequency	Percent
None	61	41.5
Wife	20	13.6
Husband	3	2
Children	49	33.3
Mother	1	0.7
other business	2	1.4

Appendix 5: Focus group discussions – Session 1

Assessing the current situation of Extension in Mauritius

Group 1

Name	Job title	Institution
Mr G Moorgen	Senior Extension Officer	AREU
Mr I Damoo	Senior Extension Officer	AREU
Mr M Sik Sun	Principal Extension Officer	AREU
Mr P Dobee	Extension Officer	AREU
Mr R Rajcumar	Principal Extension Officer	AREU
Mrs H Gowreesunkur	Principal Research Scientist	AREU
Mr S P Beni Madhu	Principal Research Scientist	AREU
Mr A Goolaub	Principal Extension Officer	AREU
Mr D Bhemah	Senior Extension Officer	AREU
Mr R Dowluth	Senior Extension Officer	AREU
Mrs Brijmohun Gopaul	Lecturer	Faculty of Agriculture, University of Mauritius

Background of group members (e.g. job titles; agencies)	Extension Researchers, Lecturer
	Assistant Director (Extension), SEOs, PRS, RS
	AREU, UoM
Key functions and goals	Conduct Research (Non sugar).
	Disseminate information Technology Transfer, Informal and vocational training, professional training, Academic education.
	Improve Agricultural productivity/Farmers Welfare.
Primary clients (give brief description)	Farmers, Agro entrepreneurs, women and youth.
	Tertiary level students – Professionals.
Key issues related to these clients	Ageing farming community, small scale operators.
	Limited resources, high costs of inputs, part-timers
	Resistance to change, limited market access.
Other clients (give brief description)	Retrenched (EX sugar cane, tea, textile) workers.
	Unemployed, NGOs, vulnerable GPs, Institutions, Corporates.
Key challenges faced by group members	Limited resources, demanding clients.
	Emerging issues (climate change, food crisis, food safety....).
	Job opportunities.

Group 2

Name	Job title	Institution
Mr R Padaruth	Senior Extension Officer	AREU
Mrs L Unmole	Principal Research Scientist	AREU
Ms R Nowbuth	Principal Research Scientist	AREU
Mr P Erigadoo	Senior Extension Officer	AREU
Mr P Toolsee	Principal Research Scientist	AREU
Mr S Chung Ting Wan	Principal Extension Officer	AREU
Mrs C Teeluck	Extension Officer	AREU
Mrs M Gungadurdoss	Principal Research Scientist	AREU
Ms S Ori	Senior Extension Officer	AREU

Background of group members (e.g. job titles; agencies)	Research scientists.
	Extension Officers - crop/livestock.
Key functions and goals	Conduct research in non sugar crops and livestock.
	Provide extension and advisory services, training.
	To improve productivity, income, welfare.
Primary clients (give brief description)	Farmers/breeders/agro entrepreneurs/processers.
	Women and youth.
Key issues related to these clients	Ageing farmers' population/part-timers.
	Limited capital/land.
	High costs of production/access to market.
Other clients (give brief description)	Ex sugar and tea planters.
	Unemployed retrenched workers.
	Public, private, NGO's.
Key issues related to these clients	Limited knowledge/skills in crop – livestock production.
	Part-timers.
Key challenges faced by group members	Ageing farmers' population, climate change.
	Sustainable production – competition from Corporate sector. Limited land - small size plots - regrouping.
	Limited budget for R & D/Human Resource. Changing from free to paid service.

Group 3

Name	Job title	Institution
Clency Barbe	Research Officer	MSIRI
Goolam Badaloo	Research Officer	MSIRI
Gunshiam Umrith	Research Officer	MSIRI
Henri Medan	Research Officer	MSIRI
Kamla Pillay Samoo	Research Officer	MSIRI
Kevin Maistry	Research Scientist	Food and Agricultural Research Council
Dhuneeroy Bissessur	Research Officer	MSIRI
Nalini Behary-Paray	Research Officer	MSIRI
Mohan Teeluck	Research Officer	MSIRI

Background of group members (e.g. job titles; agencies)	Research/Field and Extension Officers (MSIRI & FARC)
Key functions and goals	Non-sugar: Provision of planting materials, R & D on potato, palm, pitaya and maize.
	Sugar: variety development, field experiment, extension, technology transfer, land indexing.
	Weed control, crop protection, cultural practices, dissemination of scientific technical information.
Primary clients (give brief description)	Non sugar: Ornamental, fruits and vegetable growers.
	Sugar: Millers, miller/corporate, large, medium and small planters.
Key issues related to these clients	Non sugar: supply of planting material and recommendations for crop husbandry.
	Development of varieties (potato).
	Sugar: Maximising sugar cane production, increase profitability and sustainability.
Other clients (give brief description)	Institutions related to sugar cane industry (local: FSC, MCA, MSS, SPMPC etc).
	Foreign sugar cane research Institutions and private sugar cane enterprises.
	Agrochemical companies.
Key issues related to these clients	Technology transfer, training, consultancy.
	Export/import sugar cane varieties.
	Imparting knowledge.
Key challenges faced by group members	Increasing productivity and sustainability, cost effectiveness and viability.
	Poverty alleviation – increasing livelihood, ensure food security.
	Operating within reduced financial and human resources. Acceptability and adoption of novel technologies and new products (varieties).

Group 4

Name	Job title	Institution
Kishore Ramdoyal	Principal Research Manager	MSIRI
Rasack Nayamuth	Research Manager	MSIRI
Daleep Ramjutun	Senior Technical Officer	MSIRI
Seelavarn Ganeshan	Research Manager	MSIRI
Adess Gooljar	Technical Officer	MSIRI
Viswa Toory	Research Officer	MSIRI
Jean Tonta	Manager	MSIRI
Rosemay Ng Kee Kwong	Manager	MSIRI
Jugdish Sonatun	Research Officer	MSIRI

Background of group members (e.g. job titles; agencies)	Research Scientists/Extension Officers – MSIRI.
Key functions and goals	Sugar cane research and development. Goals: Improving sugar productivity.
	Technology Transfer. Goals: Sustain production, best management practices.
	Associated crops: R & D + Extension Activities. Goals: Issues related to environment.
Primary clients (give brief description)	Sugar cane growers.
	Policy makers including Government/Mauritius Chamber of Agriculture.
Key issues related to these clients	Crop improvement, crop protection, crop management, optimum resources management.
	Adoption of new varieties, resistant varieties, fertilizer and herbicides, crop cycles.
	Diseases and pests management, fertilizer and herbicides, irrigation, mechanization, land preparation, crop cycles.
Other clients (give brief description)	Sugar mills, agrochemical companies, service providers.
	Overseas sugar industry, planters organization.
	Potato and maize growers.
Key issues related to these clients	Efficiency of sugar mills and energy, evaluation of chemicals and machinery.
	Sales of expertise and consultancies.
	Advisory services to planters organizations, technical support to potato and maize growers.
Key challenges faced by group members	How to overcome increasing costs and increase production.
	Lack of resources and future of SPIs.
	Lack of interest from growers – part-time growers. Improve technology/research results adoption. Trust of growers towards extension officers/new technology.

Group 5

Name	Job title	Institution
A.K. Doorjun	Senior Technical Assistant	FSC
S. Aumeerun	Senior Technical Assistant	FSC
B. Mistry	Senior Technical Assistant	FSC
S. Lollbeeharry	Senior Technical Assistant	FSC
P.K. Soniah	Senior Technical Assistant	FSC
G. Beeharry	Senior Technical Assistant	FSC
R. Bhaugeerutty	Senior Technical Assistant	FSC
O.S. Ramburhose	Senior Technical Assistant	FSC
S. Sobha	Senior Technical Assistant	FSC
S. Thakoor	Senior Technical Assistant	FSC
S.K. Raghu	Senior Technical Assistant	FSC

Background of group members (e.g. job titles; agencies)	Senior Technical Assistants – FSC.
Key functions and goals	To decrease the yield gap between planters and sugar estates, to provide technical advice to small sugar cane growers.
	To disseminate information from research organizations to small sugar cane planters.
	To improve their standard of living, regrouping of planters through FORPS to reduce costs.
Primary clients (give brief description)	Sugar cane growers (small and medium).
Key issues related to these clients	High cost of production, labour shortage for cultural practices.
	Majority of them are part-timers and old aged.
	Cultivation on marginal lands, decrease in sugar price.
Other clients (give brief description)	Private contractors: land preparation, replantation, cutting and loading transport of sugar cane.
Key issues related to these clients	Credit cooperative societies, brokers, middleman, planters organizations, banks.
	Profitability, sustainability.
	Finance, competition.
Key challenges faced by group members	Forthcoming reforms in service providing institutions – job security.
	Lack of financial incentives, lack of scope for promotion.
	Lack of motivation.

Group 6

Name	Job title	Institution
Jeevesh Kumar Sewdeen		Mauritius Cooperative Agricultural Federation Ltd
M Nuhnuck		Sugar Insurance Fund Board
Mr Beechook		Small Planters Association
Mr Sanjiv Dindoyal		Centre/West Planters Association
Mr P Dookhitram		Small Planters Welfare Fund
Prakash Ruggoo		Mauritius Cooperative Agricultural Federation Ltd
S Ramsamy		Sugar Insurance Fund Board
Youvraj Sharma Khorugdharry		Sugar Planters Mechanical Pool Corporation
Kreepalloo Sunghoon	President	Small Planters Association
Gassen Moodelly	President	Southern Planters Association
Nitianand Kaulowa	Secretary	Southern Planters Association

Background of group members (e.g. job titles; agencies)	Planters (ADMA, SPA) and representatives of planters associations.
	Agencies: SIFB, SPMPC, MCAF, SPWF.
Key functions and goals	Key function: Planters involved in the production of agricultural products (for planters).
	Goal: for a sustainable social, cultural and economic activity (for planters).
	Institutions: to provide services to the farming community. Goal: to keep planters in a profitable business.
Primary clients (give brief description)	Planters: consumers – local and foreign markets.
	Institutions: Planters
Key issues related to these clients	Major issues: shortage/availability of agricultural land, shortage of labour, price determination.
	Local and international markets, climatic change (adverse effect on production/quality).
	Increase in cost of production, inefficient market system, lack of information, too much political interference. Poor policy decisions, decisions taken in the absence of beneficiaries, profits are absorbed by intermediates in the marketing channels.
Other clients (give brief description)	
Key issues related to these clients	Same as above.
Key challenges faced by group members	Decrease cost of production, clustering of farmers, seek for alternate market, invest in agro-processing, fair distribution of proceeds.
	Research on tailor made technologies, transparency on funds, review taxes on agricultural products.
	Create a retirement fund.

Group 7

Name	Job title	Institution
Mrs Kumari Ramkissoon	Planters Representative	Dairy
Mr Germain Lavigillante	Planters Representative	Pig
Kailash Ramdhary	Planters Representative	Planters Reform Association
Mr Ajay Beersham	Planters Representative	Crucifer / carrot
Mr Ashock Bhundoo	Planters Representative	Hydroponic / onion / potato
Mr Kumar Doseeah	Planters Representative	Fruits
Mr Vinod Beeharry	Planters Representative	Ornamentals
Naresh Gujadhur	Planters Representative	Planters Reform Association
Patrick Huet	Planters' Adviser	Medine SE
Pierre Blackburn	Secretary	Cane Growers Association

Background of group members (e.g. job titles; agencies)	Sugar cane planter/public relation, cow breeder, pig breeder.
	Farmers
Key functions and goals	Sugar cane: Maintain a tradition, sustainable socio-economic cultural environment friendly production.
	Advise planters in best crop husbandry practices.
	Cow: continue tradition of grand parents of producing fresh milk. Pig: To increase production to large scale in a professional and sustainable way and contribute to local food security.
Primary clients (give brief description)	Sugar cane: planters, MSS, Millers, Independent Power Producers.
	Cow: relatives and village inhabitants (locality).
	Pig: small-scale, larger/medium scale fatteners intermediaries, consumers.
Key issues related to these clients	Sugar cane: corporate – scale of sugar to MSS.
	Cow: planters buy manure for crop production, milk for daily consumption and religious purpose.
	Pig: prepare others to get good breed.
Other clients (give brief description)	
Key issues related to these clients	
Key challenges faced by group members	Sugar cane: convince planter to reform plantation - Overseas challenges.
	Cow: lack of land and labour.
	Pig: feed price, marketing, imported product competition.

Group 8

Name	Job title	Institution
A.Awotarowa	Manager	FSC
L. Jeeha	Manager	FSC
R.K. Soniah	Assistant Director	FSC
T. Gunesh	Manager	FSC
V.Caulloo	Manager	FSC
Y. Ramdharee	Manager	FSC
Krity Neermul		Control Board
L Jhurry		Mauritius Sugar Authority
Chatta Hookoom		Irrigation Authority
Mr Dabeah		Irrigation Authority

Background of group members (e.g. job titles; agencies)	Managers FSC, Assistant Director FSC, Divisional Irrigation Officer.
Key functions and goals	Extension and training, operational policies, small-scale irrigation project management.
	Project development and management, general management, Irrigation Officers.
	Schemes and subsidy management, Director, Supervisors (small farmers).
Primary clients (give brief description)	Small sugar cane farmers, Managers, Director.
	TAs, STAs, LNC, Researcher, Planters, Ministry, Head of Department.
	Director, Assistant Director.
Key issues related to these clients	Decreasing ability/numerous managing change, high irrigation rates/dues.
	High costs of inputs/inappropriate technology, water shortage.
	Low confidence/low adoption rate, abandoned land.
Other clients (give brief description)	Ministry/Miller/Farmer organization/CCS/Water User Associations, Sugar Estates.
	Service Providers/Contractors – labour and transport.
	Input suppliers.
Key issues related to these clients	Coordination, high irrigation dues.
	Lack of training (contractors), water shortage.
	Lack of trust contractors, abandoned land
Key challenges faced by group members	Too much workload, shortage of staff.
	Red-tapism / administrative bottlenecks.
	High expectations from above clients.

Appendix 6: Focus group discussions – Session 2

Developing a framework to evaluate Extension

Group 1

Extension goals	Description	How it is measured
Protected crop production (Producing crops under protected structures for higher productivity and quality produce)	Establish model units Incentive schemes Support by Research / Extension Market information	No. of units established No. of applications for the schemes No. of visits made
Promotion of IPDM (Managing pest and disease by integrating various components for quality and safe produce)	Development of alternatives to chemicals Training of farmers Assistance and adaptation of IPDM on farm	No. of alternatives developed No. of farmers trained / training sessions Adoption rate
Increasing pig production (Decreasing piglet mortality from birth to weaning)	Improved management Promote use of farrowing crate Sanitary measures Feeding of sow	Number of farrowing crate in use Adoption rate Reduction in mortality No. of piglets weaned per litter

Group 2

Extension goals	Description	How it is measured
Clean milk production	Help /train breeders to produce clean/quality milk thro' adoption of good animal husbandry practices	Chemical composition Bacterial load Organoleptic quality No. of breeders producing quality milk
Training in value addition to tomato	Capacity building of unemployed women in tomato processing	No. of women engaged in the business of tomato processing Volume of tomato processed
Quality seed production	Assist/encourage small planters to produce quality seeds of selected crops as an agribusiness	Number of growers who have successfully mastered/implemented seed production techniques Quantity and quality of seeds produced

Group 3

Extension goals	Description	How it is measured
Optimizing fertilization	Help farmers to adopt recommendation through soil analysis	% of farmers having soil analyzed % of farmers adopting
Crop productivity	Help farmers increase cane/sugar yield at reduced costs in a sustainable way	% increase in yield and % farmers still in business Farmers' feedback on profitability

Group 4

Extension goals	Description	How it is measured
Technology transfer	Promote adoption of new and improved technologies and practices to maintain productivity, profitability and sustainability of growers	% technology adopted Extent adopted Impact of these on productivity, profitability and sustainability
Participatory research	Encourage growers in the design, implementation and evaluation of research (what type?)	% of acceptance Trust index
Training and capacity building	Good management practices Pesticide application Date of harvest to maximise return Quality of planting material, etc. Handling and operating of equipment and tools Any other based on growers' demand	Extent applied over extent learned Change in practices!
Dissemination of information	Make information available to growers Timely Info that is reliable Info as desired by growers	Amount of publications/visits/etc. (but are they effective) User log on website?

Group 5

Extension goals	Description	How it is measured
Visits	Field: Visiting individual farms Home: Contacting farmers at their residence Targeted: Farmers needing special attention Office: Farmers calling for services	Number of farmers contacted Number of farmers contacted Number of farmers contacted Number of farmers calling
Demonstrations (On-farm trials)	Newly released varieties and services Fertilizers and herbicides (planters reluctant to adopt new technologies are selected for field demonstration	Number held
Group meetings	Evening meetings Planters' Info. meetings Vocational training Site meetings	No. of planters attended
Information on new technologies	Information on new released varieties, their performances Comparison of current practices Effectiveness of new fertilizer regimes New formulations of herbicides Technical talks on varieties, fertilizers, herbicides Regrouping projects	No. of planters informed Performance Performance Effectiveness Planters attendance

Group 6

Extension goals	Description	How it is measured
Advisory	Efficient advisory / channelling of complaints – suggestions to concerned institutions	Crop and complaint monitoring committee
Be trustworthy	Enhance trustworthiness of extension institutions	% of problems / complaints solved + satisfaction of planters
Be available	Availability of extension officers on field	Number of visits received by planters (follow-up + emergency cases)
Client-oriented	Research should be farmer-oriented . Research should communicate with planters through development phase.	% of increase in profitability (yield, etc.)
Good coverage	Efficient extension : planter ratio (sugar and non-sugar)	Currently 51 : 20000 To define new ratio

Group 7

Extension goals	Description	How it is measured
Models (proven success stories) Accessibility of officers	Be able to show a successful farm/model Regular follow up of extension agent to ensure success Ability to answer farmer's question Extension fully involved in implementation of the project Recognition of farmer's know-how and capacity and encourage sharing among farmers	Statistics Experimental results Physical presence of extension Officer is active not dormant
Use of simple/common language for communication	Use a language that farmers will easily understand and not get bored/confused	Not clarified
Feasible plans / projects	Propose projects which in the capacity of the farmer and not bring suicide Cost of investment Financially viable	Not clarified

Group 8

Extension goals	Description	How it is measured
Training	Train farmers on Good Agronomic Practices	% of farmers acquired knowledge and skills
Demonstration	Calibration of sprayers	% farmers being able to calibrate sprayers
Group formation	Bringing a group of farmers to work together for one or more activities, e.g. harvest and	% farmers performing one or more

Appendix 7: Focus group discussions – Session 3

Using the framework to evaluate Extension

Extension objective: Group formation

Description: Bringing a group of farmers to work together for one or more activities (e.g. harvest and transport)

Group evaluation of how well extension has performed in this area:

	Key areas of assessment	
Group	% farmers performing one or more activities together	How effective has extension been at fostering this
1	15% sugar cane, 5% non sugar	Low sugar cane, moderate non sugar
2	5% - Mechanical land prep, purchase of inputs, marketing of produce, pool of labour	Extension has NOT been successful in convincing growers because of their INDIVIDUAL approach
3	30% of targeted farmers are aware of the government's policy to obtain economies of scale in the reform process of the industry.	Very well on the whole
4	<10% (before FORIP)	Very low (before FORIP)
5	15 – 20 %	Good for canvassing of farmers, conducting group meetings, signing of contracts farmer/MSA and liaison with stakeholders Very good for monitoring of works in regrouping projects, Results and profits increase - 50%
6	< 1% of farmers for plantation and harvesting. Around 25% in non-sugar sector performing mechanization and harvesting (co-operative level), sales and buying of seeds.	Planters grouped in FORIP. No proper follow up afterward. Planters are not fully involved in the conception and implementation Objectives not achieved, e.g. decrease in cost of production and increase in yield.
7	Apparent: Meetings, training but no follow up. EX-BUDGET	Very short term success. But seeing the stats now is different
8	3 groups formed	Create awareness Organize training Coop formed Facilitate negotiation between farmers and contractors Timely mech harvest and post harvest practice done at reduced cost

Extension objective: Clean milk production

Description: Help/train breeders to produce clean/quality milk through adoption of good animal husbandry

Group evaluation of how well extension has performed in this area:

	Key areas of assessment		
Group	Chemical composition	Bacteriogical load	No. of breeders producing quality milk
1	Moderate	Moderate	Moderate
2	More milk analysis is required (depend on other institutions) Work with farmer groups Improvement noted for trained farmers	More milk analysis required Work with farmer groups Improvement noted for trained farmers	All those who have been trained (50)
4	Cannot assess/Don't Know	Cannot assess/Don't Know	Cannot assess/Don't Know
7	Give information but no follow up	Have given good advice on drainage which has helped reduce bact. load	Seemingly less. Small quantity

Extension objective: Sharing / participation

Description: Recognition of the farmers' know how and capacity as important and can be shared with other farmers
Encourage growers in the design/implementation/evaluation of research
Encourage growers in resource sharing to implement the above

Group evaluation of how well extension has performed in this area:

	Key areas of assessment			
Group	Good practices by other farmers	% acceptance	Trust index	How much recognition is given to farmers know-how
1	Moderate	Moderate	Good	High
2	Conducted tours and field days in successful growers' fields Farmers' liaison meeting Success stories published in F/News	Medium (app 50%)	Greater trust when growers are involved in research activities	High Publicized in F/News Share knowledge in liaison meetings Model farmers used as show case
3	Poor as extension has to abide to official recommendations from research	Poor	Poor	Recognized after having been tested by research and proved
4	Quite good (s cane)	>50% (s cane)	Seems to be good for sugar cane	Yes – most of them
5	Excellent participation of extension	25%	100%	Great importance is given to planters' know-how
6	About 25%	Above 80%	50%	Very little recognition is given to planters know how
7	Not observed in cow keeping. Good at 50%. Observed to some extent in pigs.	Not reported	Very subjective. Depends on extension. Very low for sugar cane.	Very low. Depends on extension. They accept to get farmers' know how (pig)
8			No cases known (sugar cane)	Identify the research agenda with the farmer

Extension objective: Participatory research

Group evaluation of how well extension has performed in this area:

	Key areas of assessment	
Group	To what extent and in what way are growers included in the research process	To what extent do farmers share resources
1	Low	Very low
2	Participatory approach for research activities On farm testing Technology review meetings Ext and Research Meetings	Land/Labour/Water However greater commitment required as regards to on farm trials
3	Very good. Regional committees in different sectors to enable farmers to evaluate promising varieties at pre-release stage. Demonstration plots established on new / improved cultural practices, e,g new cropping system Adoption on new varieties, etc. Training on spraying techniques.	Depend on sectors. In general, it is a successful operation among planters of same region for e.g for planting materials, fertilizer, transport and through cooperative societies and regrouping planters.
4	Farmers are represented at all levels	Good
6	Low participation of growers in research. They provide land and labour.	Extension officers often copy farmers' application to other farmers
7	Planters are not involved. They are only invited for an open day at MSIRI or given training.	Planters are reluctant to share. They fear that their know how be used by other people financially sound.
8	Selection of farmers for on farm trial Training	Monitoring and evaluation Dissemination of results

Extension objective: Promotion of Integrated Pest and Disease Management (IPDM)

Description: Development of alternatives to chemicals
Training of farmers
Assistance and adaptation of IPDM on farm
Group evaluation of how well extension has performed in this area

	Key areas of assessment			
Group	No. of alternatives developed	No. of training sessions	No. of farmers trained	Adoption rate
1	4	GM – 40/yr Field demons – 18 TRM/TRW – 5 Radio talks – 17 Information and leaflets – 1 Seeds treatment - 250	1200	Melon fly – 30% DBM – 20% Leaf miners – 40%
2	Traps, Bio-pesticides, Biological control, SMS alert, Field Sanitation, Pest and disease surveillance	30 training sessions (6 modules)/yr 60 group meetings/yr App 15-20 radio/TV talks Leaflets/pamphlets distributed 9000 field visits/yr App 7000 calls/requests attended/yr Demo ongoing on model farms	3500 trained 7000 knowledgeable	Traps > 50% Other techniques/components of IPDM 20-30%
3	Development of alternatives is done by researchers. Involvement of extension in the above is desirable.	Satisfactory performance but more to be done in collaboration with training and other institutions, e.g FSC, RTC etc.	Good performance through regular visits, meetings, open days. Training must be dynamic and continuous.	Still a lot to be done due to reluctance to adopt recommendation and unawareness of new techniques
4	Biological control Use of traps Quarantine Cultural practices Resistant varieties Certified seeds	Quite regularly (as per request and needs)	>1000	S Cane >80% Potato app 50%
7	Few alternatives but yet can have more.	Has not been offered training.	Not aware	Very low

Extension objective: Crop productivity

Description: Help farmers increase cane/sugar yield at reduced costs in a sustainable way
Group evaluation of how well extension has performed in this area:

	Key areas of assessment		
Group	% Increase in yield	% Increase in productivity	% farmers still in business
1	Low	Poor	80%
3	To some extent yes. BMP: adoption of soil analysis for proper fertilization, proper choice of varieties Constraints: Planters reluctant to adopt new recommendations. Some 20% of planters still not aware of BMP.	To some extent yes. Collaboration of planters (20%) Constraints: Reluctance of planters to provide reliable data (input and revenue), lack of trust (MRA), calculation of profitability based on assumptions and estimations.	To some extent yes (20% in regrouping project – FORIP) Constraints: sugar production no longer seems a viable business, flexibility to shift to other land use
4	-(10-15%) - yield decline	-(25-50)%	App 80% (30 000 to 21 000 planters in 2010)
5	-(10-15%) - yield decline	5%	67%
7	Yes has increased production under regrouping	Mechanization has decreased cost of production but revenue is less (sugar)	Many abandoned but extension officer has mitigated rate of 'abandonment'

Appendix 8: Focus group discussions – Session 4

Creating a vision for change

Group 1

Client: Farmer-Extension	How our relationship should look in terms of
Focus	Productivity and welfare.
	To improve farm profitability – increasing income – better livelihood.
Collaboration	Participatory, advisory, facilitator, trainer.
	Needs assessment – elaboration/implementation of projects/participatory activities – training needs.
Issues	Sustainable crop production/livestock technologies, quality and safety.
	Primary production – value added products, business plan.
Other	Support services – access to inputs, incentives, schemes.
	Environmental threats.
Client: Extension-research	How our relationship should look in terms of
Focus	Collaborative/complementary relationships to address problems of farmers.
Collaboration	A multidisciplinary approach: Identification of farmers' needs and formulation of Research Projects, implementation and monitoring.
Issues	Technology transfer (Technology Review Meetings & Workshops), On farm trials.
	Support services (P & D Diagnosis, Joint visits, seed quality tests (Q & S, Germplasm).
Other	Publications for farmers, participation in fairs etc.
Client: Research-Farmer	How our relationship should look in terms of
Focus	Improve farm productivity and farmers' welfare by addressing their needs.
Collaboration	Participatory – (Identification, formulation, implementation and impact of research projects.
Issues	Adaptation of sustainable technologies.
Other	Training, evaluation of novel pesticides and germplasm.

Group 2

Client: Farmers/Extension	How our relationship should look in terms of
Focus (Farmers participation in R & D)	Identifying problems and constraints.
	Involvement of farmer in the design and implementation of research-Extension programme by taking on board indigenous knowledge.
Collaboration	Trust/commitment/sharing of knowledge and resources.
Issues	Resistance to share (planters).
	Conflicting ideas (F Vs E/R) – lack of commitment/trust.
Other	
Client: Research-Extension	How our relationship should look in terms of
Focus (Strengthen linkages)	Improve collaborative work.
	Optimise output on both sides.
Collaboration	Regular meeting for feedback results.
	Mutual collaboration in designing programme of work.
Issues	Resistance to collaborate.
Other	

Group 3

Client: Research-Extension	How our relationship should look in terms of
Focus	More successful technology transfer (eg adaptation of varieties)
Collaboration	More interaction/participation in discussions, regional committees, assessment of varieties (field).
Issues	Workload pressure, limited resources, motivation.
	Frequency of meetings.
Other	Able, willing, committed and dedicated personnel.
Client: Farmer-Extension	How our relationship should look in terms of
Focus (Researcher-Farmer)	Acceptance and adoption of proposed technology (eg varieties).
Collaboration	On-farm/observation plots.
	Participation in variety assessments, visits, seminars, open-days, training.
Issues	Reluctance, time constraints, networking.
Other	Participation in decision-making and R & D.

Group 4

Client: Farmer-Extension	How our relationship should look in terms of
Focus (Extension Officer-Farmer)	Farmers' problem solving, communication.
	Identify nature of problem.
Collaboration	All actors involved in sector, Extension Officer to form part of planters' social environment.
Issues	Technical, financial (access to credit facilities), social, political, planters power force/votes.
	Variety selection, advice on use of inputs.
Other	Institutions/policy decisions.
	Special schemes.
Client: Farmer/Research	How our relationship should look in terms of
Focus	Identify planters needs (communication) - awareness from top to bottom, a two way.
	Research to seek solutions at planters' sector level.
Collaboration	Extension, resource, sharing.
Issues	Friendliness, listening, availability, increasing trust.
Other	Feedback on research results.

Group 4 (contd.)

Client: Research-Extension	How our relationship should look in terms of
Focus	Mutual trust and understanding.
	Complementary and communication.
Collaboration	Mutual time sharing/discussion.
	Training for sharing of knowledge and expertise.
Issues	Existing work organization.
	Superiority.
Other	Resources limited.
	Research and planting community as two banks of a river. Extension is the bridge.

Group 5

Client: Farmer-Extension	How our relationship should look in terms of
Focus	We must modernise our communication systems.
	Use of SMS, e-mails, teleconference.
Collaboration	Active participation in the communication process.
Issues	Poor level of IT literacy.
	Scarcity of resources (farmers & Extension).
Other	
Client: Research-Farmer	How our relationship should look in terms of
Focus	Communication.
	More regular contacts for more involvement in research programmes.
Collaboration	From bottom to top: carry out research according to needs of farmers as identified by Extension.
Issues	Top-down approach.
	Research is being imposed on planters.
Other	

Group 6

Client: Farmer-Extension	How our relationship should look in terms of
Focus	Planters' requirement: Extension services, recorded visit/detail sheets, reasons/objective of visits, short-term/long-term recommendations, Accessibility of Extension Service (Hotline/after office hours), schedule next visit, follow-ups during crop cycle.
Collaboration	Agronomists consultants – rapid intervention service – mobile unit.
	Pathologists/Entomologists.
Issues	
Other	4 new structural organizations for operation: 4 regional and national monitoring, committees on the Agricultural sector, meeting each six months, comprising of planters and relevant stakeholders (democratically elected planters representatives).
	Agricultural policy unit: Submission for budget.
Client: Research-Extension	How our relationship should look in terms of
Focus	Proposed new structure for extension-research for a fruitful relationship.
	Extension services: Need to focus on: recorded visits/detail sheets, short-term/long-term recommendations, accessibility of Extension services (hot line even after office hours 24/7., schedule next visit, follow ups during crop cycle.
Collaboration	Planters' requirements: Direct communication with pathologists/agronomists/consultants, rapid intervention of entomologists, direct communication,
	Rapid intervention service: mobile unit. Create a new structural organization for operation, 4 regional committees and a national committee to meet each six months. Agricultural policy unit: comprising of planters and relevant stakeholders, submission of recommendations to Ministry of finance for budget.
Issues	
Other	

Group 7

Client: Farmer-Extension	How our relationship should look in terms of
Focus	Crop (SC): sharing of know-how as below: Cow keeper/pig breeder should act as a partner in farming activities (both need good results).
	More concerned of final results and profitability and profit.
Collaboration	Response of Extension Officers should be prompt and timely.
Issues	Receptive to query. Ability to assist in solving problems.
	Extension Officer should collect the right information.
Other	Motivation should be genuine and not towards wages.
Client: Research-Farmer	How our relationship should look in terms of
Focus (Farmers))	Objective/expectations of the farmer should be met and not only for research findings/publications (which will sleep in drawers).
Collaboration	Consultative – farmers explain their problems/objectives.
Issues	Committee for liaison/committee meetings which will be a permanent one, meeting on a quarterly basis, which must be noted.
Other	Same as Extension Officer: we need them and vice versa, so we'd better work together.

Group 8

Client: Farmer-Extension	How our relationship should look in terms of
Focus (Research))	Partnership at PAR.
Collaboration	Consultative and with consent.
Issues	Formal agreement between Research-Extension.
	Proper structure and method.
Other	Adequate resources – human, financial.
	Cultural barrier.
Client: Farmer-Extension	How our relationship should look in terms of
Focus (Farmers)	Trust, honesty, integrity.
Collaboration	Participatory.
Issues	Cultural barrier, language, education level.
	Small planter profile (socio-economic, age, small, scattered fields).
Other	Change focus of extension from production to farmer well being.

Appendix 9

Chi-square tests for data presented in Chapter 5

1. Distribution of farm size across milling areas

Size	Milling area	Observed	Expected	Deviation
0.01 - <= 1 ha	B Vue	11	23.84	6.91293E+00
0.01 - <= 1 ha	FUEL	14	14.40	1.11858E-02
0.01 - <= 1 ha	Omnicane	48	34.76	5.04136E+00
1.01 - <= 2 ha	B Vue	13	11.76	1.31838E-01
1.01 - <= 2 ha	FUEL	7	7.10	1.46610E-03
1.01 - <= 2 ha	Omnicane	16	17.14	7.61905E-02
2.01 - <= 5 ha	B Vue	14	7.23	6.33136E+00
2.01 - <= 5 ha	FUEL	3	4.37	4.29424E-01
2.01 - <= 5 ha	Omnicane	5	10.55	2.91808E+00
> 5 ha	B Vue	10	5.22	4.36511E+00
> 5 ha	FUEL	5	3.16	1.07672E+00
> 5 ha	Omnicane	1	7.62	5.75030E+00
total	0.01 - <= 1 ha	73		
total	1.01 - <= 2 ha	36		
total	2.01 - <= 5 ha	22		
total	> 5 ha	16		
total	B Vue	48	**Chi-square value = 3.30E+01**	
total	FUEL	29	**df =6**	
total	Omnicane	70	**p =1.03E-05**	
	Grand total	147		

2. Distribution of land tenure across farm size

Farm size	Ownership	Observed	Expected	Deviation
0.01 - <= 1 ha	Self	55	50.16	4.68E-01
0.01 - <= 1 ha	Family	12	11.92	5.59E-04
0.01 - <= 1 ha	Leased	4	5.96	6.44E-01
0.01 - <= 1 ha	Others	2	4.97	1.77E+00
1.01 - <= 2 ha	Self	23	24.73	1.22E-01
1.01 - <= 2 ha	Family	4	5.88	6.00E-01
1.01 - <= 2 ha	Leased	6	2.94	3.19E+00
1.01 - <= 2 ha	Others	3	2.45	1.24E-01
2.01 - <= 5 ha	Self	15	15.12	8.85E-04
2.01 - <= 5 ha	Family	5	3.59	5.52E-01
2.01 - <= 5 ha	Leased	1	1.80	3.53E-01
2.01 - <= 5 ha	Others	1	1.50	1.65E-01
> 5 ha	Self	8	10.99	8.15E-01
> 5 ha	Family	3	2.61	5.76E-02
> 5 ha	Leased	1	1.31	7.17E-02
> 5 ha	Others	4	1.09	7.79E+00
total	0.01 - <= 1 ha	73		
total	1.01 - <= 2 ha	36		
total	2.01 - <= 5 ha	22		**Chi-sq =1.67E+01**
total	> 5 ha	16		**df =9**
total	Self	101		**p = 5.33E-02**
total	Family	24		
total	Leased	12		
total	Others	10		
	Grand total	147		

3. Degree of difficulty / ease of farm operations by milling areas

Replantation:

Milling area	Diff/Easy	Observed	Expected	Deviation
Belle Vue	Diff	32	28.9	3.39E-01
Belle Vue	Easy	15	18.1	5.40E-01
FUEL	Diff	11	16.6	1.88E+00
FUEL	Easy	16	10.4	3.00E+00
Omnicane	Diff	43	40.5	1.49E-01
Omnicane	Easy	23	25.5	2.37E-01
Total	Belle Vue	47		
Total	FUEL	27	**Chi-sq = 6.14E+00**	
Total	Omnicane	66	**df =2**	
Total	Diff	86	**p = 4.64E-02**	
Total	Easy	54		
	Grand Total	140		

Pre-harvest operations:

Milling area	Diff/Easy	Observed	Expected	Deviation
Belle Vue	Diff	26	22.0	7.22E-01
Belle Vue	Easy	20	24.0	6.62E-01
FUEL	Diff	13	12.4	2.49E-02
FUEL	Easy	13	13.6	2.29E-02
Omnicane	Diff	28	32.5	6.34E-01
Omnicane	Easy	40	35.5	5.82E-01
Total	Belle Vue	46		
Total	FUEL	26	**Chi-sq =2.65E+00**	
Total	Omnicane	68	**df =2**	
Total	Diff	67	**p =2.66E-01**	
Total	Easy	73		
	Grand Total	140		

Degree of difficulty / ease of farm operations by milling areas (contd.)

Harvest and Post-harvest operations:

Milling area	Diff/Easy	Observed	Expected	Deviation
Belle Vue	Diff	26	21.0	1.19E+00
Belle Vue	Easy	16	20.4	9.49E-01
FUEL	Diff	16	14.5	1.55E-01
FUEL	Easy	13	14.1	8.37E-02
Omnicane	Diff	28	33.5	9.03E-01
Omnicane	Easy	39	32.5	1.28E+00
Total	Belle Vue	42		
Total	FUEL	29		**Chi-sq = 4.56E+00**
Total	Omnicane	67		**df =2**
Total	Diff	70		**p = 1.02E-01**
Total	Easy	68		
	Grand Total	140		

4. Degree of difficulty of farm operations across farm sizes

Operation	Farm size	Observed	Expected	Deviation
Replantation	0.01 - <= 1 ha	39	3.96E+01	1.06E-02
Pre-harvest	0.01 - <= 1 ha	30	2.95E+01	7.96E-03
Harv & Post harvest	0.01 - <= 1 ha	31	3.08E+01	8.62E-04
Replantation	> 1 ha	51	5.04E+01	8.33E-03
Pre-harvest	> 1 ha	37	3.75E+01	6.26E-03
Harv & Post harvest	> 1 ha	39	3.92E+01	6.78E-04
Total	Replantation	90		
Total	Pre-harvest	67		**Chi-sq =3.47E-02**
Total	Harv & Post harvest	70		**df =2**
Total	0.01 - <= 1 ha	100		**p =9.83E-01**
Total	> 1 ha	127		
	Grand total	227		

5. Degree of difficulty of farm operations in relation to farmers' experience

Operation	Period of experience	Observed	Expected	Deviation
Replantation	< 5 yrs	2	2.36E+00	5.57E-02
Pre-harvest	< 5 yrs	2	1.78E+00	2.75E-02
Harv & Post harvest	< 5 yrs	2	1.86E+00	1.08E-02
Replantation	> 5 -10 yrs	10	9.85E+00	2.44E-03
Pre-harvest	> 5 -10 yrs	8	7.41E+00	4.67E-02
Harv & Post harvest	> 5 -10 yrs	7	7.74E+00	7.14E-02
Replantation	> 10 - 15 yrs	4	5.12E+00	2.45E-01
Pre-harvest	> 10 - 15 yrs	4	3.85E+00	5.53E-03
Harv & Post harvest	> 10 - 15 yrs	5	4.03E+00	2.35E-01
Replantation	> 15 - 25 yrs	26	2.48E+01	5.71E-02
Pre-harvest	> 15 - 25 yrs	18	1.87E+01	2.45E-02
Harv & Post harvest	> 15 - 25 yrs	19	1.95E+01	1.35E-02
Replantation	> 25 yrs	47	4.69E+01	4.01E-04
Pre-harvest	> 25 yrs	35	3.53E+01	2.20E-03
Harv & Post harvest	> 25 yrs	37	3.69E+01	5.44E-04
Total	Replantation	89		
Total	Pre-harvest	67		
Total	Harv & Post harvest	70		
Total	< 5 yrs	6		
Total	> 5 -10 yrs	25		
Total	> 10 - 15 yrs	13		**Chi-sq = 7.99E-01**
Total	> 15 - 25 yrs	63		**df = 8**
Total	> 25 yrs	119		**p = 9.99E-01**
	Grand total	226		

6. Perception of soil fertility in relation to milling areas

Status		Observed	Expected	Deviation
Belle Vue	High	24	12.64	1.02E+01
Belle Vue	Moderate	23	28.20	9.59E-01
Belle Vue	Low	0	6.16	6.16E+00
FUEL	High	6	7.80	4.15E-01
FUEL	Moderate	20	17.40	3.89E-01
FUEL	Low	3	3.80	1.68E-01
Omnicane	High	9	18.56	4.92E+00
Omnicane	Moderate	44	41.40	1.63E-01
Omnicane	Low	16	9.04	5.36E+00
Total	Belle Vue	47		
Total	FUEL	29		
Total	Omnicane	69		**Chi-sq = 2.87E+01**
Total	High	39		**df = 4**
Total	Moderate	87		**p = 8.84E-06**
Total	Low	19		
	Grand total	145		

7. Reasons for cultivating sugar cane by milling area

Reasons	Milling area	Observed	Expected	Deviation
Income	Belle Vue	32	2.79E+01	6.15E-01
Tradition	Belle Vue	23	2.30E+01	2.92E-06
Not to leave field idle	Belle Vue	8	1.05E+01	6.16E-01
others	Belle Vue	3	4.60E+00	5.56E-01
Income	FUEL	17	1.98E+01	4.07E-01
Tradition	FUEL	21	1.64E+01	1.31E+00
Not to leave field idle	FUEL	4	7.51E+00	1.64E+00
others	FUEL	5	3.27E+00	9.09E-01
Income	Omnicane	54	5.53E+01	3.05E-02
Tradition	Omnicane	41	4.56E+01	4.71E-01
Not to leave field idle	Omnicane	27	2.09E+01	1.75E+00
others	Omnicane	9	9.13E+00	1.77E-03
Total	Income	103		
Total	Tradition	85		
Total	Not to leave field idle	39		
Total	others	17		**Chi-sq =8.31E+00**
Total	Belle Vue	66		**df =6**
Total	FUEL	47		**p =2.163E-01**
Total	Omnicane	131		
	Grand total	244		

8. Use of technologies in relation to milling area

Technology	Milling area	Observed	Expected	Deviation
New varieties	Belle Vue	22	16.90	1.54145E+00
New herbicides	Belle Vue	19	17.53	1.23239E-01
Soil analysis	Belle Vue	8	14.57	2.96488E+00
New varieties	FUEL	16	12.76	8.23486E-01
New herbicides	FUEL	11	13.24	3.78065E-01
Soil analysis	FUEL	10	11.00	9.16586E-02
New varieties	Omnicane	42	50.34	1.38318E+00
New herbicides	Omnicane	53	52.23	1.12699E-02
Soil analysis	Omnicane	51	43.42	1.32235E+00
Total	New varieties	80		
Total	New herbicides	83		
Total	Soil analysis	69		**Chi-sq = 8.64E+00**
Total	Belle Vue	49		**df = 4**
Total	FUEL	37		**p = 7.077E-02**
Total	Omnicane	146		
	Grand total	232		

9. Use of technologies in relation to farm size

Technology	Farm size	Observed	Expected	Deviation
New varieties	<= 1 ha	38	40.00	1.00000E-01
New herbicides	<= 1 ha	42	41.50	6.02410E-03
Soil analysis	<= 1 ha	36	34.50	6.52174E-02
New varieties	> 1 ha	42	40.00	1.00000E-01
New herbicides	> 1 ha	41	41.50	6.02410E-03
Soil analysis	> 1 ha	33	34.50	6.52174E-02
Total	New varieties	80		
Total	New herbicides	83		**Chi-sq = 3.42E-01**
Total	Soil analysis	69		**df = 2**
Total	<= 1 ha	116		**p = 8.426E-01**
Total	> 1 ha	116		
	Grand total	232		

10. Use of technologies in relation to years of experience

Technology	Planter's experience	Observed	Expected	Deviation
New varieties	<15 yrs	17	18.62	0.141060026
New herbicides	<15 yrs	20	19.32	0.024007909
Soil analysis	<15 yrs	17	16.06	0.054977141
New varieties	>15 yrs	63	61.38	0.042793491
New herbicides	>15 yrs	63	63.68	0.007283298
Soil analysis	>15 yrs	52	52.94	0.016678459
Total	New varieties	80		
Total	New herbicides	83		**Chi-sq =2.87E-01**
Total	Soil analysis	69		**df = 2**
Total	<15 yrs	54		**p = 8.66E-01**
Total	>15 yrs	178		
	Grand total	232		

11. **Use of technologies in relation to gender**

Technology	Gender	Observed	Expected	Deviation
New varieties	male	53	54.62	0.042191336
New herbicides	male	70	67.35	0.076584762
Soil analysis	male	48	48.87	0.00488014
New varieties	female	17	15.01	0.153504649
New herbicides	female	16	18.51	0.278638175
Soil analysis	female	14	13.43	0.017755403
Total	New varieties	70		
Total	New herbicides	86		**Chi-sq = 5.74E-01**
Total	Soil analysis	62		**df = 2**
Total	Male	171		**p = 7.51E-01**
Total	Female	47		
	Grand total	218		

12. Use of technologies in relation to contribution of sugar proceeds to household income

Technology	% contribution	Observed	Expected	Deviation
New varieties	<=5%	17	15.53	1.39E-01
New herbicides	<=5%	15	15.30	5.97E-03
Soil analysis	<=5%	10	11.20	1.29E-01
New varieties	>5 to 10%	13	13.68	3.39E-02
New herbicides	>5 to 10%	14	13.48	2.00E-02
Soil analysis	>5 to 10%	10	9.87	1.80E-03
New varieties	>10%	18	18.49	3.36E-02
New herbicides	>10%	18	18.22	2.59E-03
Soil analysis	>10%	14	13.33	8.53E-02
Total	New varieties	48		
Total	New herbicides	47		**Chi-sq = 4.51E-01**
Total	Soil analysis	34		**df = 4**
Total	<=5%	42		**p = 9.78E-01**
Total	>5 to 10%	37		
Total	>10%	50		
	Grand total	129		

13. Use of technologies in relation to reasons for planting cane

Technology	Reasons	Observed	Expected	Deviation
New varieties	Tradition	43	45.45	1.33E-01
New herbicides	Tradition	46	41.82	4.18E-01
Soil analysis	Tradition	41	42.73	6.98E-02
New varieties	Income	57	54.55	1.10E-01
New herbicides	Income	46	50.18	3.48E-01
Soil analysis	Income	53	51.27	5.82E-02
Total	New varieties	100		
Total	New herbicides	92		**Chi-sq = 1.14E+00**
Total	Soil analysis	94		**df = 2**
Total	Tradition	130		**p = 5.66E-01**
Total	Income	156		
	Grand total	286		