

A SURVEY OF IRRIGATION PRACTICES FOR SUGAR CANE IN MAURITIUS

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Abstract

Irrigation is vital in subhumid areas to sustain economic production of sugar cane. It is also important input data for a GIS database for sugar cane land management. A survey was conducted in Mauritius in 1999 to collect data on irrigation practices and irrigation systems in use. The objectives were, *inter alia*, to provide up to date information on irrigation status in the sugar industry and allow studies on yield relationship to land characteristics for re-assessment of land suitability. Valuable statistics on the distribution and practices of irrigation were derived and a map was also prepared. Twenty two per cent of the total cane area in Mauritius was irrigated, the three main irrigation systems being overhead, drip (trickle) and surface. Low-pressure overhead irrigation systems, such as the centre pivot and dragline, were gradually replacing high-pressure overhead systems.

Introduction

Water is an essential commodity in subhumid areas if high cane yields are to be increased or at least maintained. As water is often scarce and expensive, concern is expressed over its injudicious use (Singels *et al.*, 1999) and cane growers aim at the best practice of irrigation management (Wood *et al.*, 1998; Romero *et al.*, 2000). Irrigation simulations have been undertaken to predict yield response to supplementary irrigation (Inman-Bamber *et al.*, 1999) and to determine the most profitable use of irrigation supplies (Brennan *et al.*, 1999). Different irrigation systems are in use and are appraised for their water application efficiency (Ahluwalia *et al.*, 1998). Benchmarking irrigation practices and taking stock of irrigation systems in use are methods to help understand the economics of irrigation, estimate the amount of water required for irrigation, and develop strategies for water storage and water application. In Mauritius, irrigation is reported to increase cane yield in subhumid areas by as much as 40 to 60 t/ha (Bachelor and Soopramanien, 1993; Anon, 1998). In line with this concept, a study was undertaken to survey and map sugar cane areas irrigated under different systems in 1999. The objectives of the study were (a) to collect data on irrigation practices on a field basis for updating a database known as the Land Index Database, (b) to produce a map showing the distribution of irrigation systems in use, and (c) to enable the investigation of yield increase under irrigation and related land characteristics, particularly to help in the re-assessment of suitability ratings for cane lands. This paper highlights the findings of the survey and emphasis is placed on various actions that should be taken to maintain the viability of the sugar industry in the dry lowlands of Mauritius.

Methodology

Land Index Database and data collection

The Land Index Database is managed within a geographic information system (GIS) for sugar cane

land (Jhoty *et al.*, 1995). It consists of the physical, edaphic, agro-climatic and agronomic data of each sugar cane field in Mauritius, including data on land suitability (Deville and Lim Shin Chong, 1984). It spans data for three distinct categories of grower: miller/corporate growers, referred to as sugar estates (generally greater than 300 ha), large planters owning 10 to 300 ha, and small planters owning less than 10 ha. Irrigation data are included in the database and used for productivity analyses. Data were collected directly from the different growers, except for the small planters. For the latter, data were provided by the Irrigation Authority which manages irrigation on their land. Listings from the Land Index Database were used to record changes in the irrigation status of each cane field and, after corrections, were used for computer data entry and updating of the database.

GIS maps

In parallel with the manual recording of data, maps of scale 1:25 000 showing cane fields of the different growers were used to represent in colours the irrigated areas under different irrigation systems and intensity of water application. When the coloured draft maps were completed, irrigation area boundaries were digitised on screen, within MapInfo, with the help of a scanned product of the same maps. Aerial photographs and satellite images were used, where appropriate, to provide precise locations of areas irrigated with the centre pivot systems. A map was prepared to show the distribution of irrigated areas, for the three categories of growers, under different irrigation systems and intensity of water application, and includes isolines of the mean annual rainfall at intervals of 500 mm.

Classification of irrigation systems and intensity of application

Irrigation systems were classified as high pressure and medium pressure overhead (sprinkler) systems,

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drip (trickle) system, and wild flooding and improved surface systems. The high pressure overhead systems are the 'targetmaster', 'boom-o-rain', 'big gun' and 'hose reel' (travelling sprinkler). The medium pressure overhead systems are the dragline and the centre pivot. The improved surface systems, whereby the amount of water applied is controlled, comprise the siphon, furrow, gated pipe and lay-flat. Two classes of intensity of irrigation were established, viz. intensive/regular and occasional/irregular. Intensive/regular irrigation relates to one or more applications in a week/fortnight/month to satisfy crop water requirements. Occasional/irregular irrigation relates to one or more applications spaced in time whenever water is available—the amount of water applied is sufficient only to save the crop and hardly satisfies the crop water requirement.

Results and discussion

Areas irrigated and irrigation systems

Irrigation was practised on 22% of the 78 000 ha of land under sugar cane in Mauritius, mostly in the dry areas of the north, west and east. Of the total irrigated areas (17 331 ha), 76% received intensive water applications and the balance received occasional applications. The irrigated areas for miller/corporate estates represented about 28% of their total cane areas, for large planters 17%, and for small planters 8% of their total cane land (Table 1). The higher percentage of irrigated areas of miller/corporate estates reflects the latter's capacity to invest and expect returns over time.

The high pressure overhead irrigation systems were in use on 6935 ha and were the most widespread systems, covering 40% of total areas irrigated. They were also the main systems utilised by miller/corporate estates and by the Irrigation Authority on small planter land. A gradual decrease in their use was, however, noted on miller/corporate estates' land, with a sharp decline from 1996 onwards (Figure 1). Of the range of high-pressure systems, the

'big gun' was used more on miller/corporate estates. The 'hose reel' equipment was used on a limited scale on their land due to poor adaptation to certain soil conditions (heavy clays, rocky soils) and high operating costs. The two medium-pressure overhead systems, the centre pivot and dragline, recently introduced in Mauritius, occupied 25% and 14% of total areas irrigated respectively, and are found mostly on miller/corporate estates. The centre pivot irrigation system, being more efficient in terms of water application, comprised 76 units in 1999. The tendency at present is to move towards greater use of these two systems, especially the centre pivot system which is less labour demanding, involves reduced investment costs as compared to drip, and is easy to operate (Monty, 2000; Teeluck, 1998). The shift to more efficient irrigation systems is also being noted in regions where there is an increase in interest in improved water use efficiency, such as in South Texas (Weidenfeld, 2000) and in Egypt (El-Yazal *et al.*, 2000).

The drip irrigation system, introduced in Mauritius in the 1970s, accounted for about 8% of total areas irrigated. It was the second most important irrigation system on small planter land, accounting for about 24% of their total area irrigated. The system's high initial capital outlay, coupled with highly demanding management inputs are, however, restricting its further expansion.

Surface irrigation was practised on about 13% of the total area irrigated, the main type being wild flooding. It was the main irrigation system on large planter land, covering about 55% of their irrigated areas. In view of its low application efficiency as a result of high losses of water, surface irrigation was less practised on miller/corporate estate land. The proportion of area irrigated by the system has declined since 1973 (Figure 1). Surface irrigation is considered to be most suitable for heavy soils or areas where water is relatively cheap and the cost of energy is high (Soopramanien, 1998).

Table 1—Area irrigated under different systems for each category of growers in Mauritius.

Main irrigation system	Irrigation sub-system/type	Area (ha)			
		MP*	LP*	SP*	Total
High-pressure overhead	Big gun	3 630	16	—	3 646
	Targetmaster	1 334	153	798	2 285
	Boom-o-rain	770	52	—	822
	Travelling sprinkler (hose reel)	153	29	—	182
Sub-total		5 887	250	798	6 935
Medium-pressure overhead	Dragline	2 072	181	146	2 399
	Centre pivot	3 767	442	28	4 237
Sub-total		5 839	623	174	6 636
Drip		1 052	93	302	1 447
Surface	Wild flooding	946	1 109	—	2 055
	Improved surface (siphon, furrow, gated pipe, lay-flat)	195	62	—	257
Sub-total		1 141	1 171	—	2 312
Total (ha)		13 920	2 137	1 274	17 331
% of area under cane		28	17	8	22

*MP = Miller/corporate estates; LP = Large planters (> 10 ha); SP = Small planters (< 10 ha)

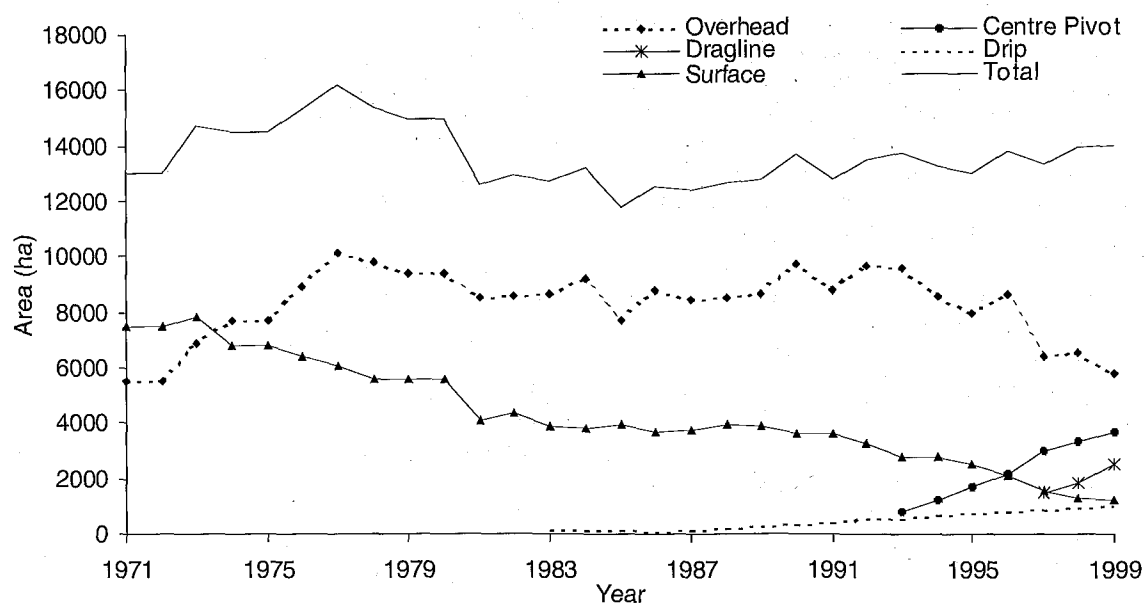


Fig. 1—Evolution of area under irrigation on miller/corporate land.

Characteristics of areas under irrigation

Irrigation was dominant in the zone receiving less than 2300 mm mean annual rainfall, and in this zone some 77% of irrigated areas were below the 1500 mm isohyet, principally in the north and west of the island. The period of moisture deficit (evapotranspiration > rainfall) in these areas is generally six or more months in the year, so that there is a greater need for irrigation water use by sugar cane to sustain high production. Further to the areas irrigated below the 1500 mm isohyet, it is estimated that about 15 510 ha of additional cane land needs irrigation and should be given priority over other areas. In effect, an area of 3500 ha in the northern plain has been earmarked for irrigation under a new irrigation scheme known as the Northern Plain M1 Pipeline Irrigation Scheme. Twenty per cent of the irrigated areas are found within the belt of 1500 to 2000 mm mean annual rainfall, where the moisture deficit generally lasts between three to six months. Within this area, there is an area of 14 528 ha which is not irrigated, and which would need irrigation, either intensive or occasional. The remaining 3% accounts for areas irrigated above the 2000 mm isohyet, where the moisture deficit may last from one to three months.

Most areas under irrigation (95.2%) are flat, generally with less than 8% slope.

Water use planning

As the sugar industry in Mauritius is at a critical point in the rationalisation of inputs for sugar cane production, the findings of the survey and the irrigation map produced are pertinent to reviewing and planning water use. The irrigation map, when used with a hydro-geological map, will enhance the process of determining the sources, storage sites and amount of water (from boreholes or rivers) required for sugar cane and other crops. Moreover, by knowing which irrigation system is most efficient and appropriate for certain land conditions, it will be

possible to reduce the cost of irrigation. All these issues will lead to a rationalisation of water use and the best allocation of water to agriculture, industry, tourism and domestic consumption.

Conclusion

Owing to the importance of sugar in the Mauritian economy and, therefore, the need to sustain high sugar production, it was fitting to conduct a comprehensive survey of irrigated areas and irrigation systems in use. The data compiled and map produced should be useful to the private and public sectors for planning purposes and also for the formulation of water policies. Moreover, the information will be useful in performing productivity studies, especially those related to a revised assessment of suitability ratings for the irrigation of the cane crop. It is estimated that irrigation areas in the dry lowlands should be doubled in order to stabilise sugar production and ensure a stable return to cane growers. However, the amount of water available, the frequency of dry periods affecting plant growth, and economic circumstances will to a large measure dictate the extent of land that will be irrigated. These aspects are presently being investigated by the Irrigation Department of the Institute. In view of increasing competition for water from other sectors, water in the sugar industry will have to be more judiciously and efficiently used so that the minimum amount necessary is applied to achieve maximum yield. This objective is gradually being realised with the introduction of more efficient irrigation systems such as centre pivot, drip and dragline.

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LES PRATIQUES D'IRRIGATION DANS LA CULTURE DE LA CANNE À SUCRE À MAURICE

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Résumé

Dans les régions subtropicales, l'irrigation est essentielle pour promouvoir une production économique de canne à sucre. C'est également une importante source d'informations pour le développement d'un système d'information géographique (SIG) destiné à la gestion des terres sous culture de canne. En 1999, à Maurice, une étude a été entreprise afin de recueillir des données sur les pratiques et les différents systèmes d'irrigation. Cette étude avait pour objectifs de fournir des données actualisées sur le statut de l'irrigation dans l'industrie sucrière et de permettre l'analyse des relations entre les rendements et les caractéristiques de terrain, afin de réévaluer la qualité du sol. D'importants résultats ont été obtenus sur la répartition et les pratiques d'irrigation. Ils ont permis la production d'une carte. Vingt deux pour cent de la superficie totale sous culture de canne à Maurice sont irrigués. L'aspersion, le goutte-à-goutte et l'irrigation de surface (inondation) sont les trois principaux systèmes d'irrigation utilisés. La technique d'irrigation par aspersion à basse pression, tels le pivot et le 'dragline', remplacent progressivement le système d'aspersion à haute pression.

Mots clés: base de données SIG, systèmes d'irrigation, application d'eau, zones pluvieuses, programme d'utilisation d'eau.

RELEVAMIENTO DE PRÁCTICAS DE RIEGO EN CAÑA DE AZÚCAR EN MAURICIO

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Resumen

El riego es vital para sostener desde el punto de vista económico la producción de caña de azúcar en regiones subhúmedas. Así mismo, es una importante variable en una base de datos GIS orientada al manejo de suelos con caña de azúcar. En 1999 se llevó a cabo en Mauricio un relevamiento cuyo propósito fue recolectar datos sobre prácticas de riego y sistemas de riego en uso. Los objetivos fueron inter alia, proveer información actualizada sobre la situación del riego en la industria azucarera y posibilitar estudios sobre las interrelaciones entre los rendimientos y las características de la tierra con el objeto de reevaluar su aptitud. Se consideraron aspectos estadísticos relevantes relacionados con las prácticas y la distribución del riego y se preparó un mapa. Un 22% del área cañera de Mauricio está bajo riego, siendo los tres sistemas más importantes el de aspersión, goteo y superficie. Los sistemas de aspersión de baja presión tales como pivote central y de arrastre han reemplazados gradualmente a los de alta presión.

Palabras claves: base de datos GIS, sistemas de riego, aplicación de agua, zonas de lluvias, planificación del uso del agua.