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An Economic Retrospective on the Policy Banning Glyphosate in Sri Lanka between 2015 and 2018: The Case of the Tea Industry

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ABSTRACT

There was a flawed policy banning Glyphosate in Sri Lanka in 2015 that was later withdrawn, but only after significant economic losses were experienced, especially in the tea industry. The focus of this study is to highlight the impact of the policy on the tea growing sector and determine the economic cost on the tea value chain. It is also aimed to remind policymakers that science and economics, theory and evidence, still matter in implementing public policies. The methods used in the study involved gross margin budget analysis of tea grower groups, thematic analysis of qualitative data collected through interviews and welfare analysis of the impacts of the ban on the industry using an Equilibrium Displacement Model. Direct impacts were experienced by the farm sector engaging in tea cultivation. An unintended consequence of this policy was rejection of tea exports from Sri Lanka to Japanese markets. The annual loss in the tea industry by banning Glyphosate was estimated to be LKR 20 billion (more than $US100 million), though the true cost likely was much more than this. Hence, policies introduced to minimize adverse impacts from market failures warrant full attention being given to the scientific, economic, social and political realities of the case at hand, and the likely consequences for the affected parties and their responses.

***Keywords**: Glyphosate; economic impact; tea industry; equilibrium displacement modelling, unintended consequences.*

1 Introduction

Decisions made by public policymakers can lead to the growth or decline of nations. Sound public policies based on well-established scientific and economic theory and empirical evidence, formed, developed, and administered through rigorous processes, are keys to increasing the wealth of nations and the welfare of their people, while helping to equip private and public sectors with knowledge of mechanisms to cope with cyclical economic instability and challenges. The modern-day rise of pseudo-science (Klinkner, 1994), accompanied by anti-science values and beliefs, hinders rather than helps policy goals of improving peoples' livelihoods and lives.

Recent public policies implemented in the agriculture sector in Sri Lanka that failed to achieve their primary goals reflect the inadequacies of information and processes of policymakers in devising strategic approaches using rigorous information from relevant disciplines of science, economics, and social sciences.

Agriculture plays a significant role in low to middle-income developing nations like Sri Lanka. Failed public policies can hinder the performance and sustainability of some important parts of the agricultural production and agribusiness sectors, and significantly affect the economy of the country.

Several public policies in Sri Lanka have gone awry recently including the decision 'to completely switch to organic farming' in 2021 (Beillard and Galappattige, 2021; Nordhaus and Shah, 2022) and to completely ban the use of Glyphosate between 2015 and 2018 (Department of Government Printing, 2015).

The organic agriculture policy had numerous consequences contributing to the recent economic problems experienced in Sri Lanka, all occurring amidst the serious COVID pandemic. Agricultural lands that had been productive lay idle across the country while agricultural production fell sharply and the reliance on imports rose with subsequent ripple effects through the economy (Jayasinghe, 2021). Although this policy was proved to be wrong-headed after a few cropping seasons when the adverse effects were experienced eventually, the decision to reverse the policy and lift the ban was taken only in the end of 2021 (Jayasinghe, 2021; Nordhaus and Shah, 2022).

Even before this policy, Sri Lanka experienced unfortunate occurrences on agriculture with the imposed island-wide ban on Glyphosate during the period from 2015 till 2018. The reason behind this public policy was the purported association of Glyphosate with the public health issue of chronic kidney disease of unknown etiology (CKDu) which prevailed in some parts of Sri Lanka (Jayasumana et al. (2014).

The Sri Lankan government decided that CKDu was a negative externality of using Glyphosate on agricultural production, and they intervened to address this market failure by enacting legislation – a command and control approach by completely banning its import, sale and use. The tea industry, as the largest user of Glyphosate, was the most affected by this policy and experienced substantial economic losses and much hardship, in the short and long term, as a result.

This policy could have served as an example of what not to do for policymakers in a subsequent time and a subsequent government. If lessons had been learned from the Glyphosate policy debacle, later economic losses and hardship could have been avoided. Given the nature of policies implemented on agriculture in Sri Lanka recently, it is important to emphasize the economic impacts that similar prior policies have had on important industries in Sri Lanka. Better informed policy decisions may help avoid the situation in agriculture in the country becoming worse.

The focus of this study is the government policy that banned Glyphosate island-wide during the period between mid-2015 and mid-2018 in Sri Lanka. While the policy led to serious economic losses across the agriculture sector, in this study it is aimed to answer the research problem 'What was the likely economic impact of the policy of banning Glyphosate on the tea industry in Sri Lanka?'.

The main objective of this research is to highlight the impact this government policy of banning Glyphosate on the tea grower sector in the industry and determine the economic cost it had throughout the whole tea value chain. The secondary objective is to remind policymakers that science and economics, theory and evidence, matter in forming and implementing public policy affecting agriculture.

This paper is organised as follows in addressing the research problem. In section 2, a literature review is presented to investigate the effects of the ban found out from studies conducted in Sri Lanka. The methods adopted in this study to achieve the objectives are elaborated in Section 3 followed by Section 4 with results and discussion. Results are presented separately for each method that evaluated the economic impact with a common discussion compiling and interpreting all results. Section 5 is the conclusion of the study.

2 Background literature

There had been a number of attempts made to investigate the adverse impacts of banning Glyphosate on agriculture in Sri Lanka.

Marambe and Herath (2019) pointed out the effects that the ban had on the tea industry at macro and micro levels. They highlighted effects such as increased production costs, falls in yields, losses of foreign earnings from exports, and increased use of informal Glyphosate products from the black market, as being direct consequences of the absence of an efficient and cost-effective weedicide option for farmers. They estimated that the ban resulted in an estimated annual loss of tea production of 33.2 million kg valued LKR 26.7 billion[1] per year. Additionally, the loss of LKR 1 billion from rejected tea consignments to Japan over incidents of exceeded MRLs of alternative weedicides such as Diuron and MCPA was reported as a having a significant negative impact on the tea industry and the economy. The annual loss from the ban was estimated to be Rs 10 – 20 billion by the Planters' Association in Sri Lanka (Marambe and Herath, 2019) as a result of escalated weeding costs on using labour, increasing costs of production from LKR 2.7 per kg to LKR 19.01 per kg. In the meantime, it was also noted that marginal tea lands were abandoned without controlling weeds and harvesting.

The impacts of banning Glyphosate on paddy cultivation in Sri Lanka was assessed by Malkanthi et al. (2019). In their study, it was pointed out that there were significant increases in the cost of weedicides used and hence in the cost of production after banning Glyphosate as farmers tried out various alternative weedicides such as MCPA, 2,4-D and Hedanol. These alternative weedicides were reported to be less effective than Glyphosate, hence innovative compositions like cocktail mixtures with Monosodium Glutamate were used on weed control in addition to mechanical weeders. Not many farmers could use just manual weeding because of shortages of hired labour, high wage rates, and unavailability of family labour.

Abeywickrama et al. (2017) assessed the impacts of the ban at the farm level in a comprehensive field evaluation on the agriculture sectors such as tea, sugarcane, and other field crops in Sri Lanka. In their study, the direct effects such as additional costs on weeding, increased costs of production, poor product quality and reduced quantities affected incomes were noted on the farm sector. There were other consequences of the ban such as enhanced soil erosion following increased harrowing, use of cocktail mixtures of kerosene and Monosodium Glutamate for weed control with no prior knowledge on the toxicity and effect on environment and human health, use of unregulated chemicals from illegal sources at excessive rates on weeding, reduction in the area of cultivation in field crops, exploitation of smallholder farmers with limited resource by contractors charging higher costs on machinery hire, declines in yields and increased costs of production as a result of allocating extra labour to weed control.

Based on nationally available published data, Abeywickrama et al. (2017) pointed out that there was a 11 per cent reduction in tea production nationally in 2016 relative to 2015, and a decline in export earnings of 5.4 per cent despite rising tea prices.

Rejection of tea consignments from Sri Lanka predictably, happened. The cost of this unintended consequence to the tea industry was LKR 399 million in just the Japanese market, according to the welfare analysis conducted using the Equilibrium Displacement Model on the tea industry (Rathnayake et al., 2022).

Although studies by Marambe and Herath (2019) and Abeywickrama et al. (2017) highlighted economic losses at the national level and some details at the farm level, a comprehensive evaluation of the changes in weed control alternatives and related costs and farm gross margins, and the overall economic impact at farm level and the consequent market levels in the tea industry, have not been fully explored.

3 Method

The nature of the research question explored in this study requires wide coverage of both quantitative and qualitative information. Evaluating consequences of the ban at key market levels of the tea industry requires exploring and understanding in depth the complexity of the situation and the explanations put forward, allied to qualitative data. Quantifying the economic effects of the ban mainly deals with quantitative data and analysis at a whole of industry level of aggregation. Studying the impacts of the policy that affected the whole agriculture from the perspective of the tea industry in Sri Lanka makes the case study approach a suitable method to focus on.

A mixed method, single case study design, as explained by Ritchie et al. (2013) and Creswell and Creswell (2018), was adopted. The case study was an embedded single case research design presented by Yin (2017), where the case is the tea industry while the embedded units of analysis are key participants in the supply chain of the tea industry such as tea growers, factory managers, labourers, secondary processors and traders. Strategies used within this case study

[1] The average exchange rate that prevailed in 2019 was 1 USD at LKR 178.6.

design were presented by employing a mixed method approach. A convergent mixed method was chosen to merge quantitative and qualitative data to provide a comprehensive analysis of the research question supported through a wide array of information sources. In this study, both primary and secondary data were collected from the embedded units of analysis in the case - the tea industry.

In-depth interviews with embedded units of analysis – participants in the supply chain as primary sources - enabled collecting both qualitative and quantitative data. Locations for the primary data collection were selected to be representative of districts with the highest national tea production and the three main regions where tea is produced in Sri Lanka. Subsequently, Galle and Rathnapura located in the low-country tea growing region, Badulla and Kandy representing the mid-country tea growing region, and Nuwara Eliya from the up-country tea growing region, were selected.

From all these districts, 35 tea smallholders (also including medium scale growers) and five estate managers were selected for interviews through convenience sampling with inputs from key informants who were officers of government institutes working with the tea industry, researchers, and academics. Interviews with key informants were also helpful in gathering critical information. Interviews were also conducted with three tea traders/exporters based in the capital city of Colombo who also engage in secondary processing.

Primary data collected from interviews with participants from the farm sector consisted of information on demographics and cultivation, changes that took place in weed management following the ban, factors that affected decision making on resource use, the impact of the ban on business budgets, issues and challenges faced because of the ban and so on.

Secondary data on prices and quantities mainly were obtained from published sources such as annual reports, the market reports and documents from institutes working with and/or collecting information on the tea industry such as Central Bank of Sri Lanka, Sri Lanka Tea Board, Tea Small Holdings Development Authority, Ministry of Plantation Industries, and Department of Census and Statistics. Research articles were also used in collecting data on market parameters.

Data were analysed in several ways to highlight the range of effects the ban on Glyphosate had on the tea industry. A thematic analysis was conducted using qualitative data and the Nvivo software to identify how decisions about weed management and resource use was affected, and to learn common issues and challenges that operators of businesses had to deal with. Analysis on variable cost and gross margin budgets of farms, with emphasis on weed management to quantify direct effects in terms of cost increases, was conducted using quantitative data from primary and secondary sources (Rathnayake et al*.,* 2023b).

The wider economic impacts of the ban on market level and whole tea industry were evaluated using a welfare analysis facilitated by an Equilibrium Displacement Model (EDM). The EDM on the Sri Lankan black tea industry developed by Rathnayake et al. (2023a) was used.

4 Results and Discussion

The ban on Glyphosate use in the tea industry affected most of the key market levels with direct impacts on the farm sector in the tea industry. There have been reported referred impacts on the tea manufacturing sector and unintended consequences on the tea export sector, in particular of the ban on Glyphosate reduced foreign exchange earnings through lost exports.

4.1 Farm sector

Tea growers from small andmedium-scale landholdings (private landholdings[2]) and the estate sector all experienced immediate and direct effects as well as indirect effects.

Chemical weed management had been the most common method of weed control over many years, triggered by scarcity of labour and high wage rates. All estate sector plantations and the majority of private tea growers with large land areas, limited labour, or with low producing aged cultivations, practiced chemical weeding before the ban. Some low productive estate sector cultivations were abandoned during the ban because of the high cost of maintenance with less returns. Following the ban, the proportion of private tea landholders practicing manual weed management increased, with a notable increase in the proportions of landholdings in the sample incorporating more manual weeding rounds to supplement chemical weeding rounds. This is shown in Figure 1. All estate sector plantations in the sample continued with chemical weed management, but with more manual weeding rounds despite the high cost on labour, so as to compensate for the relatively ineffective alternative weedicides.

[2] In the study, tea smallholders with land areas below four hectares and landholders with areas more than four hectares, but with no facilities for manufacturing made tea are called private tea landholders/ growers.

Weedicides used by tea growers during the ban were those recommended by the Tea Research Institute of Sri Lanka as alternatives to Glyphosate such as Diuron, MCPA, or Glufosinate Ammonium, or illegal Glyphosate from the black market with unregulated concentrations or other cocktail mixtures with unknown formulations. There was wide consensus that these alternative chemicals were less effective and more expensive compared to Glyphosate.

Landholdings on which non-chemical weed management was used during the ban, despite the high labour wage rates, fared better than landholdings using chemical weed management with the less effective and more expensive chemicals available during the ban (Figure 2). The direct effects were increased cost of chemical weeding and also manual weeding to compensate for ineffectiveness of chemicals, increasing the total cost of weed management. It is worth noting that there were instances highlighted by tea growers during interviews about phytotoxic effects of some chemicals used as weedicides resulting in crop losses.

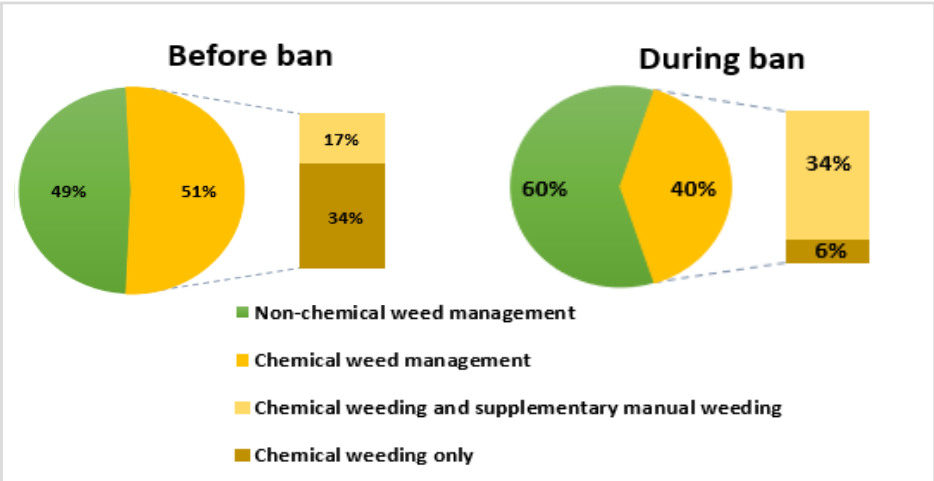

Figure 1. Weed management approaches conducted by private tea growers in the interviewed sample before and during the Glyphosate ban **(**Source: Field data 2019).

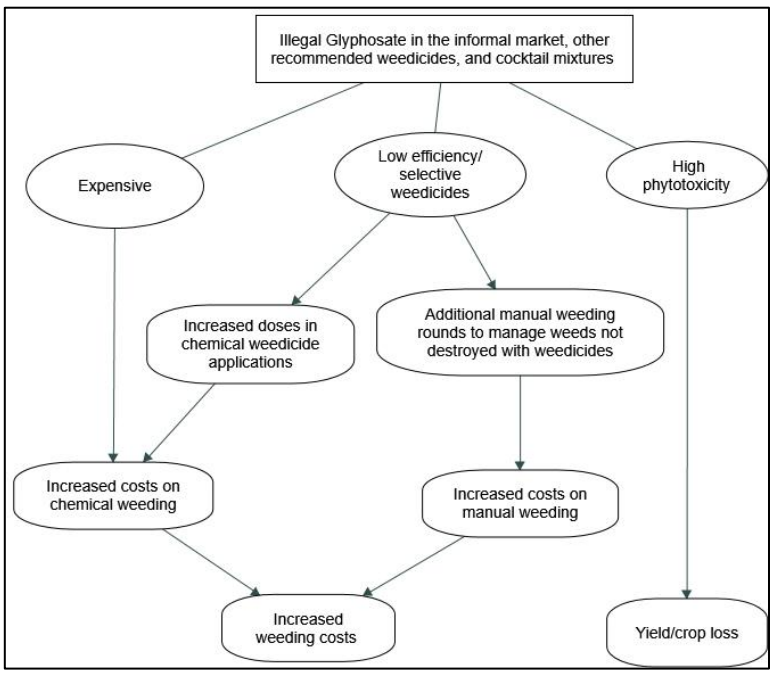

Figure 2. Use of available weedicides/chemicals available during the ban and effects experienced by the farm sector (Source: Field data 2019).

The unanticipated, yet indirect effects of the absence of Glyphosate are depicted graphically in Figure 3 showing how the ban eventually resulted in low production in the sector.

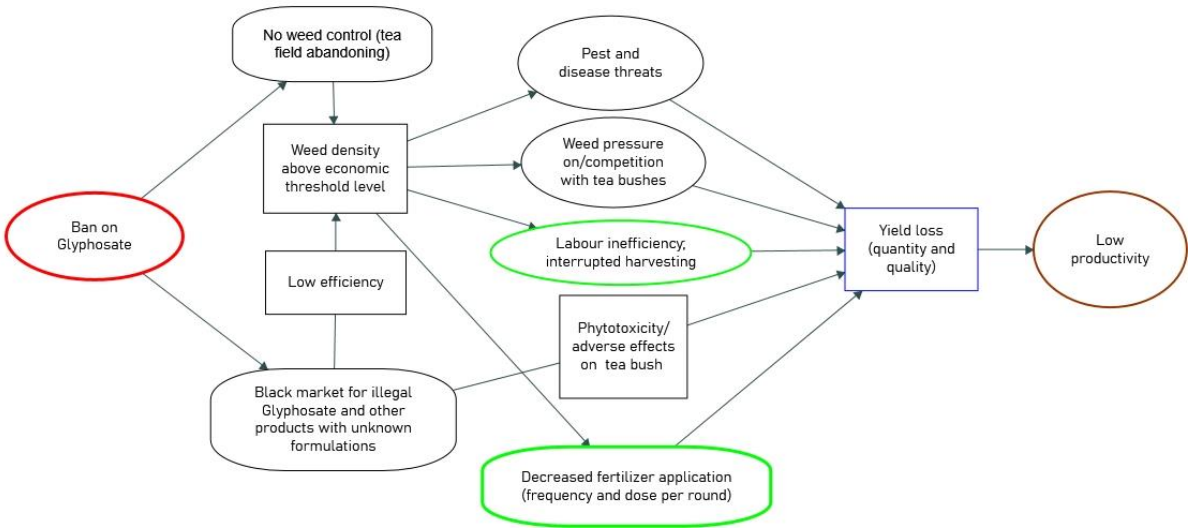

Figure 3. Impacts of the ban on Glyphosate on the farm sector (Source: Field data 2019).

The ineffectiveness of chemicals and weedicides used and abandonment of low yielding tea fields without weeding during the ban, led to uncontrolled weed densities above the economic threshold levels. This in turn resulted in labour inefficiencies and interfered with other field activities such as harvesting and fertiliser applications which directly affected yields. Populations of reptiles, leeches and wild animals in tea fields increased with dense weed growth posing threats and injuries to labourers. At the same time, better wages and conditions in the non-agricultural sector led to significant increases in labour outmigration from the farm sector into non-agricultural job markets, an observation made frequently by participants in both the estate and private tea growing sectors.

Cost of weeding increased, and gross margins reduced in green leaf producing businesses in both the private grower and estate grower sectors as reported by Rathnayake et al. (2023b). They pointed out that, given the nature of the labour requirement for manual weed management in private tea landholdings, manual weeding could have become the costliest weed management approach regardless of the ban, but the higher weed control cost could be offset to some extent by ensuring tea cultivations were operated in an overall productive manner with few plant vacancies in the plantation. According to Rathnayake et al. (2023b), chemical weeding with supplementary manual weeding became more labour intensive during the ban which increased weeding costs by nearly 94 per cent and 127 per cent compared to the cost before the ban, in private tea landholdings and the estate sector, respectively. They pointed out that the ban on Glyphosate resulted in increased costs to the farm sector and caused reduced gross margins of tea production. The estate sector experienced more severe impacts than the private tea grower sector because of the limited flexibility of the firms in the estate sector to adapt to the ban by switching between weed management approaches.

The private tea landholding sector had flexibility to adopt a range of weed management approaches based on labour availability, effectiveness, and land area under cultivation. Private tea landholders who switched from Glyphosate weeding only to integrated chemical and manual weeding with illicit Glyphosate products and labour as an adjustment to the ban experienced the highest cost of weeding and largest declines in gross margin.

Consequently, operators of representative landholdings from the tea estate sector incurred a 24 per cent increase in total variable costs and private landholdings had on average a 28 per cent increase in total variable costs during the ban.

4.2 Tea manufacturing sector

The tea manufacturing sector that depends on the farm sector for freshly harvested green leaves also faced consequences of the ban, as reported during interviews and published reports. It was stated by the Sri Lanka Tea Board (2016; 2017) that manufacturing factories had to shrink their production scale by operating with one dryer or halt their manufacture because of the decline in crop intake owing to extended plucking intervals and also higher cost of production.

It was noted by tea factory managers that the sector experienced significant losses of quantity and quality of black tea produced during the period of the ban. Interrupted fertiliser application and interrupted harvesting in tea fields resulted in a lower quality harvest with yellowish and more mature plucked leaves. This subsequently led to relatively higher proportions of off grade/quality tea with more fibre.

Furthermore, manufacturing factories operating with harvested green leaves from their own estates faced difficulties with the drop in green leaf production and they had to run machinery at sub-optimal capacities, incurring high costs of production of the made tea output. There was also competition within tea factories to buy green leaves at higher prices from the farm sector, resulting in unexpected increases in cost of production.

4.3 Black tea export sector/ Export marketing sector

Exporters experienced the unintended consequence of increases in rejected tea consignments exported to Japan. The main reason for this unfortunate situation of declined exports, according to the Sri Lanka Tea Board (2018), was levels of MCPA in final black tea products exported exceeding maximum residual revels (MRLs). This was the result of tea growers and large plantations being forced to use alternatives to Glyphosate in high doses and quantities to deal with the lower effectiveness of such chemicals.

In interviews, tea exporters reported that, as Japan was a major tea buyer, rejected shipments also adversely affected Sri Lanka as a large tea exporter. The main issue faced by companies exporting tea to Japan, Europe and Vietnam was increased costs of production from having to check MRLs of each batch of exports because of the strict quality standards imposed by those countries.

4.4 Welfare analysis of impacts of the ban on market levels in the tea industry

The economic cost of the ban in terms of a welfare analysis was evaluated in this study for the direct impact of the ban on the farm sector and unintended consequence on tea export sector. The EDM developed and validated by Rathnayake et al. (2023a) was used to quantify the economic costs of two scenarios: (i) variable cost of production increases at the farm sector and (ii) decline in demand for bulk tea exports.

Variable cost of production increases at the farm sector

Economic costs of the change in total variable costs in the farm sector because of increased costs in weeding during the ban on Glyphosate is analysed in this scenario. The percentage increase in total variable costs in representative private landholding and estate sector plantation were calculated as 24 per cent and 28 per cent respectively, taken from Rathnayake et al. (2023b).

Decline in demand for bulk tea exports

Costs incurred by the tea industry from rejected exports of black tea from Sri Lanka to Japan is evaluated in this scenario. Rathnayake et al., (2022) studied these unintended consequences and evaluated the associated welfare changes across the industry.

Exports of black tea from Sri Lanka declined from 8 million kgs in 2017 to 7.5kg in 2018 (news.lk, 2019). It is assumed that the demand for tea exports for bulk black tea from Japan reduced by 6.5 per cent during the ban because of exceeded MRLs in tea products. This was an unintended consequence of the ban that led to a shock on demand for bulk black tea as Japan is a main destination of Sri Lankan tea exports. This decline in demand by the Japanese markets is expressed as a percentage of total exports from Sri Lanka over the period as the Japanese market is not directly specified in the EDM. The decline in demand bulk tea exports is calculated as 0.39 per cent of total bulk tea exports.

4.5 Results of the welfare analysis of scenarios

Increase in variable cost of production at the farm sector

Results of the welfare analysis of the scenario of increased total variable costs in the farm sector is presented in Tables 1 and 2. Results are provided in terms of percentage changes in prices, quantities and economic surplus across the key market levels in the tea industry. The results predicted by the model are straightforward and align with expected outcomes – declines in quantities of inputs and outputs at all market levels with associated changes in prices as explained below.

Percentage changes in prices and quantities

In Table 1 is a representation of percentage changes in prices and quantities of tea products and inputs at each market level along the value chain specified in the EDM in response to the assumed exogenous shock on variable inputs in both private and estate tea landholdings. Percentage changes in prices and quantities depicted are the final equilibrium levels

reached in both market levels where the shock is taking place and in market levels downstream in the value chain to adjust to the initial shock.

Table 1.
Percentage changes in prices and quantities for scenario 1
(Source: Results obtained from the EDM by the authors)

Price variable	Percentage change in price	Quantity variable	Percentage change in quantity
Price of variable inputs used in green leaf production estate sector	0.1863	Quantity of variable inputs used in green leaf production estate sector	-0.0549
Price of fixed inputs used in green leaf production estate sector	-0.0785	Quantity of fixed inputs used in green leaf production estate sector	-0.0549
Price of variable inputs used in green leaf production private landholding sector	0.2097	Quantity of variable inputs used in green leaf production private landholding sector respectively	-0.0628
Price of fixed inputs used in green leaf production private landholding sector	-0.1258	Quantity of fixed inputs used in green leaf production private landholding sector	-0.0628
Price of green leaves	0.1344	Quantity of green leaves supplied from the green leaf production private landholding sector to the black tea manufacturing sector	-0.0550
Price of other inputs used in black tea manufacturing	-0.0571	Quantity of green leaves supplied from the green leaf production estate sector to the black tea manufacturing sector	-0.0629
Auction price of made tea for bulk black tea exports	0.0307	Total national green leaf production	-0.0571
Price of other inputs used in secondary processing of black tea exports in bulk form	-0.0571	Quantity of other inputs used in black tea manufacturing	-0.0571
Auction price of made tea for value-added black tea exports	0.0484	Quantity of black tea from the manufacturing sector to the bulk tea export marketing sector for secondary processing	-0.0571
Price of other inputs used in secondary processing of black tea exports in value-added form	-0.0571	Quantity of other inputs used in secondary processing of black tea for exports in bulk form	-0.0571
Auction price of made tea for domestic marketing of bulk loose tea	0.1566	Quantity of black tea from the manufacturing sector to the value-added tea export marketing sector for secondary processing	-0.0571
Price of other inputs used in secondary processing of black tea for domestic marketing in bulk form	-0.0571	Quantity of other inputs used in secondary processing of black tea for exports in value-added form	-0.0571
Auction price of made tea for domestic marketing of value-added black tea	0.4164	Quantity of black tea from the manufacturing sector to the loose bulk tea domestic marketing sector for secondary processing	-0.0571
Price of other inputs used in secondary processing of black tea for domestic market in value-added form	-0.0571	Quantity of other inputs used in secondary processing of black tea for domestic marketing in bulk form	-0.0571
Price of bulk black tea to export market	0.0143	Quantity of black tea from the manufacturing sector to the value-added tea domestic marketing sector for secondary processing	-0.0571
Price of value-added black tea to export market	0.0114	Quantity of other inputs used in secondary processing of black tea for domestic market in value-added form	-0.0571
Price of bulk black tea to domestic market	0.0714	Quantity of bulk black tea from secondary processing to export market	-0.0571
Price of value-added black tea to domestic market	0.1429	Quantity of value-added black tea from secondary processing to export market	-0.0571
		Quantity of bulk black tea from secondary processing to domestic market	-0.0571
		Quantity of value-added black tea from secondary processing to domestic market	-0.0571

The initial shock on the variable cost of inputs in both groups of the farm sector was an upward shift in each supply curve. Hence, increases in prices by 18.6 per cent and 21 per cent, and declines in quantities by 5.5 per cent and 6.3 per cent occurred in private tea landholding and estate sectors, respectively, for variable inputs used on the production of green leaves. Based on the assumption of a fixed proportion of inputs in the green leaf production process, a shift in the demand curve takes place subsequently with no change in the supply curve for fixed inputs as the quantity of variable inputs decline. This leads to a reduction in both quantities and prices of fixed inputs in both grower sectors. As a result, the quantities of green leaves supplied from the private grower and estate sector to the manufacturing sector eventually decline by 5.5 per cent and 6.3 per cent respectively with an increase in the green leaf price by 13.4 per cent.

Subsequently, quantities of all other inputs used in the production processes at each market level downstream are predicted to decline by 5.7 per cent. At the secondary processing sector levels, it was predicted by the model for made tea sold at auction to increase prices in export markets by 3 per cent and 4.8 per cent for bulk and value-added tea, and in domestic markets by 15.6 per cent and 41.6 per cent for bulk loose and value-added tea. An increase in the prices of final tea products in export markets by 1.4 per cent and 1.1 per cent (for bulk and value-added tea respectively) and in domestic markets by 7.4 per cent and 14.3 per cent (for bulk loose and value-added tea respectively) was indicated from the shock at the farm level.

Changes in economic surpluses and their percentage distributions

Based on the change in prices and quantities noted in Table 1 above, the change in economic surpluses and their proportions as a percentage of the total change in economic surplus are presented in Table 2.

The shock on the farm sector resulted in economic surplus losses at all market levels amounted to a total loss of LKR 17.7 billion per year in the tea industry (approximately $US 98 million). The largest proportion of the welfare loss of LKR 11.5 billion per year would be borne by producers and other input suppliers who incurred 65 per cent of the total loss, with private tea growers incurring the largest loss of LKR 3.8 billion per year, bearing 21.5 per cent of the total loss.

Domestic consumers of value-added tea (VAT) were predicted to experience a cost of LKR 3.9 billion per year (22 per cent of the total loss).

Decline in demand for bulk tea exports

Rathnayake et al*.,* (2022) provided detailed analysis of the scenario on unintended consequence of declined demand for bulk tea exports.

The total loss of economic surplus of this unintended consequence was estimated to be LKR 339 million per year on the tea industry (approximately $US 1.8 million). Despite the initial shock being located in the black tea export sector, the producer sector experiences the largest proportion of the loss, amounting to LKR 220.2 million per year. The VAT consumers in domestic markets were the most affected consumer group, experiencing the largest price increases and incurring a total loss of LKR 76.6 million per year.

4.6 Implications of the ban on Glyphosate on the tea industry

The primary goal that the government attempted to achieve in 2015 by imposing the ban on Glyphosate was to reduce the social costs of the presumed public health externalities of the incidence of CKDu. While a regulation such as a ban is a feasible way of addressing the problem of social costs, its effectiveness was questionable considering the responses of participants in the industry and the impacts and consequences they experienced following the ban.

Hence, policymakers are one of the main focus groups of the study outcomes as they were directly involved in formulating and implementing the policy to ban the use of Glyphosate.

State-imposed regulations become ineffective when standards that are hard or impractical to meet are implemented, whether because of the lack of knowledge, skills or finance on the part of actors or mismanagement of policymakers in policy formulation processes. Expected outcomes from policies have a better chance of coming to fruition with well-informed processes, sound planning and good knowledge of economic, intellectual, political, logistical, and technological aspects of production of the industries involved.

By nature, regulations such as bans are rigid and less likely to be changed if effectively enforced. Regulations also can be considered to be an effective method to achieve the goals of public policy since the regulation applies to all the actors who undertake an activity as described in the regulation and treats them on the same basis regardless of the level of impact. Regulation however can be also a very blunt instrument, and costly; this means the objective, if achieved, is unlikely to be achieved at least cost. As found in the study, the policy on Glyphosate resulted in economically, environmentally, and socially damaging outcomes for the tea industry. Imposing a ban on an agricultural input has to take into consideration more than just restricting its use – implications for other inputs involved in production too need considering. Policy about one input has to also pay attention to the possible alternative inputs. It would be incumbent on a government banning an input such as a weedicide to make sure there are stocks of genuinely suitable alternative weedicides. The expected social benefit outcomes from government interventions will not be achieved if government policy formation and implementation is dominated by short-term political considerations.

Welfare analysis on impacts and consequences of the ban provides indications of economic consequences, and gives guidance for policymakers to consider, if and when introducing a similar policy banning Glyphosate or any other input in an agricultural industry. Informed adjustments to policy plans can be made while formulating policy to better match the hoped-for intentions and minimize the unintended consequences that can lead to losses.

Table 2.
Economic surplus changes and their distributions across market levels in the tea industry for scenario 1
(Source: Results obtained from the EDM by the authors)

	Million Rs.	Distribution
Green leaf production		
Private grower sector		
Producer surplus for variable inputs	(2,830.73)	15.99%
Producer surplus for fixed inputs	(985.58)	5.7%
Subtotal	(3,816.30)	21.56%
Estate grower sector		
Producer surplus for variable inputs	(1,317.6)	7.44%
Producer surplus for fixed inputs	(686.1)	3.88%
Subtotal	(2,003.7)	11.32%
Total	(5,820.0)	32.88%
Black tea manufacturing		
Producer surplus for other inputs	(2,380.60)	13.45%
Secondary processing of tea for bulk tea exports		
Producer surplus for other inputs	(924.49)	5.22%
Secondary processing of tea for value added tea exports		
Producer surplus for other inputs	(1,436.85)	8.12%
Secondary processing of tea for domestic consumption in loose form		
Producer surplus for other inputs	(41.74)	0.23%
Secondary processing of tea for value added tea consumption in domestic markets		
Producer surplus for other inputs	(920.84)	5.20%
Total producer surplus	(11,524.56)	65.11%
Consumer surplus for bulk black tea exports	(1,238.65)	6.99%
Consumer surplus for value-added tea exports	(820.19)	4.63%
Consumer surplus for domestically consumed black tea in loose form	(131.01)	0.74%
Consumer surplus for domestically consumed value-added tea	(3,985.61)	22.51%
Total consumer surplus	(6,175.46)	34.88%
Total Economic Surplus	(17,700.03)	100%

When there is a lack of information and knowledge on a potential negative externality, command and control policy instruments can be helpful in early stages. As explained in economic theory, a market-based approach such as a tax on Glyphosate users could have served as a better policy alternative since the blanket ban proved to have economic costs on agriculture and tea industry. As well as command and control and price-based policy instruments that require a regulatory framework, voluntary agreements are other options that operate through the voluntary participation of polluters agreeing to act by themselves. Government can encourage relevant parties through information and other incentives. There is always potential for policymakers to try such policies as part of a multi-pronged attack on problems.

5 Conclusion

The government policy banning Glyphosate in Sri Lanka in 2015 seriously adversely affected people in the tea industry. Participants in key market levels in the tea industry experienced either direct effects or unintended consequences with the ban in place.

The farm sector faced direct adverse effects in tea cultivations and on their businesses because of issues in weed management and associated increased costs. Both private tea landholdings and estate holdings in the farm sector experienced quantity and quality losses in the harvest that both reduced incomes and increased total variable costs. Total variable cost in the private tea landholding and estate sector increased by 24 and 28 per cent respectively during the ban. This resulted in an economic cost of LKR 17.7 billion per year on the tea industry.

The tea manufacturing sector as well experienced quantity and quality losses along with increased production costs. There was an unintended consequence on the black tea export sector – one of the largest foreign exchange earners, particularly a decline in demand for bulk tea exports by Japanese markets because of not meeting quality standards. This caused an economic loss of LKR 339 million per year on the tea industry.

Of late, government policies in Sri Lanka have been unpredictable and subject to frequent change. The organic agriculture policy implemented in 2021 is a good example of repeating the mistakes of past policies that went wrong - the adverse impacts and consequences of the ban on Glyphosate in 2015. Hence, the investigation on economic costs this ban imposed between 2015-2018 had on the tea industry is a useful case study to remind policymakers how much science and economics, theory and evidence, matter in the formation and implementation of public policy affecting agriculture.

References

Abeywickrama, L.M., Sandika, A.L., Sooriyaarachchi, P., and Vidanapathirana, I. (2017). *Impacts of Banning Glyphosate on Agriculture Sector in Sri Lanka: A Field Evaluation*. https://www.croplifeasia.org/wpcontent/uploads/2018/04/Impacts-of-Banning-Glyphosate-on-Agriculture-Sector-in-Sri-Lanka-A-Field-Evaluation.pdf.

Beillard, M.J., and Galappattige, A. (2021). *Sri Lanka Restricts and Bans the Import of Fertilizers and Agrochemicals*. F. A. S. United States Department of Agriculture. https://www.fas.usda.gov/data/sri-lanka-sri-lanka-restricts-and-bans-import-fertilizers-and-agrochemicals.

Creswell, J.W. and Creswell, J.D. (2018). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. SAGE Publications, Inc., Thousand Oaks, California.

Department of Government Printing. (2015). *Import and Export (Control) Act No. 01 OF 1969*. Colombo, Sri Lanka: Department of Government Printing Retrieved from http://www.documents.gov.lk/files/egz/2015/6/1918-22_E.pdf.

Jayasinghe, U. (2021). Sri Lanka rows back on chemical fertiliser ban, but yields may not rebound. *Markets: Commodities*. https://www.reuters.com/markets/commodities/sri-lanka-rows-back-organic-farming-goal-removes-ban-chemical-fertilisers-2021-11-24/ .

Jayasumana, C., Gunatilake, S., and Senanayake, P. (2014). Glyphosate, hard water and nephrotoxic metals: are they the culprits behind the epidemic of chronic kidney disease of unknown etiology in Sri Lanka? *International Journal of Environvironmental Research and Public Health*, **11**(2): 2125-2147. https://doi.org/10.3390/ijerph110202125.

Klinkner, P.A. (1994). Beyond Pseudo-Science: Political Parties and Policymaking. *Polity*, **26**(4): 769-791.

Malkanthi, S.H.P., Sandareka, U.G., Wijerathne, A.W., and Sivashankar, P. (2019). Banning of Glyphosate and its Impact on Paddy Cultivation: A study in Ratnapura District in Sri Lanka. *Journal of Agricultural Sciences – Sri Lanka*, **14**(2). https://doi.org/10.4038/jas.v14i2.8515.

Marambe, B. and Herath, S. (2019). Banning of Herbicides and Its' Impact on Agriculture-The Case of Glyphosate in Sri Lanka. *Weed Science*, **68**: 246-252. https://doi.org/10.1017/ wsc.2019.71.

News.lk. (2019). Tea export revenue for 2018 dips 2%. *Development - Economy*. Retrieved 08/12/2020, from https://www.news.lk/news/business/item/24178-tea-export-revenue-for-2018-dips-2 .

Nordhaus, T. and Shah, S. (2022). In Sri Lanka, Organic Farming Went Catastrophically Wrong. *Foreign Policy: Analysis*. Retrieved 10/08/2022, from https://foreignpolicy.com/2022/03/05/sri-lanka-organic-farming-crisis/

Rathnayake, C., Malcolm, B., Griffith, G., and Sinnett, A. (2023b). Economics of banning Glyphosate at Farm Level of the Tea Industry in Sri Lanka. *The Sri Lanka Journal of Economic Research [Submitted for review]*.

Rathnayake, C., Malcolm, B., Griffith, G., Sinnett, A., and Farquharson, B. (2023a). Developing an Equilibrium Displacement Model of the Sri Lankan Tea Industry. *Australasian Agribusiness Review,* **31**(2)*:* 28-64.

Rathnayake, C., Malcolm, B., Griffith, G., and Sinnette, A. (2022). Trade Consequences of the Farm Production Regulation: The Glyphosate Ban in the Sri Lankan Tea Industry. *Industria: Jurnal Teknologi dan Manajemen Agroindustri*, **11**(2): 81-100.

Ritchie, J., Lewis, J., Nicholls, C.M., and Ormston, R. (2013). Qualitative research practice: A guide for social science students and researchers. SAGE Publications.

Sri Lanka Tea Board (2016). Annual Report 2015 Sri Lanka Tea Board, Colombo, Sri Lanka, pp 104.

Sri Lanka Tea Board (2017). Annual Report. Sri Lanka Tea Board, Colombo, Sri Lanka, pp 124.

Sri Lanka Tea Board (2018). Annual Report. Sri Lanka Tea Board, Colombo, Sri Lanka, pp 103.

Yin, R.K. (2017). *Case study research and applications: Design and methods* (6th Edition ed.). Sage Publications.