Report of the
Committee on Public Finance

On

Use of Glyphosate on Plantation Crops in Sri Lanka

COMMITTEE ON PUBLIC FINANCE

Hon. Anura Priyadharshana Yapa (Chair)

Hon. (Dr.) Bandula Gunawardana

Hon. Vidura Wickramanayaka

Hon. Kanchana Wijesekera

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Hon. (Dr.) Sarath Weerasekera

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Hon. (Dr.) Kavinda Heshan Jayawardhana

Hon. Mujibur Rahuman

Hon. Isuru Dodangoda

Hon. Anupa Pasqual

Hon. (Prof.) Ranjith Bandara

Report of the Committee on Public Finance

Background

The Committee on Public Finance considered the Regulations under the Imports and Exports (Control) Act, No.1 of 1969, published in the Gazette Extraordinary No.2256/23 dated 30.11.2021, banning the importation of certain chemical fertilizers including glyphosate, at its meeting held on 08.02.2022. The Gazette had been presented to Parliament on 20.01.2022 and referred to the Committee.

The Regulations were considered with the participation of the officials from the Ministry of Finance, Department of Imports and Exports Control, State Ministry of Agriculture and Ministry of Environment. The Committee, in unison, decided to discuss the matter further with all stakeholders before approval is given to the subjected gazette, since it was reported that there would have been bad repercussions in the agricultural sector due to the unavailability of glyphosate.

Accordingly, the Committee had discussions on 08.02.2022, 10.02.2022 and 11.02.2022 in Parliament with the participation of the officials from Ministry of Finance, Department of Imports and Exports Control, Ministry of Agriculture, State Ministry of Agriculture, Ministry of Environment, Ministry of Plantation and Ministry of Health.

The Committee was of the view that there should be a reasonable justification for giving approval for this gazette notification. Hence, the Hon. Anura Priyadharshana Yapa, the Chair of the Committee, directed that a meeting of officials from all related institutes be convened, chaired by the Secretary to the Ministry of Agriculture, and a comprehensive report be submitted, including how the glyphosate ban was initially imposed, reasons and scientific basis for the ban, a research based alternatives for glyphosate and their effects, to the Committee before 14.03.2022.

Thereafter, the Report prepared by the Pesticide Technical Advisory Committee on "Use of Glyphosate on Plantation Crops in Sri Lanka" (Annexure) as requested by the Committee, was considered by the Committee on 19.05.2022 and decided to present it to Parliament.

The following officials were participated for these discussions.

Mr. S.R. Attygalle, Secretary, Ministry of Finance
Ms. Damayanthi Karunarathna, Controller General, Department of Imports and Exports Control
Mr. A.H.L. De Zoysa, Controller, Department of Imports and Exports Control
Mr. M.K.U.S. Fernando, Deputy Controller, Department of Imports and Exports Control
Mr. J.R.C. Jayathilake, Additional Director General, Ministry of Finance
Mr. Rohan Jayathilaka, Additional Director, Department of Trade & Investment Policy
Dr. R.D.S. Jayathunga, Additional Secretary (Environment Development), Ministry of Environment
Mrs. N.D. Wickramarachchi, Director (Land Resources), Ministry of Environment
Mr. S.M. Werahera, Director (Pollution Control & Chemical Management), Ministry of Environment
Mr. I.S.H.J. Ilukpitiya, Additional Secretary, Ministry of Plantation
Dr. (Mrs.) E.R.S.P. Edirimanna, Director General, Ministry of Plantation
Ms. P. Malathy, Additional Secretary, State Ministry of Agriculture
Mr. A.B.M. Wijayathunga, Director (Technology), Ministry of Agriculture
Mr. S.N.L. Ratnaweera, Deputy Registrar of pesticides, Ministry of Agriculture
Dr. R. Jayawardena, Head of Poison Information Centre, National Hospital, Ministry of Health
Dr. V.T.S.K. Siriwardana, Deputy Director-General, Ministry of Health
Dr. (Mrs.) Inoka Suraweera, Consultant Community Physician, Ministry of Health

Appreciation

The Committee expresses its appreciation to all the Committee Members and Officials who assisted in completing this task.

Committee

Hon. Anura Priyadharshana Yapa (Chair)
Hon. (Dr.) Bandula Gunawardana
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Use of Glyphosate on plantation crops in Sri Lanka

Executive Summary

The Plantation sector occupies a significant position in Sri Lanka's economy contributing almost 17% of foreign exchange to the country. However, sustainability of plantation industry depends on the adoption of key Good Agricultural practices. Weed management is one of the most important field operations, next to supply of plant nutrients through fertilizer applications. It plays an important role in establishment, growth and productivity of plantation crops. Strategies for managing weeds at minimum cost are of paramount importance for the sustainability of plantation sector. Thus, Plantation Crop Research Institutes recommend Integrated Weed Management (IWM) strategies to control weeds in crop lands and chemical weeding as the one of the effective methods under IWM strategies.

Glyphosate is the most suitable and cost-effective weedicide in controlling numerous broadleaf weeds, sedges, and grasses. Moreover, it is used for controlling diseases in rubber, coconut and sugarcane plantations. Annual Glyphosate requirement for tea, rubber, coconut and sugarcane sector is estimated to be around 759, 932 liters, 155,000 liters, 300,250 liters and 82,010liters, respectively.

There are several consequences on the unavailability of Glyphosate for plantation crops such as difficulties in controlling problem weeds, negative effect on growth of young plants, interference with routine agricultural practices, increase cost of production, neglecting weeding, difficulties in controlling new leaf fall disease, Weligama Coconut Leaf Wilt Disease and White Leaf Disease.

Furthermore, banning Glyphosate usage on plantation crops in 2015 has affected the economy in numerous ways. The loss of tea production without weed control has been estimated as 32.2 million kg per year, causing an economic loss as reducing export earnings of Rs. 26.7 billion per year. Additional cost for manual weeding in tea compared with a combination of chemical and manual weeding has been calculated as Rs 2.70 - 19.01 of made tea. The benefit cost ratio and NPV are 1.68 and Rs.1,773,869/ha, respectively in the case of manual weeding in rubber plantations while they are 1.75 and Rs.1,879,877/ha in the case of chemical weeding using Glyphosate. In coconut cultivation, the highest return on investment (benefit: cost ratio of 7.51) was reported by the application of Glyphosate as a weed control tool compared with other mechanical and agronomic techniques. Weeds account for a 10%- 70% yield loss in sugarcane and manual weeding requires nearly 70 labour days for cropping season (cost of Rs.105,000/ha).However, increased use and excessive dosage have increased concerns as to its effects on human health and the environment.

In view of the above facts and figures, the Pesticide Technical Advisory Committee (PeTAC) recommends to extend the importation and restricted use of Glyphosate in limited volumes as per the stipulations via reputed registered companies to address concerns expressed by the stakeholders in plantation crops until such time low toxic and cost-effective alternative weedicides are available in the market and/or suitable alternative interventions are developed which would invariably bring about foreign exchange earnings to the country as well.

1. Plantation industry in Sri Lanka

Plantation industry remains a vital component of Sri Lanka's exports, generating approximately US$ 1674 million of income in 2020, surpassed only by garments, representing 3.15 of the Gross Domestic Product (GDP) and contributing 16.66 percent to country's export earnings (CBSL, 2020). In addition, the plantation sector significantly contributes to the socio-economic development of the country, generating about 2.5 million employment opportunities. Therefore, it is pivotally important to maintain plantation sector as a sustainable industry by adopting key Good Agricultural Practices (GAPs) recommended by the Plantation Crop Research Institutes (PCRIs).

2. Importance of weed management in plantation crops

Weeds have evolved to be the most troublesome biological constraints to crop production (De Silva *et al*. 2018; Marambe *et al*. 2015; Rao *et al*. 2017).It reduces volume of crop yields, quality of the crops produced, thereby reducing overall land productivity thus farmers' income. Weed management is one of the most important field operations next to supply of plant nutrients through fertilizer applications, which should be carried out on a regular basis for the sustainability of industry. It plays an important role in establishment, growth and productivity of plantation crops. The objective of adopting preventive measures is to minimize weed seed build-up in the soil which would in turn assist in lowering the cost of management of the present and futuristic weed population in agricultural fields.

The PCRIs recommend Integrated Weed Management (IWM) strategies to control weeds in crop lands. It includes manual, chemical, cultural, ecological and biological methods. Manual weeding is the removal of weeds by hand. Cost effectiveness of weed management is beneficial to ensure sustainability of the industry due to the commercial nature of plantation crops in Sri Lanka. The cost of manual weeding is significantly higher than the cost of the combination of chemical and manual weeding and IWM strategies. Furthermore, use of mechanical aids such as *sorandies* or *mammoties* for removal of weeds on sloppy lands cause severe soil erosion. In contrast, chemical weed control minimizes soil-erosion and reduces the loss of plant nutrients, which are removed in the form of weed biomass from the field. Moreover, low productivity, scarcity and high cost of labour have become the common limiting factors and challenging issues in plantation sector. Therefore, plantation sector is compelled to practice chemical weeding as the one of the effective methods under IWM strategies.

3. Usage of Glyphosate in plantation sector

- ***As a chemical method of control in IWM strategy***

The most popular broad-spectrum weedicide prior to 1990 in the plantation crop sector was Gramaxone (Paraquat). However, with the banning of Gramaxone in 1990 owing to social issues, herbicide use was shifted from a broad-spectrum weedicide to a systemic weedicide; viz. Glyphosate. It is a translocated, post emergent and a total weed killer which was used to kill all plant types including grasses, perennials, and woody herbs. In 1997, Glyphosate was introduced to Sri Lanka (Marambe and Herath, 2019) and is a relatively inexpensive herbicide for agricultural applications (MRD, 2012-2016) that provides control of numerous broadleaf weeds, sedges, and grasses. Glyphosate application effectively controls weeds that are difficult to control by other traditional methods. Due to the nature of weed incidences, unusual weather patterns and nature of

cultural operations in respective crop sectors, use of Glyphosate as a total weed killer has become quite popular among the growers in the plantation sector.

- ***To Control new leaf fall disease in rubber plantations***

The abandoned and neglected rubber cultivations have a significant impact on the spread of new leaf fall disease. Some of the plantations are not reachable for fungicide spraying as they have a dense cover growth. Application of a weedicide is imperative for the cover crop management in such situations. Moreover, this pathogen is capable of growing on the leaf debris and application of a weedicide and/or fungicide has destroyed the viability of the fungus, promoting the decaying of the leaf litter.

- ***To control the spread of Weligama Coconut Leaf Wilt Disease (WCLWD)***

Weligama Coconut Leaf Wilt Disease (WCLWD) is a phytoplasma-borne debilitating disease prevalent in the Southern province of Sri Lanka. It was identified in 2006 from the Weligama area in the Matara district and the disease is transmitted by insect vectors. The affected area is nearly 22,935 ha which is about 5 % compared to the total coconut land extent (443,000 ha). WCLWD has been declared a quarantine disease in coconut plantations by the special gazette notification bearing no. 1623/11 issued on 14 Oct 2009. Because of the incurable nature of the disease, a management decision has been taken to remove all the affected palms in endemic areas and maintain a disease-free boundary zone encompassing the endemic area under the provisions of Plant Protection Act, No.35 of 1999. The objective is to prevent spread of the disease within the endemic areas and to unaffected areas. By now, 335,000 WCLWD affected palms have already been removed from the area. Hence, it is necessary to control the disease in order to safeguard the crop. Therefore, un-removed WCLWD palms have to be killed by injecting a systemic weedicide. CRI has identified Glyphosate as the most suitable and effective weedicide for killing these coconut palms.

- ***To control White Leaf Disease (WLD) in Sugarcane***

It is the considered opinion that the above disease ought to be controlled given the operational circumstances in the sugarcane sector.

4. The events on the use of Glyphosate in Sri Lanka

Table 1 presents the events occurred in chronological order for reference purpose.

Table 1: Events on the use of Glyphosate in Sri Lanka

Year	Event
1977	Glyphosate imported on the recommendation of the Tea Research Institute of Sri Lanka (TRISL)
1978	TRISL recommends the use of Glyphosate on non -crop land
1983/84	Mahaweli Authority of Sri Lanka (MASL) carried out experiments on the use of Glyphosate for its use in zero-tillage systems (Experiments were abandoned)
1986	TRISL recommends Glyphosate for use in pruned and mature plucking tea fields for control of troublesome weeds
1994	TRISL recommends Glyphosate for general weed control in tea fields
1995	Tests of the bio-efficacy of Glyphosate on weed control in rice cultivation initiated by the Department of Agriculture (DOA)

1998	Tests of the bio-efficacy of Glyphosate on weed control in rice cultivation completed by the DOA after 04 cultivation seasons
1998	DOA recommends Glyphosate for pre-plant weed control in paddy cultivation
2010	Increase in importation and use of Glyphosate in paddy cultivation
2014	Regional restrictions for sale, offer for sale and use in selected districts
2015	Ban of importation
2018	Ban lifted for 36 months and only for the use of tea and rubber cultivations
2019	Restricted quantities of Glyphosate permitted to be imported for devitalization in the Floriculture industry and removal of diseased sugarcane plants (White Leaf Disease) and coconut palms (Weligama Coconut Leaf Wilt Disease)
2021	Banned N-(Phosphonomethyl) Glycine and its salts and derivatives (Glyphosate)

Source: Marambe and Herath, 2019

5. Gazette Notifications in relation to Glyphosate: Extraordinary

The Government of Sri Lanka (GOSL), via Gazette Extraordinary No. 1894/4 of December 22, 2014 restricted Glyphosate use in five main districts namely Anurhadapura, Polonnaruwa, Kurunegala, Moneragala, and within the Divisional Secretariat Divisions viz. Mahiyangana, Rideemaliyadda, Kandeketiya in the Badulla district where paddy is mainly cultivated.

The Glyphosate was banned from importation and use in 2015 by the Gazette Extraordinary No. 1813/14 of June 5, 2015, under the Imports and Exports (Control) Act No. 01 of 1969 as amended, and Gazette Extraordinary No. 1937/35 of October 23, 2015, under the control pesticides Act.

The GOSL lifted the ban on Glyphosate in 2018 through Gazette Extraordinary No. 2076/4 of June 18, 2018 under the Import and Export Control Act No. 1 of 1969 (as amended) and Gazette Extraordinary No. 2079/37 of July 11, 2018, under the control of Pesticides Act.

N-(Phosphonomethyl) Glycine and its salts and derivatives (Glyphosate) was banned by the Gazette Extraordinary No. 2256/23 of November 30, 2021, under special Import License Regulations, published in the Gazette Extraordinary No. 2044/40 dated 09 November 2017, as amended.

6. Glyphosate requirement for plantation crops

6.1 Tea plantations

Undertaking alternative rounds of manual and chemical weeding in tea lands is encouraged in order to minimize the cost of weeding as well as the use of weedicides. Number of chemical rounds to be applied per year is also restricted to 2 applications. The dosage recommended for general weeds in tea lands was 1.4 to 2.8 liters of Glyphosate/ha and rates as high as 11 liters was recommended for problem weeds such as *Panicum repens* (Couch) and *Imperata cylindrica*(Illuk). However, this rate could be reduced to 5.5 liters with the use of Kaolin. Around 95% of tea lands (except fully covered mature tea in bearing) use Glyphosate for weed control in their mature tea

fields. Since the total extent of mature tea lands in the estates under Regional Plantation Companies is about 72,878 ha (MPI, 2018), the extent treated with Glyphosate could be estimated as 69,234 ha. Considering the modest dosage of Glyphosate as 2 liter/ha and two rounds of chemical weeding, annual Glyphosate requirement for the corporate sector was 276,937 liters. When it comes to tea smallholding sector including medium scale proprietary stakeholders, mature tea extent is about 120,037 ha. The annual Glyphosate requirement is estimated as 456,140 liters. Total volume of Glyphosate required per annum for state owned estates (JEDB, SLSPC, Elkaduwa, TRI, RRI) is about 26,854 liters. Therefore, annual Glyphosate requirement for tea sector, rubber, coconut and sugarcane is estimated to be around 759, 932 liters (Table 2).

Table 2: Annual Glyphosate requirement for different sectors

Sector	Quantity required (Liter/annum)
Tea smallholdings	456,141
Regional Plantation Companies	276,937
Elkaduwa	4,583
JEDB	11,411
SLSPC	10,294
TRI, RRI	566
Total	***759,932***

6.2 Rubber Plantations

In rubber cultivation, Glyphosate is recommended to be applied for assuring weed free circle around plant base while maintaining proper cover crops in other spaces in the field. The total requirement of Glyphosate for the rubber industry in Sri Lanka is around 155,000 liters per year. However, only 50% - 60% of the above amount (around 75,000 liters) is recommended considering the potential use of alternative methods.

6.3 Coconut Plantations

In 2021, 200 liters of Glyphosate were imported with the approval of the cabinet and the special permission of the Registrar of Pesticides for injecting WCLWD affected palms and the injection program was recommenced. In 2022, a decision has been taken by the Ministry of Plantation to implement an extensive program to remove all the affected palms before end of this year and accordingly, nearly 12,000 palms will have to be injected in the coming months. Hence, another additional 250 liters of Glyphosate is necessary for this year. Also, in the future, around 200 liters of Glyphosate will be essentially required annually to continue the disease palm removal program in the Southern province.

In this process, trunk injection method is used for applying Glyphosate to the palms, therefore, there won't be any environmental hazards or impact on humans. Moreover, the Glyphosate used for this purpose is never released to the growers and trunk injections have been conducted under the close supervision of Coconut Research Institute or Coconut Cultivation Board officers. Given the above circumstances, 250 liters of Glyphosate in 2022 and 200 liters in successive years is necessary to continue the removal of WCLWD-affected palms. Glyphosate requirement for weed management in 3,800 ha of coconut plantations is 300,000 liters (8 liters per ha) per year.

6.4 Sugarcane plantations

Sugar plantations require Glyphosate for both weed control and management of WLD (Tables 3 & 4).

Table 3. Glyphosate requirement for weed control

Company	Requirement (Liter)
Lanka Sugar-Sevanagala	11,000
Lanka Sugar-Pelwatta	30,000
Gal-Oya Plantation-Hingurana	16,000
Ethimale Plantation	10,000
Total	***67,000***

Source: Based on personal communication with sugar industry officers

Table 4. Glyphosate requirement for WLD management

Institute	Requirement (Liter)
Sugarcane Research Institute	10
Lanka Sugar-Sevanagala	1,000
Lanka Sugar-Pelwatta	4,000
Gal-Oya Plantation-Hingurana	9,000
Ethimale Plantation	1,000
Total	***15,010***

7. Possible consequences of unavailability of Glyphosate for plantation crops

7.1 Tea Plantations

Growers faced many difficulties in weed management in tea lands owing to unavailability of herbicides having properties of translocated, post emergent and a total weed killing ability in the market place particularly in the absence of alternatives to Glyphosate.

- ***Difficulties in controlling problem weeds***

Couch grass (*Panicum repens*) is a problematic weed in tea plantations due to its underground rhizome. Manual removal of couch rhizome is a highly labour - intensive activity. Deep forking is required to remove couch rhizomes from the tea land and it consumes 3-4 times more labour than controlling of other weeds present in tea lands. Furthermore, labour shortage in tea plantations limits the manual removal of couch grass. Loosening of soil and scraping lead to erosion of top soil reducing the soil fertility and causing environmental issues. However, Glyphosate is water soluble and translocated weedicide and therefore it could kill underground parts of many perennial weeds when sprayed on the foliage without disturbing soil.

- ***Crop losses***

Among the critical factors limiting optimum productivity from tea plantations, weediness is considered to be one of the important factors. Uncontrolled weed growth causes loss of tea productivity levels due to severe competition for growth factors, restricted branching and frame development, harbouring of disease pathogens and pests as alternate hosts, less plucking efficiency, contamination of harvested shoots, and blocking the drainage outlets. The yield reduction in tea has been estimated as 5 -15%, when weeding was delayed by 4 - 6 months, respectively (Wettasinghe, 1971).

- ***Negative effect on growth of young tea***

Premathilake *et al* (1999) reported that the critical period of weed competition in young tea is 8-16 weeks after planting and weed infestation for more than 12 weeks adversely affect the growth of tea. As per the experience and field observation of the scientists, delay in bringing into bearing of young tea due to excessive weed growth could be about 4 months.

- ***Interference with routine agricultural practices***

A dense weed cover could also interfere with the adoption of routine field practices such as plucking, pruning and fertilizer application etc. resulting in a high cost of field operations and reducing quality of the product as well. Other social dilemma among the workers is that they are reluctant to work in tea fields with a dense weed cover. Therefore, the plantation management is facing problems when deploying workers to those tea fields.

- ***Higher cost for manual weeding***

The cost of weeding is in the range of 7-8% of the total cost of field practices and it is second only to the plucking and fertilizer application. Although the TRI recommends IWM strategies, the common method of weed control is the combination of chemical and manual weeding due to labour shortage prevalent in the tea sector and high cost of labour. On the other hand, cost of manual weeding alone is significantly higher than the cost of combination of chemical and manual weeding. The additional cost to be incurred for manual weeding throughout the year (when compared to combination of chemical and manual weeding) varied between Rs. 16, 000 – 105,000 (Rs. 13 – 87 per kg of made tea) for 100% bush cover and seedling fields. The average incremental cost due to manual weeding in tea field is Rs. 39.32 per kg of made tea. At the national level, Rs. 6,400 and Rs. 4,200 million of additional investments have to be incurred annually for manual weeding in the corporate sector and small holdings sector respectively.

- ***Neglecting manual weeding in tea lands due to labour scarcity***

About 70-150 percent labour is required additionally to practice manual weeding throughout the year. When the tea extent in the corporate sector is considered, additional 5,771,686 worker days (19,239 workers) are required annually to undertake manual weeding in the corporate sector. In the small holding sector, it would be around 3,849,414 days (12,831 workers). Hence; about 32,070 additional workers are required at the national level to practice manual weeding throughout the year in the absence of herbicides. Therefore, finding additional workers for weeding is a serious challenge in the tea industry.

7.2 Rubber plantations

- ***Negative effect on growth and yield***

Noxious weed species are being grown during the immature period of rubber, competing with rubber plants for space, soil moisture, nutrients and light thus affecting the growth and yield of the plants.

- ***Hinder the routine estate practices such as tapping and fertilizing.***
- ***Allelopathic compounds inhibit the growth***

Some weeds exude allelopathic compounds, that inhibit growth of rubber plants and also acts as an alternative host for many pests and diseases.

- ***Difficulties in controlling new leaf fall disease prevailing in the country***

The abandoned and neglected rubber cultivations have a significant impact on the spread of new leaf fall disease. Some of the plantations are not reachable for fungicide spraying as they have a dense cover growth. Application of a weedicide is imperative for the cover crop management in such situations. Moreover, this pathogen is capable of growing on the leaf debris and application of a weedicide and/or fungicide has destroyed the viability of the fungus, promoting the decaying of the leaf litter.

7.3 Coconut Plantations

- Difficult in controlling weeds

Canopy structure of coconut palms requires wide spacing between palms which permits the penetration of abundant sunlight to the ground vegetation allowing wide range of perennial and annual weed species to invade the unutilized understory. These weeds compete with coconut for soil moisture and nutrients affecting the growth and yield and sometimes act as an alternative host pests and diseases while increasing the cost of production. Therefore, management of the understory weed growth is an essential step in maintaining the plantation and increasing the productivity. Chemical weeding with systematic herbicides is considered as one of the effective weed management strategies to control rhizomatous and perennial weeds in Coconut plantations. Glyphosate has been used for several decades as to manage most of the problematic weeds effectively by the Coconut growers.

- ***Difficulties in controlling spreading WCLWD***

There is no promising systemic weedicide available in the local market for this purpose other than Glyphosate and also, there is no other practically feasible and cost-effective method for this purpose. Thirty milliliters (30 ml) of Glyphosate, is injected into the palm using the trunk injection method to kill un-removed diseased palms. This treatment is cost-effective and practically feasible compared to cutting those palms. Also, it is effective and a coconut palm will gradually die within 02 weeks after the administration of injection.

7.4 Sugarcane plantations

- ***Difficulties in weed control***

Application of Glyphosate 360 g/L SL at the rate of 4-5 L/ha at post emergent stage of weeds has been recommended by Sugarcane Research Institute (SRI) for controlling problematic weeds such as *Panicum repens* (Torpedo grass or *Etawara*), *Imperata cylindrical* (Cogan grass or *Illuk*) and *Cyperus rotundus* (Nut sedge or *Kalanduru*) in

fallow and non-cropped lands before sugarcane planting (SRI Information sheet, 2012/04). Because being rhizomatous perennial weeds, adequate control of these species is essential before planting. Application of Glyphosate 360 g/L SL is an efficient, effective and economical approach to control problematic weeds mentioned above in sugarcane cultivation since other weed management techniques such as manual or mechanical methods are not that much effective.

Also in a situation where when new sugarcane nurseries are established, the stubbles of previous sugarcane crop has to be removed to prevent mixing of varieties. For this, Glyphosate 360 g/L SL is applied to kill the stubbles of the previous sugarcane crop. Otherwise these stubbles have to be removed manfully and it is not a cost effective method.

- ***Difficulties in controlling White Leaf Disease (WLD)***

Sugarcane WLD is one of the major threats to the cane sugar industry in Sri Lanka and it causes low sugar yields due to severe reduction of cane yield, juice volume and pure obtainable cane sugar (POCS). Disease primarily transmitted by infected seed cane and secondarily by insect vector. Disease infected plants are augmenting its vector by attracting, enhancing survival and population build-up which promotes the transmission of WLD phytoplasma itself. Thereby regular inspection and rouging out of WLD infected clumps make a great impact on secondary transmission of WLD by vector. Under local conditions, roguing out of infected sugarcane plants from the field and replanting or fallowing the fields where infection level is more than 20 percent (SRI, 2015) have been recommended to manage WLD. Uprooting sugarcane plant after symptom appearance is a difficult task, and there is a possibility of remain underground parts of the disease clumps in the soil when uprooting them manually and it causes high labour consumption and cost. In here spot application of systemic weedicide is the best strategy to kill the infected sugarcane plant to avoid secondary transmission. Therefore, Glyphosate is necessary in managing secondary transmission of the disease in the industry.

8. Impact of Banning Glyphosate on the Economy

In 2014, regional restriction was imposed for sale, offer for sale, and use in selected districts. Then, ban was imposed on Glyphosate in June 2015 and the GOSL lifted the ban 2 years after its imposition for 36 months for tea and rubber plantations. However, banning Glyphosate usage on plantation crops has affected the economy in numerous ways and some of these are highlighted as append below.

8.1 Tea plantations

The loss of tea production without weed control has been estimated as 32.2 million kg per year, causing an economic loss as reducing export earnings of Rs. 26.7 billion per year (Shyamalie, 2016). According to data published by SLTB, tea production in Sri Lanka was severely affected in 2016 and 2017 as compared to 2015. One of the main reasons for production decline may be the unavailability of effective weedicides. Overall, tea production at 292million kg showing a decrease of 36.4 million kg compared with 328.2 million kg in the year 2015. In 2016, tea export totaled 288.7 million kgs compared with 306.9 million kgs in 2015 and export quantity decreased by 18.2 million kg. The Planters' Association of Sri Lanka estimated a loss of Rs 10-20 billion per year due to the ban of Glyphosate. This is mainly due to the increased cost of production with the use of labour intensive alternate weed control techniques or abandoning weed control in tea fields as a result of scarce and costly labour resources.

Additional cost for manual weeding in tea compared with a combination of chemical and manual weeding has been calculated as Rs 2.70 - 19.01 of made tea (Shyamalie, 2016). The labour cost of weed control in large plantations has increased over 3 folds at Telbedda estate in Badulla District; Rs. 2.97 million in 2016 to Rs9.88million in 2017. The increment is about Rs.5.50 per kilogram of green leaf (Abeywickrama *et al* 2017). After banning of Glyphosate, large tea plantations are facing a problem due to absence of adequate labour and the labour requirement increased by about 30% (Abeywickrama *et al* 2017). The ban has triggered the heavy use of more hazardous and non-recommended herbicides and has also promoted smuggled products in the country (Abeywickrama *et. al*, 2017).

De Silva *et al* (2018) reported that the ban on Glyphosate has compelled tea planters to use alternate chemicals such as Diuron and MCPA, leading to detection of residues from these herbicides in made tea exported from Sri Lanka, affecting the country's economy.

8.2 Rubber plantations

A financial analysis was performed per hectare basis considering the costs and benefits for 30-year lifespan of rubber under the conditions of manual Weeding and chemical weeding with Glyphosate. Benefit cost ratio, NPV (Net Present Value) and IRR (Internal Rate of Return) were the criteria used in this regard. The benefit cost ratio is 1.68 in the case of manual weeding while it is 1.75 in the case of chemical weeding using Glyphosate. Higher benefit cost ratio in chemical weeding with Glyphosate is mainly due to the less labor requirement in weeding. For 30-year lifespan of rubber, NPV is Rs.1,773,869 per hectare for manual weeding while it is Rs.1,879,877 in the case of chemical weeding with Glyphosate. Value of IRR for the manual weeding and chemical weeding with Glyphosate are 22% and 23% respectively. Hence, the practice of chemical weeding with Glyphosate is more profitable in rubber lands when compared to the manual weeding. To calculate above financial indicators, rubber price was considered as Rs. 500 per kg and discount factor was 8%. In rubber (*Hevea brasiliense*) cultivation in Sri Lanka, a cost - benefit comparison of weed control with Glyphosate against manual weeding has revealed ratios of 1.3 and 1.17 respectively (RRI, 2016).

Labour scarcity and high labour cost associated with manual weeding result in negligence in weed control in most rubber lands affecting other routine estate practices such as fertilizing and tapping. In particular, applying fertilizer without weed control reduces the plant response to fertilizer and lower fertilizer use efficiency. This will affect detrimentally the yield and income of those plantations ultimately, the profitability of the industry. Cost of the chemical will be also a matter of concern for the application of the chemical. Accordingly, the continuous availability of Glyphosate for an affordable price will positively affect on improvement of the economic productivity in rubber sector.

8.3 Coconut plantations

In coconut (*Cocos nucifera L.*) cultivation, the highest return on investment (benefit: cost ratio of 7.51) was reported by the application of Glyphosate as a weed control tool compared with other mechanical and agronomic techniques (Senarathne and Perera, 2011). Furthermore, it has been identified by the Coconut Research Institute that the use of Glyphosate as the most successful and cost - effective approach to destroy disease -

affected plants by injecting Glyphosate into trees to prevent spreading of WCLWD (Office of the Cabinet Ministers of Sri Lanka (OCM), 2019) ,

Since 2008 about 11,200 WCLWD palms have been injected and killed using Glyphosate. There was a declining trend of the disease incidence observed up to 2016 due to palm removals and continuous injections. But from 2017 onwards, again, disease incidence was almost doubled compared to that of previous year in the southern area due to the banning of Glyphosate. In 2021, 200 liters of Glyphosate were imported with the approval of the cabinet and the special permission of the Registrar of Pesticides for injecting WCLWD affected palms and the injection program was restarted.

Even though coconut is not a labour-intensive crop, it requires labour when managing coconut lands especially for weeding, fertilizer application, fencing etc. The labour costs contribute around 20 - 35% to the total cost depending on weed growth and it is difficult to find labour for these operations as most of the workforce has been migrated to other industries. Cost of production calculations show that when Glyphosate weeding is employed that will give the lowest cost of production while increasing coconut yield. The non-availability of Glyphosate for weed control has increased the cost of production in the plantations and decreased the productivity due to competition for water and nutrients with coconut. The ban has also triggered the heavy use of more hazardous and non-recommended herbicides and has also indirectly promoted smuggled products in the country.

8.4 Sugarcane plantations

Weeds account for a 10-70% yield loss in sugarcane, and in some instances, it may rise up to 100% and weed control accounts for 10-12% of the cost of sugarcane production (Witharama, 2001). Manual weeding in sugarcane requires nearly 70 labour days for cropping season and it costs Rs.105,000/ha. Up to hundred percent yield loss could occur due to unsuccessful management of WLD due to inability to roguing out the infected plant at the initial stage.

9. Detrimental effects of use of Glyphosate

Excessive and incorrect use of herbicides causes significant damages to crops and the environment and human health. Some people argue that there are detrimental effects of use of Glyphosate on crop cultivation. Over the years of extensive usage, many issues in relation to toxicity and carcinogenicity etc. may have resulted. However, increased use and excessive dosage have increased concerns as to its effects on human health and the environment.

9.1 Human health effects

FAO-WHO in 2017 reported that Glyphosate is unlikely to be genotoxic and unlikely to pose a carcinogenic risk to humans from exposure though the diet. In 2016, the Australian Pesticides and Veterinary Medicines Authority (APVMA) examined Glyphosate and found there were no grounds for its approved uses to be re-considered. Furthermore, it stated that Glyphosate does not pose a cancer risk to humans when used in accordance with label instructions (Crop Life Australia, 2016).b The International Agency for Research on Cancer categorizes Glyphosate as a probable carcinogen for humans. In 2020, the Environmental Protection Authority (EPA) released a statement

that Glyphosate does not pose a risk to humans as long as it is used according to directions. They also stated that it is unlikely to cause cancer in humans (Glyphosate Interim Registration Review Decision, 2020) De Roos *et al*., (2005) reported that Glyphosate was contemplated to be less toxic to humans, as there had been little evidence of carcinogenicity or Genotoxicity in mammals. Increased use and excessive dosage of Glyphosate have increased concerns as to its effects on human health and the environment. Increasingly, significant evidence shows that Glyphosate herbicides may indeed affect health, stimulating the need for more surveillance (Benachour and Seralini, 2009). The Joint Meeting on Pesticide Residues' (JMPR) scientific evaluation concluded that Glyphosate is unlikely to pose a carcinogenic risk to humans. Furthermore, the JMPR found that it was not necessary to establish an acute reference dose because of Glyphosate's low acute toxicity.

Every independent, science-based regulatory agency globally (including; Germany, New Zealand, Canada, the United States and the European Union) has comprehensively evaluated Glyphosate and found it safe to use in accordance with label directions (The EU Assessment Group on Glyphosate in 2021, The United States Environmental Protection Authority in 2020, The European Chemicals Agency in 2017, The New Zealand Environmental Protection Authority in 2016, The European Food Safety Authority in 2015, Health Canada's Pest Management Regulatory Agency in 2015). Health Canada (2019) stated that **"**No pesticide regulatory authority in the world currently considers Glyphosate to be a cancer risk to humans at the levels at which humans are currently exposed."

9.2 Ecosystem health effects

Compared with most other herbicides, Glyphosate has a half-life in soil and water that is relatively short (averaging about 30 d in temperate climates), mostly due to microbial degradation. Glyphosate has a lower environmental impact quotient than most synthetic herbicide alternatives (Stephen O. Duke, 2020). A frequently cited advantage of using herbicides such as Glyphosate in farming is that their use decreases soil tillage and, with less tillage, earthworm populations will increase. A review study reported by Broines and Schmidt (2017) analyzes data gathered over approximately 65 years to support this claim. However, a number of reports suggest that Glyphosate does affect earthworms. Findings include avoidance (Verrell and Van Buskirk 2004), bio-accumulation (Contardo-Jara *et al.* 2009), a decrease in interaction between an earthworm species and mycorrhizal fungi (both essential components of healthy soil; Zailer *et al*. 2014), With respect to avoidance, a more recent study did not detect avoidance behavior among earthworms exposed to recommended application doses of Glyphosate (Santos *et al*. 2012).

10. Alternative weed control methods against the Glyphosate

10.1 Tea plantations

As a pre-emergent herbicide, (i) Oxyfluorfen 48% SL (Goal 4F) at 700ml/ha; alternatives to Glyphosate, (ii) Glufosinate ammonium 28% (Lifeline) at 600-700 ml/ha and (iii) Diuron liquid at 1.5 l/ha in 500 l of water are effective while (iv) Triasulfuron 75 WG (Logran) at 60-70 g/ha in 500 l could replace MCPA as they also meet MRLs in the EU and Japan. Recommendation of Imazapic isopropylamine + Imazapyr isopropylamine

(Mayoral) at 0.75-1.0 l/ha is pending until an increased MRL is granted from EU and Japan after submission of duly perfected dossier.

Bio herbicides could be recommended to be incorporated in Integrated Weed Management program when necessary as per spot applications owing to higher volumes required and cost effectiveness.

10.2 Rubber plantations

Weed Management by cover crops in rubber plantations is effective in suppressing weed growth in young rubber clearings and essential for the preservation of soil fertility and soil conservation. However, it is recommended to keep a weed free circle around the plant base which could be achieved by proper and regular mulching practices. Mulching methods such as application of straw, power mat, polythene and shade net mulches, are laborious, costly need repeated applications. Manual weeding is also laborious, costly, time consuming and also breakdown the structure of top soil enhancing top soil erosion. As an alternative method, the potential of using machines such as grass cutters is low in most rubber fields due to steep lands and rockiness present in soil surface. Mostly, perennial weeds are unlikely to be efficiently controlled by other methods other than using chemicals. Furthermore, trials are continued at RRISL to recommend alternative chemicals.

10.3 Sugarcane plantations

Based on the available total killer weedicide at present, there are no any other herbicides are available to get the similar effect for the control of problematic weeds and stool eradication Glufosinate ammonium 150 g/L SL is a total killer contact weedicide and could be used as a pre-plant herbicide in sugarcane. However efficacy of controlling problematic weeds and stool eradication is low compared to Glyphosate 360 g/L SL since Glufosinate ammonium 150 g/L SL is a contact herbicide.

11. Recommendation

In view of foregoing, the Pesticide Technical Advisory Committee (PeTAC) recommends to extend the importation and restricted use of Glyphosate in limited volumes as stipulated in the report via reputed registered companies to address concerns expressed by the stakeholders in plantation crops until such time low toxic and cost-effective alternative weedicides are available in the market and/or suitable alternative interventions are developed which would invariably bring about foreign exchange earnings to the country as well.

Department of Agriculture has also identified the necessity of glyphosate on weed management in Maize, Chilli, Groundnut, Mung bean, Sesame, B-onion, Red onion, Potato, Rice (only for wet zone) due to difficulty & high cost of mechanical weed control and no alternatives for the pre-plant, post emergent total killer herbicides and thus extension division of DOA has suggested to expand the use of glyphosate for those crops.

References

Abeywickrama LM, Sandika AL, Sooriyaarachchi P, Vidanapathirana I (2017) Impacts of Banning Glyphosate on Agriculture Sector in Sri Lanka: A Field Evaluation. Mapalana, Kamburupitya, Sri Lanka: Faculty of Agriculture, University of Ruhuna. https://www.croplifeasia.org/wp-content/uploads/ 2018/04/Impacts-of-Banning-Glyphosate-on-Agriculture-Sector-in-Sri-LankaA-Field-Evaluation.pdf. Accessed: March 4, 2022

A.J. De Roos, A. Blair, J.A. Rusiecki, J.A. Hoppin, M. Svec, M. Dosemeci, D.P. Sandler, M.C. Alavanja 2005 Cancer incidence among glyphosate-exposed pesticide applicators in the agricultural health study Environ. Health Persp., 113 (1) (2005), pp. 49-54, 10.1289/ehp.7340

Benachour, N., Séralini, G.E., 2009. Glyphosate formulations induce apoptosis and necrosis in human umbilical, embryonic, and placental cells. Chem. Res. Toxicol. 22 (1), 97–105. doi: 10.1021/tx800218n .

Broines MJI, Schmidt O (2017) Conventional tillage decreases the abundance and biomass of earthworms and alters their community structure in a global meta-analysis. Glob Chang Biol 23(10):4396–4419. https://doi.org/10.1111/gcb.13744

Central Bank of Sri Lanka, 2020, Annual Report, Central Bank of Sri Lanka, Colombo
Join FAO/WHO Meeting of Pesticide Residues, 2016 http:// www.who.int /foodsafety / jmprsummary 2016.pdf, http://www.fao.org/3/a-i5693e.pdf

Contardo-Jara V, KlingelmannE,Wiegand C (2009) Bioaccumulation of glyphosate and its formulation roundup ultra in Lumbriculusvariegatus and its effects on biotransformation and antioxidant enzymes. Environ Pollut 157(1):57–63. https://doi.org/10.1016/j. envpol.2008.07.027

De Roos AJ, Blair A, Rusiecki JA, Hoppin JA, Svec M, Dosemeci M, Sandler DP, Alavanja MC (2005) Cancer incidence among glyphosate-exposed pesticide applicators in the agricultural health study. Environ Health Perspect 113:49–54. https://doi.org/10.1289/ehp.7340

De Silva MSDL, Liyanage MGS, Wijesekera SN, Prematunga EWTP, Pushpakumari WHDU (2018) An update on herbicide screening and potential alternatives. Paper presented at the 235th Experiments and Extension Forum for Corporate Sector “New Pesticides for Integrated Pest Management in Tea.” https://www.tri.lk/userfiles/file/235%20E&E%20Jan%202018/03_235_E&E_26Jan2018_Paper_II_Dr(Mrs)MSDLDeSilva.pdf.Accessed: April 5, 2022

[DoA] Department of Agriculture (2017) Unpublished data. Peradeniya, Sri Lanka: Economics and Statistics Division

Duke SO. 2014 Perspectives on transgenic, herbicide-resistant crops in the USA almost 20 years after introduction. *Pest Manag Sci.* 2014;71(5):652–657. doi: 10.1002/ps.3863.

FAO-World Food Program] Food and Agriculture Organization of the United Nations–World Food Program (2017) Special Report-Crop and Food Security Assessment Mission to Sri Lanka. Rome: Food and Agriculture Organization of the United Nations and World Food Program. 42 p

Glyphosate Interim Registration Review Decision Case Number 0178Docket Number EPA-HQ-OPP-2009-0361 www.regulations.gov. January 2020

Marambe B, Abeysekara ASK, Herath HMS (2015) Weeds and weed management in agricultural and natural ecosystems: an overview of the Sri Lankan context. Pages 213–240 in Rao VS, Yaduraju NT, Chandrasena NR, Hassan G, Sharma AR, eds. Weed Science in the Asian-Pacific Region. Hyderabad, India: Asian-Pacific Weed Science Society and Indian Society of Weed Science

Mitchem, W.E.2016. Weed management considerations for peach orchards. North Carolina StateUniversity.Available:https://peaches.ces.ncsu.edu/wpcontent/uploads/2017/02/weedmanagement.pdf?fwd=no

MRD. 2012-2016. Market research data collected and sold by a private market research firm. Data collected on pesticide use for about 60 crops by annual surveys of agricultural users in the continental United States. Survey methodology provides statistically valid results, typically at the state level.

[OCM] Office of the Cabinet of Ministers Sri Lanka (2019) Devitalization of the Propagatable Floriculture Items to Be Exported to Australia and the Use of Glyphosate for the Control of White Leaf Disease in the Sugarcane Cultivation and Weligama Coconut Leaf Wilt Disease. http://www.cabinetoffice.gov.lk/cab/index.php?option=com_content&view=article&id=16&Itemid=49&lang=en&dID=9989. Accessed: March 5, 2022

Premathilake, KG, Froud-Williams, RJ, Ekanayake, PB (1999) Investigation of periodthreshold and critical period of weed competition on young tea. Proceedings of the Brighton Conference on Weeds, held in Brighton, United Kingdom on 15th-18th, November 1999;p263-368

Prematillake KG (2013) Development of resistance in two weeds for glyphosate herbicide. Sri Lanka Plant ProtInd J 7:102–104

Rao AN, Wani SP, Ahmed S, Ali HH, Marambe B (2017) An overview of weeds and weed management in rice in South Asia. Pages 247–281 in Rao AN, Matsumoto H, eds. Weed Management in Rice in the Asian-Pacific Region. Hyderabad, India: Asian-Pacific Weed Science Society, Weed Science Society of Japan, and Indian Society of Weed Science

Santos MJG, Ferriera MFL, Cachada A, Duarte AC, Sousa JP (2012) Pesticide application to agricultural fields: effects on the reproduction and avoidance behavior of Folsomia candida and Eiseniaandrei. Ecotoxicology 21(8):2113–2122. https://doi.org/10.1007/s10646-012-0963-7

Senarathne SHS, Perera KCP (2011) Effect of several weed control methods in tropical coconut plantation on weed abundance, coconut yield and economical value. Int Res J Plant Sci 2:25–31

Shyamalie HW (2016) Cost analysis of weed management in tea lands. Paper presented at the 231st Experiments and Extension Forum for Corporate Sector on Year of Adoption 2015—Soil Conservation and Fertility Improvement. Tea Research Institute of Sri Lanka, Talawakele.
https://www.tri.lk/userfiles/file/231%20E&E/07_E&E_231_Paper_V_Shyamalie.pdf Accessed: March 4, 2022

Sri Lanka Tea Board, 2020 Statistical Bulletin Sri Lanka Tea Board, Colombo

Sri Lanka Tea Board, 2015 Statistical Bulletin Sri Lanka Tea Board, Colombo

Sri Lanka Tea Board, 2016 Statistical Bulletin Sri Lanka Tea Board, Colombo

Stephen O. Duke 2020 Glyphosate: environmental fate and impact Weed Science Volume 68Issue 3 May 2020 Published online by Cambridge University Press: 07 May 2020, pp. 201-207 Print publication: May 2020

Wettasinghe, DT (1971) Report of the Research Officer for the TRI Low country station and Kottawasub-station for 1969, Annual Report, Tea Research Institute, Ceylon; p145-167

Witharama, W.R.G. 2001. Studies on Crop Weed Competition in Sugarcane, Variety Co775. In: Sri Lanka Association for theAdvancement of Science (Ed). Proceedings of the 57th Annual Sessions, 26th November to 01st December, Part 01, Abstract, pp 33.

Verrell P, Van Buskirk E (2004) As the worm turns: Eiseniatetida avoids soil contaminated by a glyphosate-based herbicide. Bull Environ ContamToxicol 72:219–224

Zailer JG Heigl F Reuss L Grabmaier A (2014) Glyphosate herbicide affects belowground interactions between earthworms and symbiotic mycorrhiza. Sci Rep 4
https://archive.org/stream/pubmed-PMC4087917/PMC4087917-srep05634#page/n5/mode/2uphttps://doi.org/10.1038/srep05634