EFFICIENCY OF MECHANICAL CANE LOADING IN EGYPT

By

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Abstract

THE CANE growing area along the Nile valley in Upper Egypt has expanded. Most of farmer holdings are small, typically ranging from 0.5 to 1 hectare. Cane delivery schedules and consequently harvesting dates mainly depend on the delivery allocation and the date of harvest last season. The mill administration assigns a transport vehicle (main vehicle) for each farmer according to the schedule. Farmer/s harvest and transport cane from inside field/s (using a tractor-pulled-trailers) to temporary storage sites at which the main vehicle/s are loaded. Loader efficiency can be low due to time losses associated with travel from one storage site to another. To achieve reasonable efficiency of the loader, storage sites may be amalgamated allowing greater utilisation of loaders. This procedure may increase the infield transport distance which may reduce the rate of cane supply from fields, thus contributing to increased cane delivery delay. Farmers may have to transport a part of the main vehicle load to the storage site the previous day to secure continuous operation of the loader. In this study, loader efficiency, loading rate, the percentage of main vehicle/s load/s delayed more then 24 h and cane collection efficiency were studied. In most cases, one main vehicle is assigned to each farmer, where a trailer pulled by tractor is used to transfer cane from inside the field to the storage area. Results show that total efficiency of the loader was 75% in case of loading lorries in a large storage area and 81% in case of railway wagons loaded at a station. Average total efficiency of the loader was 61% when loading decauvelle wagons distributed in several storage areas within the same production region. Efficiency of loading tractor trailers in the field was 54%. Maximum efficiency was observed to be achieved if the loader works for the full operational day in one storage area. Cane collection efficiency was variable for the variable operating conditions. The percent of cane delayed more than 24 h was also estimated. Large temporary storage areas at which lorries are loaded with cane, and cane loading stations for railway wagons may represent more optimal conditions for loader operation. The paper discusses the efficiency of loader operation under a range of variable conditions, and related cane delivery delay. The results highlight the role of loader operation efficiency as a factor determining the adoption of mechanical loading of sugarcane. Recommendations for proper operation of cane loader are suggested.

Introduction

Due to soil and water limitations, the sugarcane growing area in Upper Egypt is limited to about 350 000 feddan (150 000 hectares). Average production has been maintained at over 120 t/ha for several years and may be classified as one of the highest cane yielding areas in the world. Cane-to-mill delivery activities are performed according to schedules (prepared by the mill administration) which determine the date of harvesting and the main transport vehicle. According to the schedule, the common procedure is to each day assign a main vehicle to each farmer, thus allowing for low productivity of the harvesting and transport activities. Farmers harvest and transport cane to temporary storage areas at the trans-loading sites for the main vehicles. Cane has to be loaded again to the main vehicles. These temporary storage areas are the main area where mechanical loading of cane is undertaken, to load cane on the main transport vehicles to the mill.

Efforts to mechanise cane loading started more than 20 years ago when the Ministry of Agriculture initiated three mechanisation companies for sugarcane. The largest of these companies (Aswan Mechanisation Company) invested large amounts of its capital to purchase and rent cane loaders (especially Bell loaders). Despite the unlimited chances for operating these loaders, the company lost a large part of their investment and could not afford to replace the loaders at the end of their useful life. Therefore mechanical loading activities reduced from about 8% to less than 2%. Operating loaders at lower efficiency may have been one of the most important factors contributing to the loss of such investments and subsequent decline in the percent of mechanical loading. The number of workers ready to load has been declining because most of them prefer to find other easier jobs. Therefore the cost of cane loading has been constantly increasing.

Uichanco (1976) and Edilbert and Uichanco (1977) stated that cane loading is an arduous task which limits the productivity of manual cane cutters. In the Philippines, cane cutters can cut and load only one tonne a day. The wider use of mechanical loaders in the sugar industry can be an intermediate step in improving harvesting efficiency. Cochran and Whitney (1976) reported that Louisiana conditions require that sugarcane be burned and cut ½ to 1 day ahead of the loader and then transported to the mill. Libunao (1978) reported that, in the Philippines, sugarcane is loaded manually in trucks or carts for in-field transport. Cane loaders carry on their shoulders about ten to twenty cane stalks, from the ground to the trucks, through a ladder or ramp placed on any side of the truck. Manual loading complements sugarcane cleaning in the field which is also done manually.

Blackburn (1984) described the Bell self-loading trailer drawn by a wheeled tractor, designed and developed in South Africa. Cane is cut manually and formed into heaps or bundles. When loading takes place, the trailer is manoeuvered into position and its skids are dropped. A wire or chain attached to the winch is then passed around the bundle and draws it up the ramp into the trailer. Bell self-loading trailers are also used, with local modifications, in Trinidad and have been used since 1968 in the Philippines. Yang and Wang (1993) evaluated the performance of mechanical loading of sugarcane and compared it with the traditional manual loading on flat and sloping lands under two different yielding conditions. The manual loading efficiency was 0.54 t/man/h in comparison with 23.9 t/h for mechanical loading. Saif El-Yazal and Abdel-Mawla (1994) compared mechanical and traditional loading and transporting of sugarcane. The performance of the two mechanical systems was tested. The first was a 5 tonne capacity self-loading trailer equipped with a loading boom and the second was the grab loader. The self-loading trailer transported 6.4 t/h. The locally made trailer transported 5.3 t/h from a field 0.5 km from the store location, when loaded by the grab type loader.

Hansen *et al*. (1998) and Eggleston *et al*. (2001) conducted intensive studies on the problems of deterioration due to cane delay. The authors highlighted the problems caused by deterioration with different processing stages and recommended that the transport process be accelerated to reduce delivery delay. Abdel-Mawla (2000) studied mechanical loading of sugarcane and stated that efficient management of cane area and delivery system may facilitate increasing mechanical loading productivity and control cane delivery delay. Legal and Requis (2002) reported that the South African sugar industry relies on a large number of small-scale growers for a significant part of its production. In that respect, the management of the cane harvest and supply to the mill represents the key-issue regarding both the reduction of burn to crush delays, the regularity of deliveries and the reduction of production costs.

Abdel-Mawla and El-Lithy (2006) developed an expert system approach for selecting a cane transport system. They specified the possibility of mechanical loading as one of the most important qualifiers that attract farmers for selecting the cane delivery system. Meyer (2007) stated that, in South Africa, only about 2% of the annual crop is currently harvested mechanically. It is estimated that 40% of the whole stalk sugarcane is either loaded manually onto transport vehicles or stacked in 3–5 tone bundles to be transported by a self-loading tractor trailer/trailer combination. The remaining tonnage is mechanically loaded by grab and push-pile loaders onto a wide range of vehicles which transport the cane either directly from the fields, or indirectly from trans-loading zones to the mill.

The cane delivery process includes two transport links. In the first link the farmers use camels, carts or tractor-trailers to transport cane from inside fields to temporary stores (trans-loading sites). In the second link (according to the mill delivery schedule) a main transport vehicle is assigned to each farmer. The main vehicles may be a decauvelle-wagon or a railway-wagon if available in the region otherwise a wheel vehicle is used. In case of mechanical loading, farmers use tractor-trailers for infield transport to supply cane to the main vehicles waiting in the trans-loading site.

To maintain continuous operation of the loader, variable regulations have been arranged depending on the type of vehicles and other conditions. The study aimed to evaluate the efficiency of mechanical loading at the conditions under which the loader is operated.

Materials and methods

The area of cane planted for each mill is organised into regions. Each region is divided into plots bounded by irrigation channels, drainage channels, and rod system expanded in the agricultural area. Cane fields planted in the same plot may be owned by several farmers (prevailing holding sizes ranged from 0.5 to 1 hectare) and may not be of the same ratoon. Cane delivery schedules and consequently harvesting dates mainly depend on the ratoon and date of last season harvesting. Therefore, fields of the same region assigned for cane harvesting at certain dates may not be neighbours and main vehicles may be loaded at different trans-loading sites. Because cane is harvested manually and infield transport may depend on carts and such slow means, the mill administration assigns one main vehicle (daily) for each farmer. The main vehicle may be a decauvelle or a railway wagon depending on the availability; otherwise, a wheeled vehicle may be used. In case of mechanical loading, the farmers use a trailer pulled by a medium size tractor for infield transport.

A large temporary store (trans-loading site) is that in which the loader can work for a full operational day. Such sites may exist in one of the following conditions: 1) At large fields of the sugar company, governmental farms or large farmer holdings where lorries are shipped with cane. This may represent a small part of the total production area of sugarcane. 2) At the main railway line of Upper Egypt where trans-loading sites are established for transporting the cane crop of farms on both sides of the railway line. The railway wagons transport less than 3% of the total cane production.

Field measurements were undertaken at several locations in Upper Egypt. A Bell mechanical loader was used in the study. The mechanical efficiency of the Bell loader was assessed in the three most likely operational scenarios. These included:

1. Loading vehicles in one site:

   Lorries loaded in one trans-loading site.

   Railway wagons loaded simultaneously in a railway trans-loading site.

2. Loading vehicles in several sites:

   Decauvelle wagons or trucks waiting single or combined in 2, 3, 4 or 5 vehicles in the same trans-loading site.

3. Infield mechanical loading.

In the three scenarios, no time losses due to maintenance or repair were recorded. Hence, these losses are not considered in determining loader efficiency.

Loader efficiency

The loader efficiency was determined by multiplying the efficiency of loading an individual vehicle by the efficiency of continuous loading.

Total efficiency of loader L_E may be computed as the following:

$$L_E = L_{E1} \times L_{E2}$$

where:

Efficiency of loading individual vehicle (E_1)

Only time lost while loading a vehicle was considered.

Efficiency of continuous operation (E_2)

Only time lost for the loader to shift from one vehicle to another was considered.

Loading rate

The loading rate for the full operational day of the loader was computed using the following equation.

$$L_R = \frac{Sum\ vehicle\ loads\ (tonnes)}{Operation\ \ hours\ /\ day}$$

where:

L_R = Loader rate (t/h).

Load delays

According to the schedule of the mill, decauvelle wagons are distributed to the locations of temporary stores before sunrise and pulled back to the mill (loaded with cane) that afternoon.

The time available for infield transport may expand till the wagon is completely loaded, and this depends on the rank of the vehicle/store considered for mechanical loading.

Where there is simultaneous loading of railway wagons, loading duration (time available for infield transport) of each vehicle may expand to be equal to the full operational day.

The time available for infield transport for a vehicle waiting for the loader, may be determined as follow:

$$T_{FT} = \frac{V_{2L} \times V_{2N} \times S_{rank}}{L_R}$$

where:

T_{FT} = Time available for infield transport, h.

V_{2L} = Average load of the main vehicle, tones.

V_{2N} = Number of main vehicles in a store.

S_{rank} = Rank of the site considered for mechanical loading.

In case of mechanical loading, the loader operator informs each farmer with the rank of loading his vehicle two days early.

The farmer may estimate the quantity of infield cane transported from the early morning till the loader starts to load his wagon and transport the rest of the vehicle load from the field to the store at the previous day.

The percent of a vehicle load to be transported from the previous day (delayed more than 24 h) to secure continuous operation of the loader may be computed as follow:

Q_D % = The percent of the main vehicle load delayed more than 24h,

$$Q_D\% = \{1-(\frac{V_{1R}\times T_{FT}}{V_{2L}})(\frac{V_{1N}}{V_{2N}})\}\times 100$$

V_{1R} = The rate of infield transport by a tractor-trailer, t/h.

V_{1N} = Number of infield transport vehicle/s that supply cane to main vehicle/s. The ratio of (V_{1N} / V_{2N}) in common conditions equal to the unity.

The same form may be used to estimate the quantities of infield transported while loading railway wagons simultaneously. In this case, loading duration (time available for infield transport, T_{FT}) for each wagon may be equal to the operational hours of the day.

Cane collection efficiency

Cane collection efficiency is a measure of cane losses due to mechanical loading. The loader operator performs loading cycles as fast as possible to maximise the loader rate and income. Cane stalks may be scattered from the loader grab and the loader may pass over while working. Even though a worker may be assigned to collect scattered cane, some cane may be lost or damaged. Loader collection efficiency was determined as follows:

Results and discussion

Mechanical loading in large stores

Where lorries are loaded in a large trans-loading site, the loader loads each lorry individually. Before the loader starts loading a vehicle, the full cane load should be ready in the site. Mechanical loading accelerates the transport cycle and may facilitate repeated trips of a lorry from the trans-loading site to the mill. During mechanical loading, the lorry driver adjusts the lorry to the most suitable position for the loader to manoeuvre while loading to minimise the loading cycle time and maximise loader rate. Loading lorries individually in a large site was accomplished at a maximum mechanical loading rate of 23.1 t/h. Total efficiency computed for a full operational day while loading lorries in a large site was not less than 75%.

In the case of the railway wagons, large trans-loading stations are established with a sufficient number of wagons for a full day of operation of the loader (8 h/day or more). In most cases each wagon is assigned for a farmer. The wagons may be detached and separated little distance apart to allow more room for each farmer to unload his cane opposite to the wagon. The loader operator loads several wagons simultaneously while farmers continue to transport cane from fields. To maintain continuous operation of the loader, each farmer determines the quantity of cane that could be transported within loading duration and transports the rest of the load the previous day. Loading duration for each wagon is considered equal to the loader operational hours of the full working day. A maximum operational efficiency of 81% was achieved for loading railway wagons due to the maximum use of time because of simultaneous loading. Average loading rate was 21.9 t/h.

Mechanical loading in several stores

If the cane is transported from inside the field to load single vehicles waiting at the road, then the loader operator has to move along the road to load vehicles one by one. Decauvelle wagons are distributed on the rail slide opposite to the fields before sunrise and pulled back to the mill (loaded) afternoon. The wagons considered for mechanical loading during the operational day ranked and the full load of each wagon should be ready on time. Vehicles may be combined to more than one vehicle in the same site to save the loader time losses due to travel among small sites. When decauvelle wagons are combined in a store, the loader operator may load all vehicles in the same site simultaneously. Similarly, trucks may be waiting on the road opposite to fields. They may also be single or combined according to the possibility of having more than one vehicle together.

Lorries are loaded individually because they perform repeated transport trips during the operational day.

The larger the number of vehicles combined in the same store, the longer the average field to store distance and the lower the infield transport rate as shown in Figure 1.

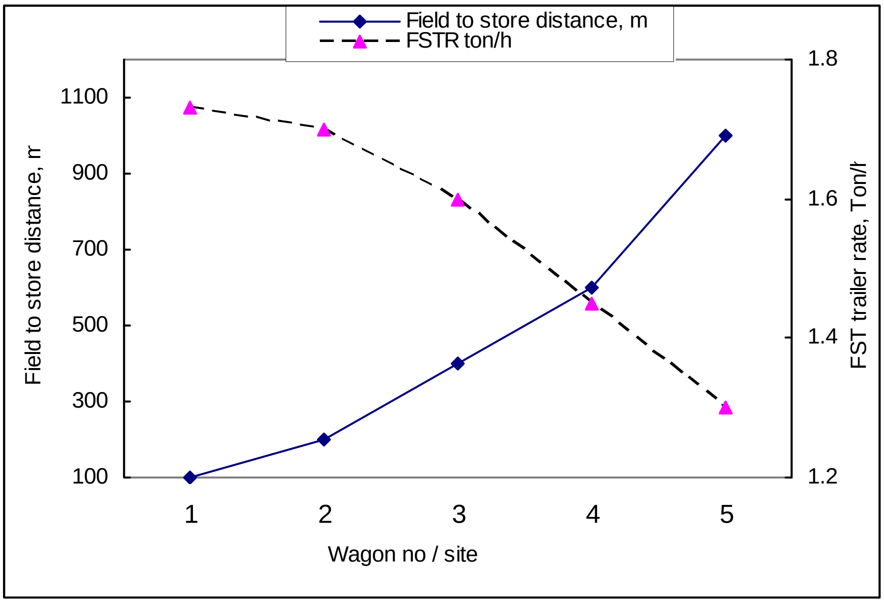

Fig. 1—Effect of combining vehicles in one site as a procedure for improved loader efficiency.

Therefore, farmers within a certain area who wish to use mechanical loading may plan to establish a common trans-loading site. It has been observed that under such conditions the maximum number of vehicles that could be combined in a common store was five while combining three vehicles may be more practical. Loader efficiency improves from 60% to 74% when loading several vehicles in one store as indicated in Figure 2.

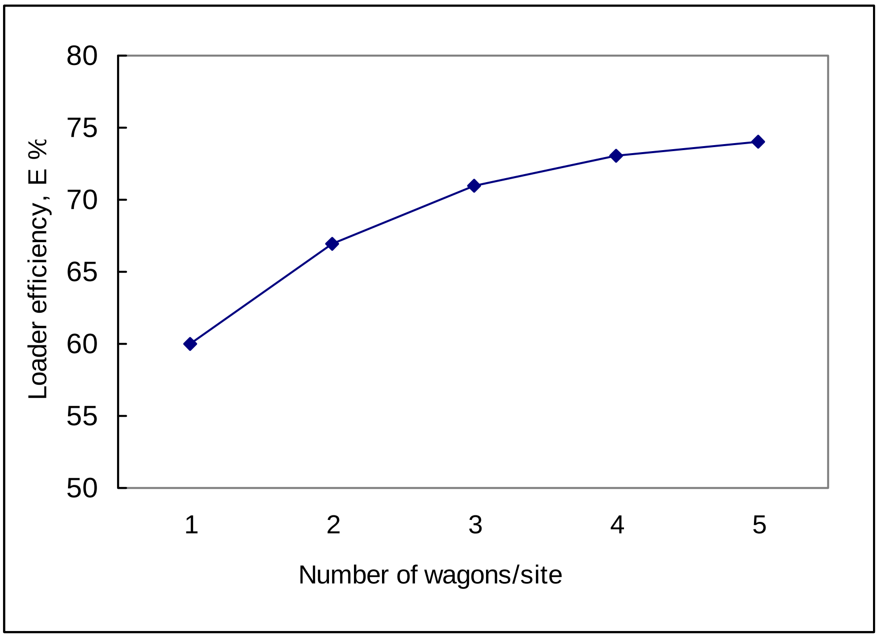

Fig. 2—Loader efficiency as related to combining several vehicles in one site.

The loader operator prepares a schedule for the loader work along the operational day that ranks sites in which vehicles are waiting for mechanical loading. The farmer determines the quantity of cane to be transported in the same day of loading and transport the rest of the vehicles load from the previous day. Therefore a percent of the vehicle load may be delayed more than 24 h as shown in Figure 3.

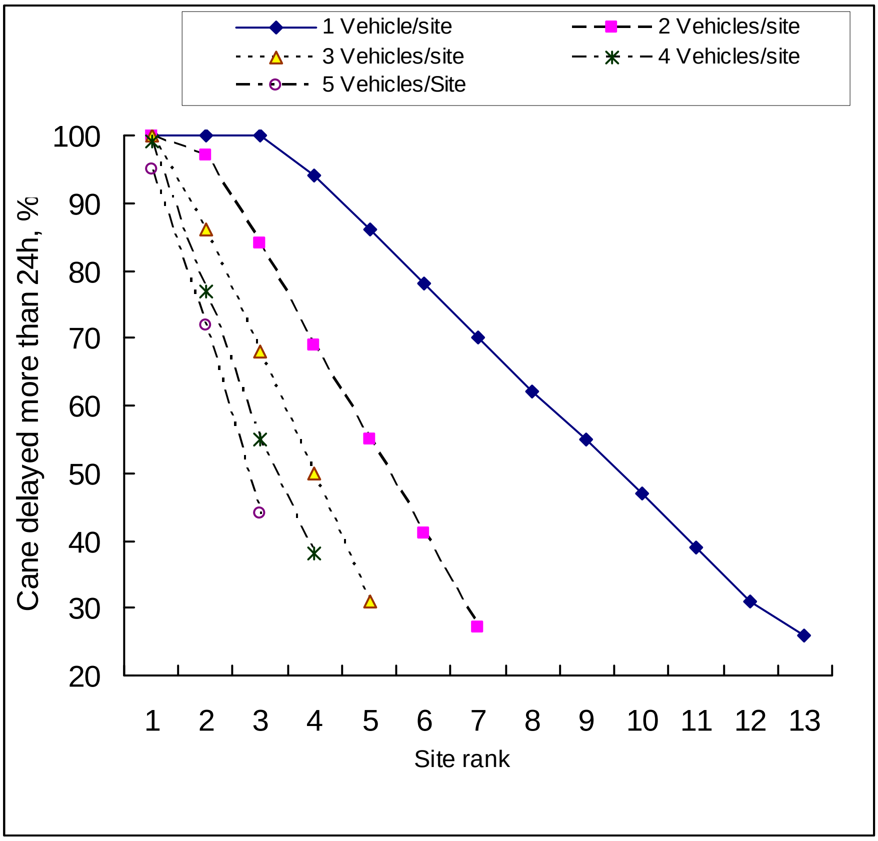

Fig. 3—Percent of vehicle loads delayed more than 24 h to maintain continuous loader operation.

Mechanical loading inside fields

Several attempts to operate loaders for loading decauville wagons on a portable slide line have been tried in the experimental farm of the sugar company. Other trials to load tractor-trailers inside the field were also evaluated. The results show that mechanical loading of cane inside the field is completed at low rate and poor efficiency. This is due to the loader having to move around the stationary vehicle to collect cane piles and travel back to discharge the grab load inside the vehicle. The poor performance of the loader is mainly because of moving across furrows and irrigation channels. The irregular form and size of cane piles due to manual harvesting contributed the poor performance of mechanical loading inside the field. In these conditions, the loader rate was limited to 13 t/h. Efficiency of mechanically loading a stationary vehicle inside the field was up to 54%.

Comparison loader efficiency

Loader rate, loader efficiency and cane collection efficiency are the main criteria to compare the performance of the loader in certain conditions.

Figure 4 shows the loader rate in the four scenarios under which the loader was assessed. Loading lorries resulted in the maximum rate of 23.1 t/h due to the manoeuvres made by the lorry driver to facilitate accomplishing the loading cycle in shorter time. Simultaneous loading of railway wagons resulted in a loading rate of about 22 t/h due to the continuous loader operation. The rate of loading an individual decauvelle wagon was much higher than the continuous rate computed for the operational day . The loader loses a lot of time, change arrangement, location and people that largely reduced loading rate to be 17.1 t/h.

The loading rate for decauvelle wagons on portable slide or tractor-trailers in the field was as low as 13 t/h.

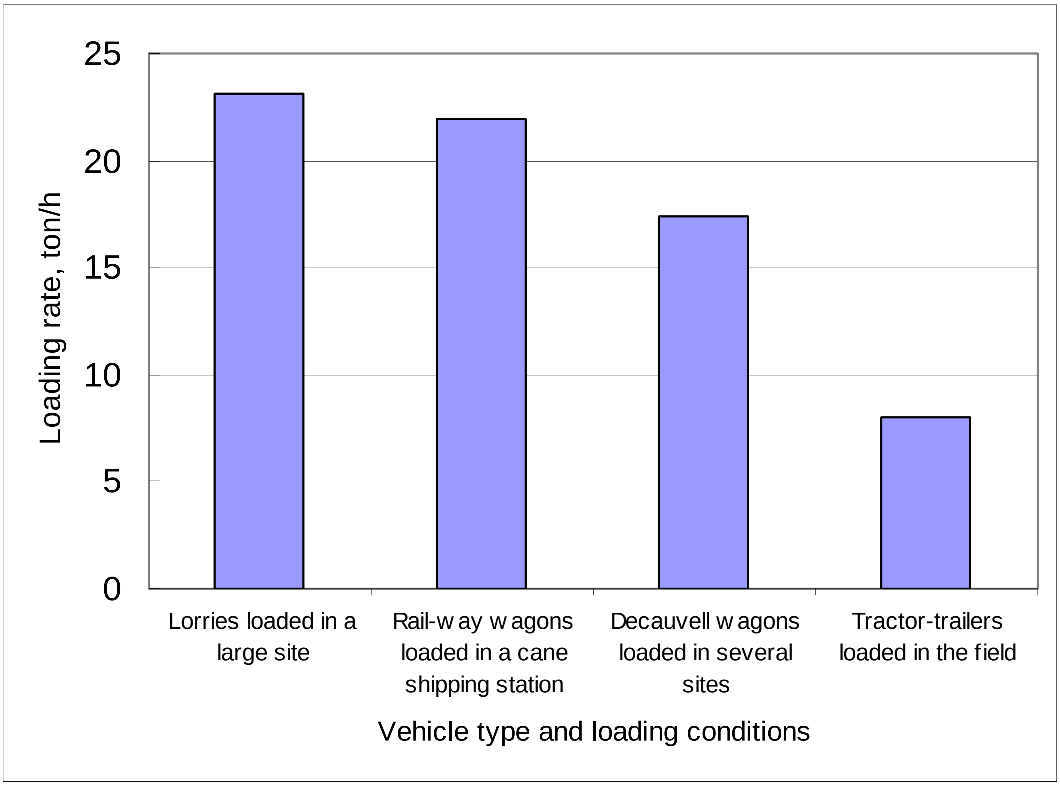

Fig. 4—Comparison loader rate.

Figure 5 shows loader efficiency for the four scenarios under which the loader was assessed. The large store is a yard at which the farmers bring their cane to be loaded on the main transport vehicle.

When the loader has finished loading a lorry, the loaded vehicle needs to turn around and leave.

Shifting from one lorry to another represents an inefficiency in the process. Efficiency of loading lorries in a large store was found to be about 75%.

Loading railway wagons simultaneously may represent the most suitable conditions for maximising loader efficiency.

The trial included 12 railway wagons in one station. Each farmer is assigned a wagon and he piles his cane in a windrow opposite to his wagon. Twelve tractor trailers each belong to a farmer supply cane from fields.

The loaders start loading a wagon and, when the cane for a wagon is loaded, the operator shifts to another wagon. Efficiency of loading railway wagons was as high as 81%.

Due to the time taken in travelling from one store to another, the loader efficiency of loading vehicles in several stores was limited to about 61%.

Due to difficult field conditions, the loader efficiency of infield loading was the lowest of all operations (54%).

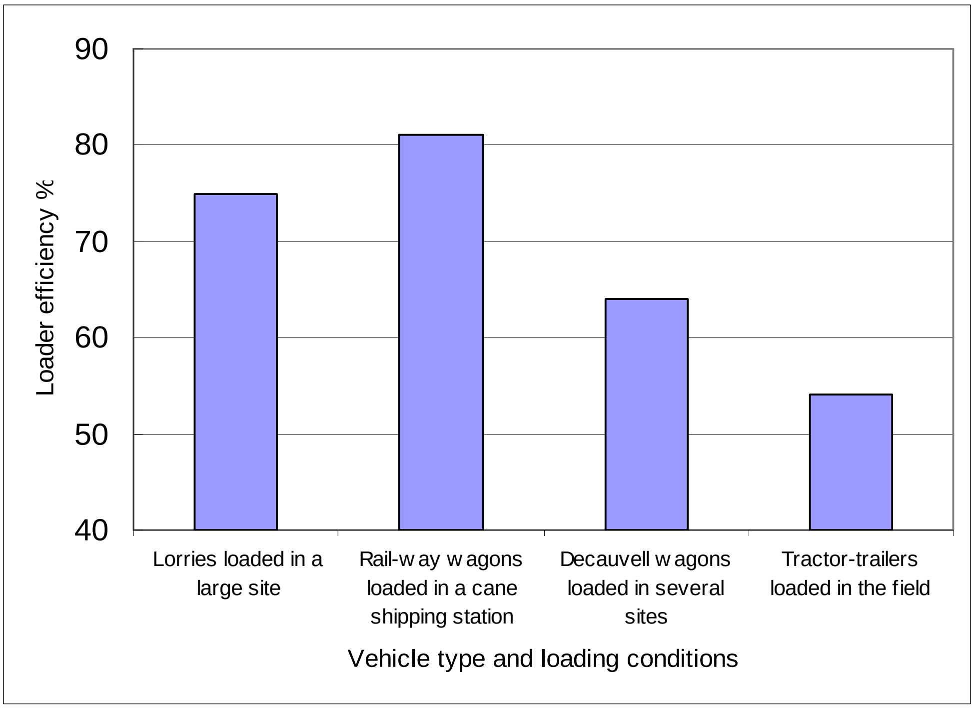

Fig. 5—Comparison loader efficiency.

Figure 6 shows cane collection efficiency in the four scenarios. The efficiency determined represents the cane damaged with the loader wheel in the store yard or that lost in the field. Cane losses recorded were 0.8%, 0.7%, 0.6% and 1.1% for loading lorries, railway wagons, decauvelle and infield loading respectively. Corresponding collection efficiencies were 99.2%, 99.3%, 99.4% and 98.9%. It seems that the rough surface of the field contributed more scattered cane and less collection by the labour.

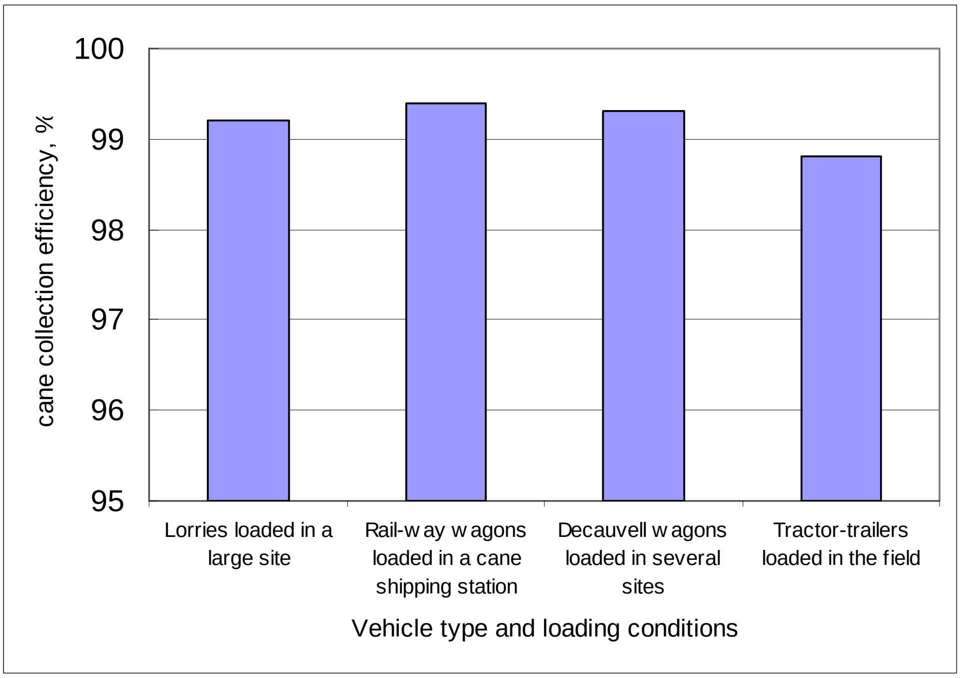

Fig. 6—Comparison cane collection efficiency.

Conclusion

Mechanical loading of sugarcane in the Nile Valley in Upper Egypt is required to substitute for the decreasing availability of labourers for manual loading. Farmers have been striving to increase the number of loaders available. Practical procedures can be developed which facilitate the operation of cane loaders at increased efficiency and productivity. Operational strategies which facilitate profitable operation of cane loaders will lead to a significant increase in the proportion of the crop which is mechanically loaded. The following items may represent some of the possible procedures to secure applicable efficiency of loader operation:

1. Loaders should be operated in conditions that facilitate reasonable efficiency, such as:
    a) At railway cane trans-loading sites. Operating loaders in such sites should attract more farmers to request cane transportation by railway. Consequently, more wagons would be loaded at each trans-loading site, increasing loader operation hours per day. Efficiency would be improved and cane delivery delay reduced.
    b) At large trans-loading sites (cane loading stations) such as at government farms, sugar company farms and private large farms.
    c) At farms belonging to strong cooperatives that may force their members to act as one large farm to facilitate mechanisation of such operations.
2. Efforts should be exerted to gradually adjust scheduled date of harvesting as well as the determined harvest allocation for each cane plot area. In this case, each cane growing plot will represent a large farm where a large temporary trans-loading site could be established with no reduction of infield transport rate. Early success of such a strategy is expected, since farmers have been striving for mechanical loading. Management of cooperatives and mill administration can also use their influence to convince farmers to change and optimise allocation of harvesting units to fields and harvesting dates.
3. Gradual adjustments to a common date of harvesting for neighbouring fields could be applied through the cane delivery schedules prepared annually by the mill administration.
4. Avoiding operating a loader for loading single vehicles, or at small trans-loading sites which are distributed far from each other.
5. Avoid infield mechanical loading unless the irrigation system has been developed to reduce intensive furrows, channels and transverse ridges. A system of harvesting that results in uniform windrowing or piling of cane after harvesting may help to improving infield loader efficiency.

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L'EFFICIENCE DU CHARGEMENT MECANIQUE DE LA CANNE EN EGYPTE

Par

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LA ZONE de culture de la canne le long de la vallée du Nil dans la Haute Egypte s'est étendue. Les parcelles des agriculteurs sont restreintes, typiquement dans une gamme de 0.5 à 1 hectare. Le planning de livraison de la canne et donc la date de récolte pour chaque champ dépend principalement du quota de livraison et de la date de la récolte précédente. La direction de l'usine attribue une unité de transport (cellule motrice principale) à chaque agriculteur en se basant sur le planning Les agriculteurs récoltent et transportent la canne de l'intérieur des champs (avec une remorque attelée à un tracteur) vers des zones de transfert où les cellules motrices principales sont chargées. L'efficience du chargement peut être faible suite au temps perdu pendant le transport entre zones de transfert. Afin d'obtenir une efficience raisonnable du chargeur, les zones de transfert peuvent être fusionnées permettant ainsi une meilleure utilisation des chargeurs. Cette procédure peut augmenter la distance de transport à l'intérieur des champs, ce qui pourrait réduire la fréquence de livraison, contribuant ainsi à des délais de livraison accrus. Les agriculteurs pourraient avoir à transporter le jour précédent, une partie du chargement de la cellule motrice principale vers la zone de transfert afin d'assurer l'opération continue du chargeur. Dans cette étude, l'efficience du chargeur, la fréquence de chargement, le pourcentage des voyages des cellules motrices principales retardés plus de 24 heures ainsi que l'efficience du ramassage de canne ont été déterminés. Dans la plupart des cas, une cellule motrice principale est attribuée à chaque agriculteur et une remorque attelée à un tracteur est utilisée pour transférer la canne de l'intérieur du champ vers la zone de transfert. Les résultats montrent que l'efficience totale du chargeur était de 75% pour le chargement de camions dans une grande zone de transfert et de 81% dans le cas de wagons de chemin de fer chargés à une station. L'efficience moyenne totale du chargeur était de 61% pour le chargement de wagons 'decauvelle' distribués dans plusieurs zones de transfert dans la même région de production. L'efficience du chargement au champ des remorques attelées au tracteur était de 54%. Une efficience maximale était obtenue si le chargeur travaille toute la journée dans une seule zone de transfert. L'efficience du ramassage de la canne était variable pour les différentes conditions d'opération. Le pourcentage de canne retardé plus de 24 h fut aussi estimé. De grandes zones de transfert où les camions sont chargés de canne et des stations de chargement pour les wagons de chemin de fer pourraient offrir des conditions plus optimales pour l'opération du chargeur. Ce papier discute de l'efficience de l'opération du chargeur sous une gamme de conditions variables et le retard à la livraison qui en découle. Les résultats soulignent le rôle de l'efficience de l'opération du chargeur comme facteur déterminant l'adoption du chargement mécanique de la canne à sucre. Des recommandations pour une opération adéquate du chargeur de canne sont suggérées.

EFICIENCIA DEL CARGUE MECÁNICO DE CAÑA EN EGIPTO

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PALABRAS CLAVE: Cargue de Caña Entera, Eficiencia del Cargador de Caña, Sistemas de Transporte De Caña de Azúcar, Programación de La Cosecha.

Resumen

EL ÁREA de cultivo de caña a lo largo del valle del Nilo en el Alto Egipto se ha ampliado. El área de las unidades de producción es pequeña, normalmente entre 0.5 a 1 hectárea. Los plazos de entrega de caña y, en consecuencia las fechas de recolección para cada campo dependen principalmente de la asignación de entrega y la fecha de cosecha de la temporada pasada. La administración del ingenio asigna un vehículo de transporte (vehículo principal) para cada agricultor en función de la programación. El agricultor/es cosechan y transportan la caña desde los campos interno/s (usando remolques tirados por tractor) a los sitios de almacenamiento temporal en los que el vehículo principal/es es cargado. La eficiencia del cargue puede ser baja debido a pérdidas de tiempo asociadas con los viajes de un sitio de almacenamiento a otro. Para alcanzar una eficiencia razonable del cargador, los sitios de almacenamiento deberían estar centralizados de manera que permitan una mayor utilización de los cargadores. Este procedimiento puede aumentar la distancia de transporte interno, lo que puede reducir la tasa de abastecimiento de caña desde los campos, lo que a su vez contribuiría a incrementos en la demora en la entrega de caña. Para garantizar la operación continua del cargador, los agricultores pueden tener que transportar una parte de la carga del vehículo principal al sitio de almacenamiento desde el día anterior para garantizar la operación continua del cargador. En este estudio la eficiencia del cargador, la tasa de carga, el porcentaje de vehículo/s principales o carga/s retrasados más de 24 horas y la eficiencia de recolección de caña fueron estudiados. En la mayoría de los casos, un vehículo principal se asigna a cada agricultor, donde un remolque tirado por tractor, se utiliza para transferir la caña desde el interior del campo hasta la zona de almacenamiento. Los resultados muestran que la eficiencia total del cargador fue del 75% en el caso de camiones de carga en una gran zona de almacenamiento y 81% en el caso de vagones de ferrocarril cargados en una estación. El promedio de la eficiencia total de la cargadora fue de 61% cuando cargó vagones de carga decauvelle distribuidos en varias zonas de almacenamiento dentro de la misma región de producción. La eficiencia de carga de remolques de tractor en el campo fue del 54%. Se observó que se alcanzará la máxima eficiencia si el cargador trabaja el día operativo completo en un área de almacenamiento. La eficiencia de recolección de caña fue variable en condiciones de funcionamiento variables. El porcentaje de la caña con retrasos superiores a 24 horas también fue estimado. Grandes zonas de almacenamiento temporal en las que los camiones son cargados con caña, y estaciones de carga de caña en vagones de ferrocarril pueden representar las condiciones óptimas para el funcionamiento del cargador. El documento analiza la eficacia de la operación del cargador en virtud de una serie de condiciones variables, y en relación con la demora en la entrega de caña. Los resultados destacan el papel de la eficiencia de operación del cargador como un factor determinante de la adopción de cargue mecánico de la caña de azúcar. Se hacen recomendaciones para el buen funcionamiento del cargador de caña.