



Present Status of Herbicide and Inorganic Fertilizer use for Sugarcane Farming in Fiji Islands

D.M.C. Champathi Gunathilake, A. Prasad, I.R. Singh

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ABSTRACT

Sugar industry is important to Fiji's economy as it contributes 1.1% of GDP. Sugarcane is cultivated as an intensive mono-cropping in Fiji, inorganic fertilizer and herbicides were commonly used. This survey was conducted to evaluate the present status of herbicide and inorganic fertilizer application to sugarcane and assessed the farmer's knowledge and perceptions. As well, this survey evaluated present socioeconomic status of sugarcane farmers. Results revealed that average Fiji sugarcane farm land size was 11.5 acres (4.6 hectares). Diuron (800-900g/kg Diuron), Amine (720g/L 2,4-D Dimethyl Amine Salt) and Glyphosate (Glyphosate isopropyl amine salts) were the most popular herbicide. The 30% of farmers used Glyphosate together with Amine and Diuron. Most farmer (>80%) were aware about correct application dosage and 81% of farmers use protective equipment during application. Labasa sugarcane farmers used more herbicide and chemical fertilizer than other areas. Most sugarcane farmlands become infertile due long-term use for intensive mono-cropping. At present most farmers heavily depend on inorganic fertilizer. Almost all farmers who participated to this survey aware of environment and health effect of herbicide and chemical fertilizer. The 78% farmers pass 40 years' age and most of them were not happy about sugarcane farming due its less profit in comparison to past. Therefore, currently, very few selected farmers are farming sugarcane as their livelihood profession.

Key words: Herbicide, Inorganic fertilizer, Sugarcane farmers, Survey.

INTRODUCTION

Fiji is a country consisting of a group of 330 islands in the South Pacific. Sugarcane is the major commercial crop in Fiji Islands, it contributes 1.1% of GDP and at present, close to 48,000 people are directly/indirectly dependent on it as the country's largest enterprise (Sugar Research Institute Fiji (SRIF) - Annual report 2015). Sugarcane was started by early British settlers in Fiji and they brought indentured laborers from India to work on the sugar cane plantation in 1879. The Indian workers were given 4.5 hectares of land to start their own farming. Sugarcane is mainly grown in Western and Northern areas of the Fiji where generally less rainfall is received. In 2015 the total sugarcane cultivated areas of Fiji was 39,291 hectares and around 14000 farmers actively involved for sugarcane cultivation. (SRIF- Annual report 2015).

Fiji is facing problems of fertile land degradation due to application of high dose of agro-chemicals such as chemical fertilizer, pesticide, weedicide and biological invasions (UNEP, 2002). Sugarcane is cultivated as an intensive mono-cropping in Fiji for long time in same lands. Therefore, currently, inorganic fertilizer and herbicide/weedicides are highly used in sugarcane farming. Weed control of sugar cane farming is intensive operation during seedling stage and it required high number of labors (Asafu, 2008; Tyagi and Naidu, 2016). Traditionally, weeding was performed manually by farm laborers. However, at present the laborers are becoming scarce and costly due to transform of agricultural labors to other industries. Therefore, herbicide is used extensively to control weeds (Tyagi and Naidu, 2016). Many studies conducted around the globe

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has been identified that inorganic fertilizer and herbicide application caused huge environment and health problems (Yadav, *et al.*, 2016; Jayasumana *et al.*, 2014). Even though herbicide and inorganic fertilizer widely use in Fiji sugarcane farming, several of studies were conducted to investigate present status of inorganic fertilizer and herbicide application and current socioeconomic conditions of farmers. Therefore, this survey was conducted to evaluate and assess present status of sugarcane farming in Fiji.

MATERIALS AND METHODS

This survey was conducted in major sugarcane cultivation areas of two major islands i.e. Viti Levu and Vanua Levu of Fiji Islands situated between 16°20'–19°50' South latitude and 177°- 179' East longitude. Fig 1 shows the sugarcane cultivation areas and other land use of Fiji Islands. The major sugarcane growing areas located in the two main islands namely Labasa, Ba, Lautoka, Nadi and Tavua where the survey was conducted. These areas were called dry zone

of Fiji because these areas receive relatively low rainfall in comparison to other areas of Fiji. Generally, annual rainfall of these areas are around 1500mm to 2500mm.

Sampling procedure

The SRIF annual report in 2015 shows that total sugarcane growing area in Fiji was 39,291 hectares and 14,000 active sugarcane farmers around the Fiji. Accordingly, 5% out of total farmers’ population (696 farmers) were selected in all sugarcane growing areas by probability sampling techniques. Sugarcane farmers should be registered in each of area sugarcane mill. Accordingly, sugar mills were taken as clusters and farmers were selected by simple random sampling techniques in those clusters as shown in Table 1. The structured questionnaire was prepared. Questionnaire was design with most closed-ended questions and few open-ended question. Few open ended questions were designed to obtain information about farm size, highest cane price, other crops and family members who doing farming. Close ended questions were in a double-choice or multiple-choice format and some questions demanded multiple answers. Farmers were not informed in advance to avoid bias and modifications. Questions were structured to avoid leading farmers to “acceptable” answers. For example, reasons for mixing herbicide use were sought by asking ‘why do you like to use herbicide mixtures’. The questionnaire was designed in the English language. Questioners were distributed among selected farmers (Table 1) by the help of leaders of sugarcane growers. These leaders are called

“Sardars” locally. As well random field observation was performed in surveying areas in order to identify accuracy of survey questioner distribution. Qualitative and descriptive primary data was collected by the questioner.

Questionnaire was used to obtain information on: (1) respondent farmers’ farm conditions (i.e. total area of farm, area use for sugarcane cultivation, (2) herbicide use practices (i.e., types and sources of herbicide acquisition, spray equipment, time and frequency of herbicide application, herbicide spraying technique, protection measures taken during spraying, herbicide storage, etc.), (3) the perception of farmers about herbicide and inorganic fertilizer application [their attitudes regarding the health hazard and potential environmental contamination (i.e., decision to apply herbicide, herbicide mixtures, inorganic fertilizer etc.), (4) amount of inorganic fertilizer used and (5) the socioeconomic information of farmers (i.e. age, family member’s involvement of sugarcane farming, farmer’s idea about profitability of cane farming etc). Data were analysed by descriptive qualitative statistics (percentage, mean and standard deviation) using Microsoft EXCEL and Minitab Statistical software package.

RESULTS AND DISCUSSION

Farm area use for sugarcane cultivation

The average farm size was 17 acres (6.8 hectares) however, farmers do not fully utilize their farm lands for sugarcane cultivation. Average farm area used for sugarcane cultivation

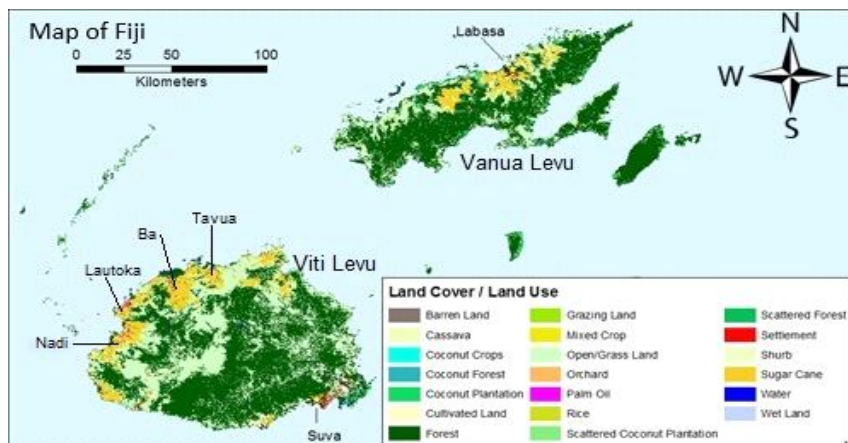


Fig 1: Fiji sugarcane cultivation areas and other land use.

Table 1: Number of farmers selected in different sugarcane cultivation areas of Fiji.

Sugarcane mill	Areas Covers	Total No. of registered farmers under the mill	No. of farmers selected for survey (probability sampling)
Labasa mill	Labasa District	3,452	175
	Seqaqa District	664	35
Lautoka mill	Lautoka District	2,113	106
	Nadi District	2,175	110
Rarawai mill	Rarawai District	3,695	185
	Tavua District	1,663	85
Total	13,762	696	

Source: Sugar Industry Tribunal, Lautoka, Fiji.

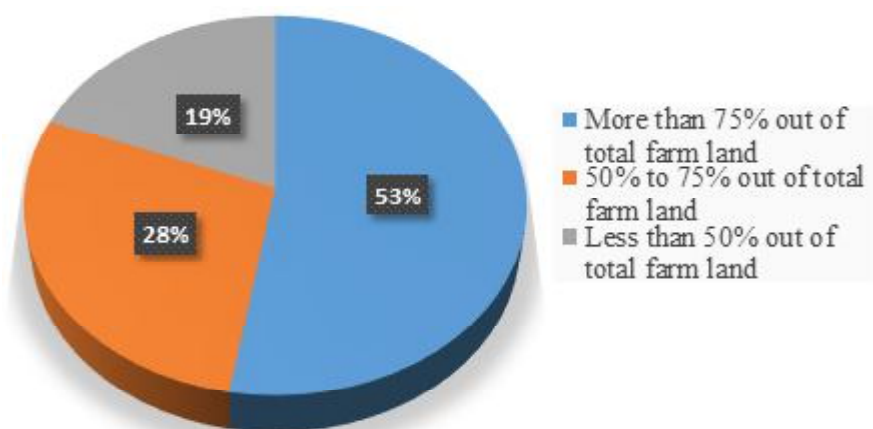


Fig 2: Use of farm land for sugarcane cultivation.

Table 2: List of SRIF recommended herbicides and target weed.

Trade Name	Active ingredient	Target weed
Atradex	900g/l Atrazine	Annual broad leaf weed and some grass
Nutrazine	500g/l Atrazine	
Cane Spray 333	75g/l of Dicamba, 300g/l 2,4-D	Broadleaf weeds
Diuron 80	800g/kg Diuron	Annual broad leaf weed and grass
Diuron 900DF	900g/kg Diuron	
Weed Master	360g/l Glyphosate isopropyl amine + mono ammonium salts	Non – selective
Sting	120g/l Glyphosate isopropyl amine salts	
Roundup	360g/l Glyphosate isopropyl amine salts	
Glyphosate CT	450g/l Glyphosate isopropyl amine salts	
Velpar K4	1:4 Hexazinone 123g/kg; 468g/kg Diuron	Grass and Broadleaf weeds
Weed-killer E40	40% 2,4-D ester	Growing broadleaf and vines
Weed-killer E80	80% 2,4-D ester	
Amine 720	720g/L 2,4-D Dimethyl Amine Salt	Broadleaf and convolvulus vines

Source: SRIF Herbicide guide 2009.

was 11.5 acres (4.6 hectares). Fig 2 shows the land utilization for sugarcane. The 53% farmers utilized more than 75% land area out of total land for sugarcane farming, 28% farmers used 50% to 75% land area out of total area and 19% of farmers used less than 50% land area out of total farm land. This 19% farmers have bigger farm land in comparison other 87% farmers. In this 19% farmers average farm size was 27.5 acres (11 hectares). These bigger farm land owners did not fully utilized their farm for sugarcane farming.

Type of herbicide and practices

Table 2 shows the SRIF recommended herbicide to control weeds in sugarcane farming in Fiji. Herbicide and chemical fertilizer were subsidized by the Fiji government.

Fig 3 shows the frequently use herbicide in Fiji according to the survey findings. Diuron was the most used/popular herbicide among sugarcane farmers. Around 46% farmers used this herbicide. Amine was the second most used herbicide and 8.86% farmers were used. Glyphosate was the 3rd most used herbicide. Previous studies also show that farmers mixing of herbicide for its instance action (killing weeds within short period) (Choudhary *et al.*, 2016; Bhimwal,

et al., 2018) hence, 30% of farmers used Glyphosate together with Amine and Diuron (Fig 3). Although Glyphosate was recommended only for controlling hardy weeds on the edges of sugarcane farms, it is used inside their farm lands too. Many studies revealed that heavy use of glyphosate can be harmful for environmental as well as human health (Jayasumana, *et al.*, 2014; Inna, *et al.*, 2010) Around 90% framers use knapsack sprayers to apply herbicide. As explain above, most Fiji sugarcane farm plots are smaller than 10 hectares therefore, knapsack sprayer was appropriate.

Table 3 shows the inorganic fertilizer mixtures apply to the sugarcane. Blend-A is mostly used during land preparation for re-planting new sugarcane. When plants are well established then used Blend-B and later Blend-C used as plant growth.

Farmers' knowledge of herbicide application

The SRIF recommendation was 20 litres (20,000 ml) capacity knapsack tank 250-300 ml of chemical and 6 knapsack tank for one acre. Most farmers were aware about correct application dosage, all most all farmers participated to this survey, apply correct herbicide dosage and amount. The

81% of farmers wear safety clothes and protective equipment however, 19% farmers didn't use any protective cloths or equipment during herbicide application. But almost all farmers sprayed herbicides with considering the wind direction to minimise inhaling herbicides and skin contact. Further, they read written information on herbicide packaging before use, including the directions on how to mix, apply, store and dispose of pesticides.

Herbicide and inorganic fertilizer application frequency

The Table 4 shows the herbicide application frequency per farmer, farmer's expenditure percentage for herbicide,

number of inorganic fertilizer bags (50kg bags) add for the season and distance (km) farmers have to travel to purchase herbicide and chemical fertilizer. Labasa sugarcane farmers apply herbicide more number of times than other areas i.e. one farmer apply average 2 to 3 times per season. As well Labasa farmers spend comparatively higher cost percentage for herbicide. Nadi sugarcane farmers were also spending comparatively higher cost percentage for herbicide. As well, Labasa and Tavua farmers apply higher amount of inorganic fertilizer whereas, Nadi and Ba farmers use comparatively low amount. Sugarcane farm-land become infertile due long term use for intensive mono-cropping. Therefore, farmers

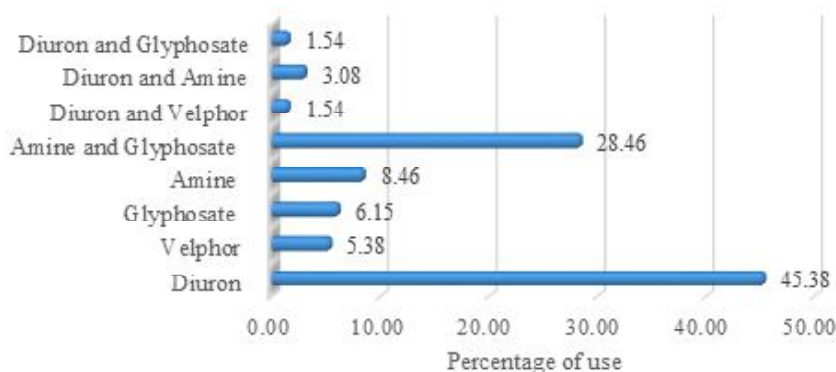


Fig 3: Type herbicide use of sugarcane farmers.

Table 3: Different inorganic fertilizer mixtures apply to the Fiji sugarcane.

Name of inorganic Fertilizer	Nitrogen (N) %	Phosphorus (P) %	Potassium (K) %
Blend-A	10%	46%	0%
Blend-B	16%	0%	15%
Blend-C	16%	6%	13%

Source Fiji Sugar Cooperation.

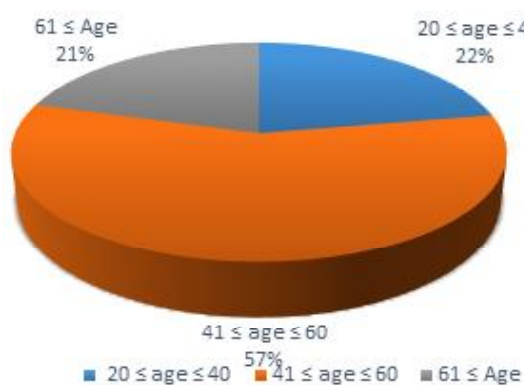


Fig 4: Fiji sugarcane farmer's age distribution.

Table 4: Herbicide application frequency, cost % use of inorganic fertilizer and distance to authorize dealer.

Sugarcane cultivation areas in Fiji	Herbicide application frequency/season	Cost for herbicide	Use of inorganic fertilizer 50kg bags (per season)	Distance to authorize dealer
Labasa	2 to 3 times	30%	40 to 65 bags	12.6km
Ba	2 times	15%	25 to 45 bags	6.4km
Lautoka	2 times	25%	30 to 50 bags	7.7km
Nadi	1 to 2 times	30%	25 to 45 bags	3.5km
Tavua	1 to 2 times	25%	40 to 60 bags	6.75km

depend on inorganic fertilizer during cultivation. Ba sugarcane farmers spend the lowest for herbicide application. Farmers purchased herbicides from authorised dealers. Authorize dealer was far away from Labasa sugarcane farmer's fields in comparison to other areas they have to travel average 12.6km distance. Whereas authorize dealers were very close to Nadi sugarcane farm lands, average distance was 3.5km (Table 4).

Attitudes concerning herbicide use and environmental damage

Almost all farmer's aware environment and health effect of herbicide. However, 95% of farmers were concerned about the impact of herbicide poisoning and protecting of environment. The 88% have got the knowledge about herbicide toxicity from herbicide labels and information sheet with pack and 12% get that information from dealers. 82% farmers stored leftover herbicide safe place until next season further after use, most empty herbicide packages were gathered and kept in safe places, however, 18% were dispose to the open environment without concerning environmental damage.

Current socioeconomic status of the Fiji sugarcane farmers

Fig 4 shows the average age of the Fiji sugarcane farmers. 78% farmers were above 40 years age and 22% farmers were between 20 to 40 years age. However, only 2% farmers were reported less than 30 years of age, it was indicated that young generation in Fiji did not select sugarcane farming as their livelihood profession. The highest price received for one metric ton of sugar cane for last 10 years was FJD \$ 88.40 (around USD \$ 44.20). Most farmers were not satisfied about the current price of sugarcane due to increase of cost of production of sugarcane and their living cost in comparison to past.

The 28% of farmers participate for this survey cultivate only sugarcane in their farms. The 33% farmers rearing animals such as sheep, cattle, goat, duck, chicken and fish with sugarcane farming and 19% farmers cultivate other crop such as vegetable, legume crop and pineapple with sugarcane whereas, 20% farmers were practicing animal and crop husbandry with sugarcane farming. As well, 27% farmers cultivate sugarcane without getting support from their family or labor however, 55% farmers cultivate sugarcane by the support of one or 2-3 family members such as wife, brother, son or daughter. 18% farmers hired the outside labors.

CONCLUSION

It can be concluded that average farm land size in Fiji sugarcane farming was 11.5 acres (4.6 hectares). Diuron was the most used herbicide in Fiji, (46% farmers used). Amine was the second most used/popular, 8.86% farmers

used. Glyphosate was the 3rd most popular herbicide however, 30% of farmers used Glyphosate with Amine or Diuron. Most farmer aware about correct application dosage and 81% of farmers wear some of safety clothes and protective equipment during application. Labasa sugarcane farmers apply more herbicide and chemical fertilizer than other areas of Fiji. Labasa farmers have to travel comparatively long distance for purchasing herbicide and fertilizer. Most sugarcane farmland became infertile due long-term use for intensive mono-cropping hence, inorganic fertilizer was commonly used. Almost all farmers who participate in this survey were aware of environment and health effect of herbicide. Fiji sugarcane farmers were aged as more 78% sugarcane farmers were more than 40 years' age. Accordingly; it can be concluded that currently among young generation, very few selected were talking up sugarcane farming as their livelihood profession.

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