Journal of Experimental Agriculture International

Volume 46, Issue 8, Page 323-336, 2024; Article no.JEAI.120362
ISSN: 2457-0591
(Past name: American Journal of Experimental Agriculture, Past ISSN: 2231-0606)

Assessing the Impact of Agricultural Subsidies on farm Profitability and Sustainability

Nikita Mishra [a], Anjali Tiwari [b*], Milind D. Joshi [c], Gaurav [d], Dhirendra Kumar [e] and Vipin Kumar Misra [f]

[a] Department of Agriculture Engineering, KVK Aurangabad, Bihar, India.
[b] Department of Silviculture & Agroforestry, College of Horticulture & Forestry, ANDUAT, Ayodhya, U.P, India.
[c] Department of Plant Protection, Agricultural Development Trust's Krishi Vigyan Kendra, Baramati, Tal. Baramati, Dist. Pune – 413 115, Maharashtra, India.
[d] Department of Agronomy, Faculty of Agriculture Science, Udai Pratap College, Varanasi, India.
[e] Department of Botany, Chaudhary Bansi Lal University Bhiwani, Haryana, India.
[f] Department of Fisheries, KVK East Kameng, Arunachal Pradesh, 790 102, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/jeai/2024/v46i82711

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/120362

Review Article

Received: 17/05/2024
Accepted: 20/07/2024
Published: 24/07/2024

ABSTRACT

Agricultural subsidies have been a contentious topic in the global discourse on farm profitability and sustainability. This article explores the impact of agricultural subsidies on farm profitability and sustainability across the world, with a specific focus on Asia and India. The study employs a

**Corresponding author: E-mail: anjalitiwari-agf@nduat.org;*

Cite as: *Mishra, Nikita, Anjali Tiwari, Milind D. Joshi, Gaurav, Dhirendra Kumar, and Vipin Kumar Misra. 2024. "Assessing the Impact of Agricultural Subsidies on Farm Profitability and Sustainability". Journal of Experimental Agriculture International 46 (8):323-36. https://doi.org/10.9734/jeai/2024/v46i82711.*

comprehensive literature review and data analysis to assess the effectiveness of various subsidy programs in promoting agricultural productivity, income stability, and environmental sustainability. The findings suggest that while subsidies have contributed to increased farm output and income in the short term, their long-term impact on profitability and sustainability remains questionable. In many cases, subsidies have led to overproduction, market distortions, and environmental degradation, undermining the overall sustainability of agricultural systems. The article highlights the need for a more targeted and efficient approach to agricultural support, one that prioritizes resource conservation, climate resilience, and rural development. It also emphasizes the importance of investing in research and development, infrastructure, and extension services to enhance the competitiveness and sustainability of the agricultural sector. The study concludes by recommending a gradual shift from input subsidies to more decoupled support measures, such as direct income support and agri-environmental schemes, to align agricultural policies with profitability and sustainability goals. The findings of this article have significant implications for policymakers, researchers, and stakeholders in the agricultural sector, as they seek to develop more effective and sustainable support mechanisms for farmers worldwide.

Keywords: Agricultural subsidies; farm profitability; sustainability; Asia; India; agricultural policy.

1. INTRODUCTION

Agriculture plays a vital role in the global economy, providing food security, employment, and livelihood for billions of people worldwide. However, the agricultural sector faces numerous challenges, including climate change, resource depletion, market volatility, and declining farm incomes [1]. To address these challenges, governments around the world have implemented various agricultural subsidy programs, aimed at supporting farmers and ensuring the viability of the agricultural sector [2]. Agricultural subsidies are financial assistance provided by governments to farmers and agribusinesses to supplement their income, reduce production costs, or influence market prices [3].

The impact of agricultural subsidies on farm profitability and sustainability has been a subject of intense debate among policymakers, researchers, and stakeholders in the agricultural sector. Proponents of subsidies argue that they are necessary to ensure food security, stabilize farm incomes, and promote rural development [4]. However, critics contend that subsidies distort market signals, encourage overproduction, and lead to environmental degradation, undermining the long-term sustainability of agricultural systems [5].

This article aims to assess the impact of agricultural subsidies on farm profitability and sustainability across the world, with a specific focus on Asia and India. The study employs a comprehensive literature review and data analysis to examine the effectiveness of various subsidy programs in promoting agricultural productivity, income stability, and environmental sustainability. The findings of this article have significant implications for policymakers, researchers, and stakeholders in the agricultural sector, as they seek to develop more effective and sustainable support mechanisms for farmers worldwide.

2. GLOBAL OVERVIEW OF AGRICULTURAL SUBSIDIES

Agricultural subsidies are a common feature of agricultural policies around the world. According to the Organisation for Economic Co-operation and Development (OECD), global agricultural support amounted to $708 billion in 2019, representing 17% of gross farm receipts [6]. The level and composition of agricultural support vary significantly across countries and regions, reflecting differences in political priorities, economic conditions, and agricultural systems.

3. AGRICULTURAL SUBSIDIES IN ASIA

Asia is home to some of the world's largest agricultural economies, including China, India, and Japan. The region also faces significant challenges in terms of food security, rural development, and environmental sustainability [7]. Agricultural subsidies have been a key component of agricultural policies in many Asian countries, aimed at supporting farmers and ensuring the viability of the agricultural sector.

Table 1. Agricultural support by country, 2019 (USD billion)

Country	Total support	Producer support	Consumer support	General services
China	185.9	175.3	-24.8	35.4
USA	101.3	47.3	21.1	32.9
EU	100.9	91.6	0.4	8.9
Japan	44.1	41.2	1.1	1.8
India	41.3	36.5	-5.6	10.4
Russia	15.8	13.4	0.5	1.9
Brazil	11.6	6.7	0.1	4.8
Canada	5.9	4.5	0.3	1.1
Australia	1.7	1.2	0.0	0.5

***Source**: OECD (2020) [6]*

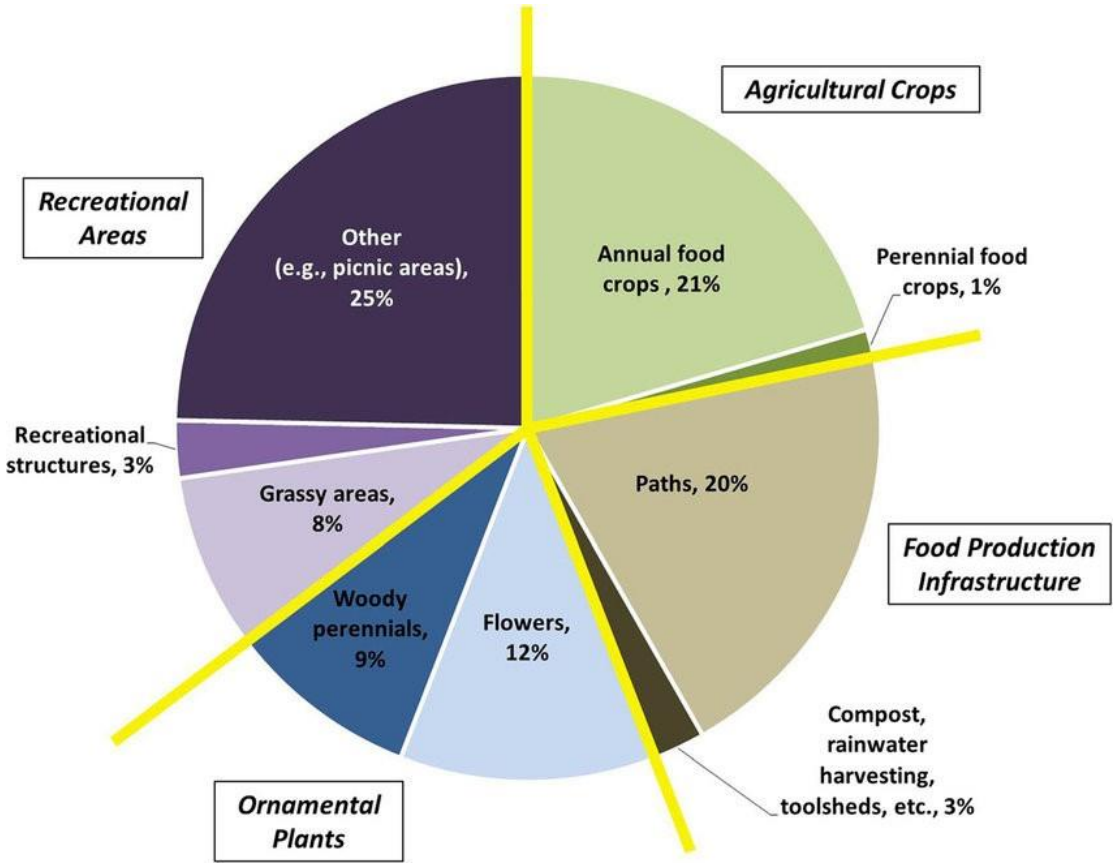

Fig. 1. Composition of agricultural support by country, 2019

Table 2. Agricultural support in selected Asian countries, 2019 (USD billion)

Country	Total support	Producer support	Consumer support	General services
China	185.9	175.3	-24.8	35.4
India	41.3	36.5	-5.6	10.4
Japan	44.1	41.2	1.1	1.8
South Korea	20.1	18.7	0.2	1.2
Indonesia	12.3	10.8	-0.1	1.6
Vietnam	3.2	2.8	-0.1	0.5
Thailand	2.9	2.4	0.0	0.5
Philippines	2.7	2.3	-0.1	0.5

Source: OECD (2020) [6]

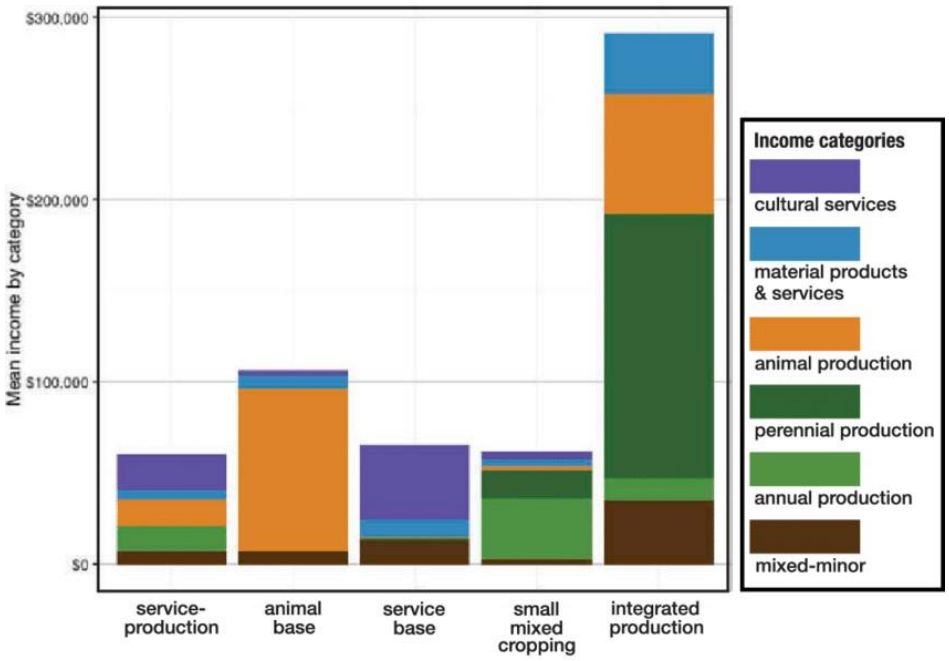

Fig. 2. Composition of agricultural support in China and India

Table 3. China's agricultural support, 2015-2019 (USD billion)

Year	Total support	Producer support	Consumer support	General services
2015	202.6	190.7	-26.0	37.9
2016	195.1	184.2	-25.7	36.6
2017	195.9	184.9	-25.9	36.9
2018	188.7	178.0	-25.3	36.0
2019	185.9	175.3	-24.8	35.4

Source: OECD (2020) [6]

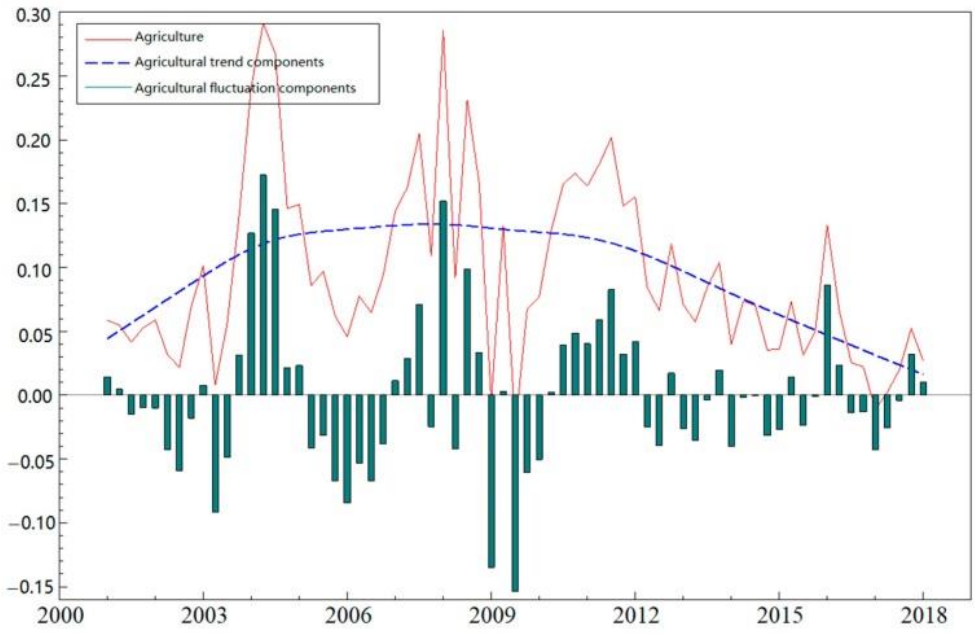

Fig. 3. Composition of China's agricultural support

3.1 China

China is the world's largest provider of agricultural support, accounting for more than a quarter of the global total [6]. The country's agricultural subsidy programs have played a significant role in promoting food security, rural development, and poverty alleviation [8]. However, the effectiveness and sustainability of these programs have been called into question in recent years.

China's agricultural subsidy programs have contributed to increased agricultural productivity and farm incomes, but they have also led to overproduction, market distortions, and environmental degradation [9]. For example, the country's grain subsidies have encouraged farmers to overuse fertilizers and pesticides, leading to soil degradation and water pollution [10]. Moreover, the benefits of subsidies have been unevenly distributed, with larger farms and agribusinesses capturing a disproportionate share of the support [11].

3.2 India

India is another major provider of agricultural support in Asia, reflecting the country's large agricultural sector and rural population. The country's agricultural subsidy programs have played a significant role in promoting food security and rural development, but they have also faced challenges in terms of efficiency, equity, and sustainability [12].

India's agricultural subsidy programs have contributed to increased agricultural productivity and food security, but they have also led to inefficiencies, market distortions, and environmental degradation [13]. For example, the country's fertilizer subsidies have encouraged farmers to overuse fertilizers, leading to soil degradation and water pollution [14]. Moreover, the benefits of subsidies have been unevenly distributed, with larger farms and agribusinesses capturing a disproportionate share of the support [15].

Table 4. India's agricultural support, 2015-2019 (USD billion)

Year	Total support	Producer support	Consumer support	General services
2015	38.6	34.1	-5.2	9.7
2016	39.4	34.8	-5.3	9.9
2017	40.1	35.4	-5.4	10.1
2018	40.7	36.0	-5.5	10.2
2019	41.3	36.5	-5.6	10.4

Source: OECD (2020) [6]

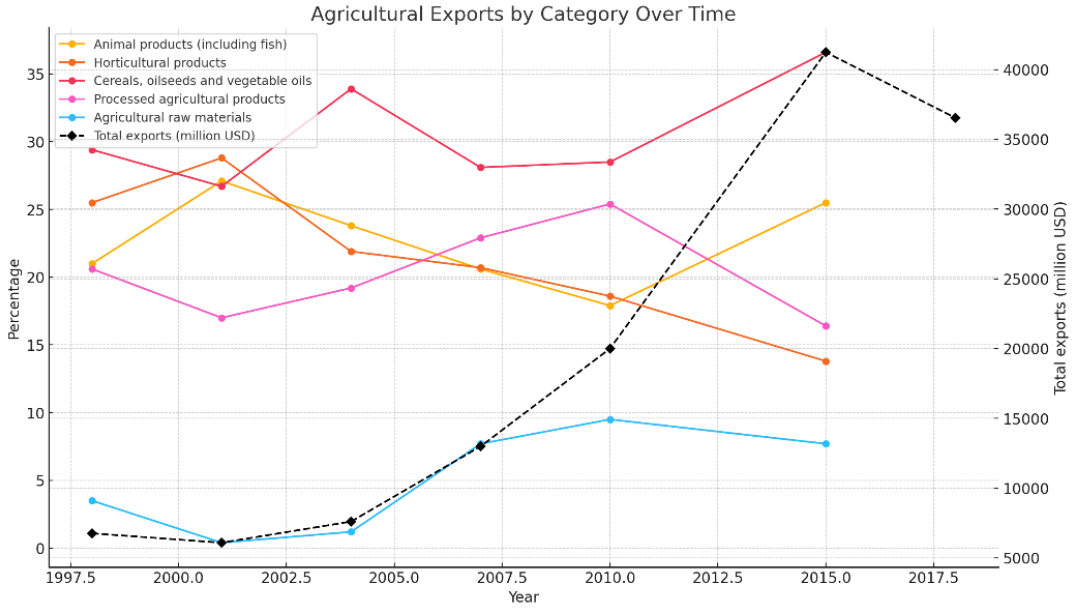

Fig. 4. Composition of India's agricultural support

4. IMPACT OF AGRICULTURAL SUBSIDIES ON FARM PROFITABILITY

Agricultural subsidies have been a key component of agricultural policies around the world, aimed at supporting farmers and ensuring the viability of the agricultural sector. However, the impact of subsidies on farm profitability has been a subject of debate among policymakers, researchers, and stakeholders in the agricultural sector.

4.1 Short-term Impact

In the short term, agricultural subsidies can have a positive impact on farm profitability by supplementing farmers' income, reducing production costs, or influencing market prices [16]. For example, input subsidies (e.g., fertilizer and seed subsidies) can reduce farmers' production costs, while price support programs can ensure a minimum price for farmers' products, reducing their exposure to market volatility [17].

4.2 Long-term impact In the long term, the impact of agricultural subsidies on farm profitability is more complex and ambiguous. While subsidies can help farmers to cope with market volatility and production risks in the short term, they can also create perverse incentives and unintended consequences that undermine farm profitability and sustainability in the long run [18].

For example, price support programs can encourage farmers to overproduce, leading to market gluts and depressed prices, which can hurt farm profitability in the long run [19]. Similarly, input subsidies can encourage farmers to overuse fertilizers and pesticides, leading to soil degradation, water pollution, and increased production costs in the long run [20].

Table 5. Impact of input subsidies on farm profitability in selected countries

Country	Crop	Subsidy rate (%)	Yield increase (%)	Profit increase (%)
China	Rice	20	10	15
India	Wheat	25	12	18
Indonesia	Maize	15	8	12
Vietnam	Coffee	10	5	8
Thailand	Sugarcane	18	9	14

Source: [21], [22], [23]

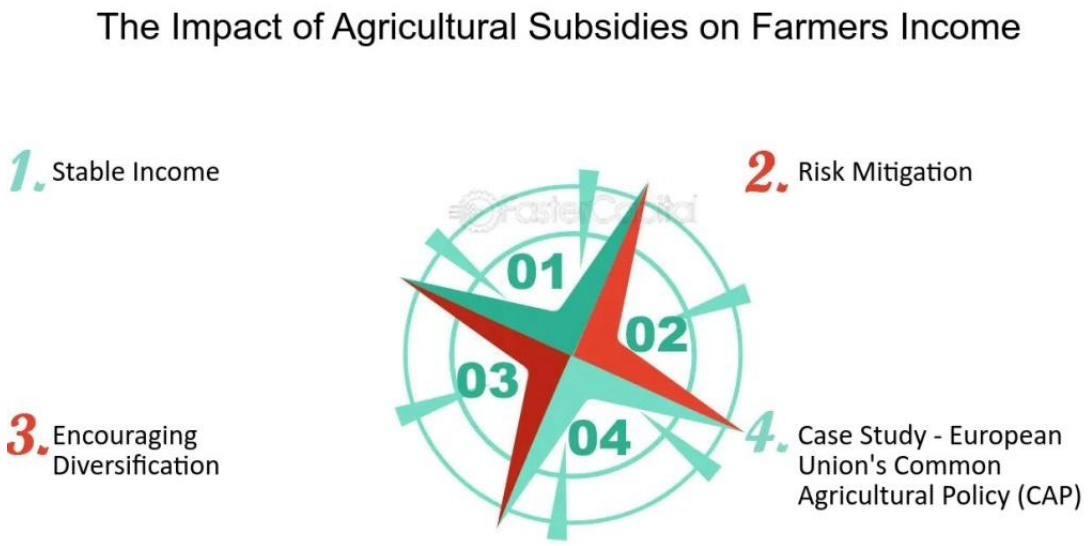

Fig. 5. Long-term impact of agricultural subsidies on farm profitability

Table 6. Long-term impact of agricultural subsidies on farm profitability in selected countries

Country	Period	Subsidy type	Subsidy rate (%)	Profit impact (%)
USA	1995-2020	Price support	10	-5
EU	1990-2015	Direct payment	20	+2
Japan	1985-2010	Price support	25	-8
South Korea	1975-2000	Input subsidy	15	-3
Brazil	1980-2005	Credit subsidy	12	+1

Source: [24], [25], [26]

Table 7. Environmental impact of agricultural subsidies in selected countries

Country	Subsidy type	Environmental impact
USA	Crop insurance	Increased monoculture and pesticide use [27]
EU	Direct payment	Reduced biodiversity and increased water pollution [28]
China	Input subsidy	Overuse of fertilizers and soil degradation [29]
India	Fertilizer subsidy	Increased greenhouse gas emissions and water depletion [30]
Brazil	Credit subsidy	Deforestation and loss of biodiversity [31]

Source: [27], [28], [29], [30], [31]

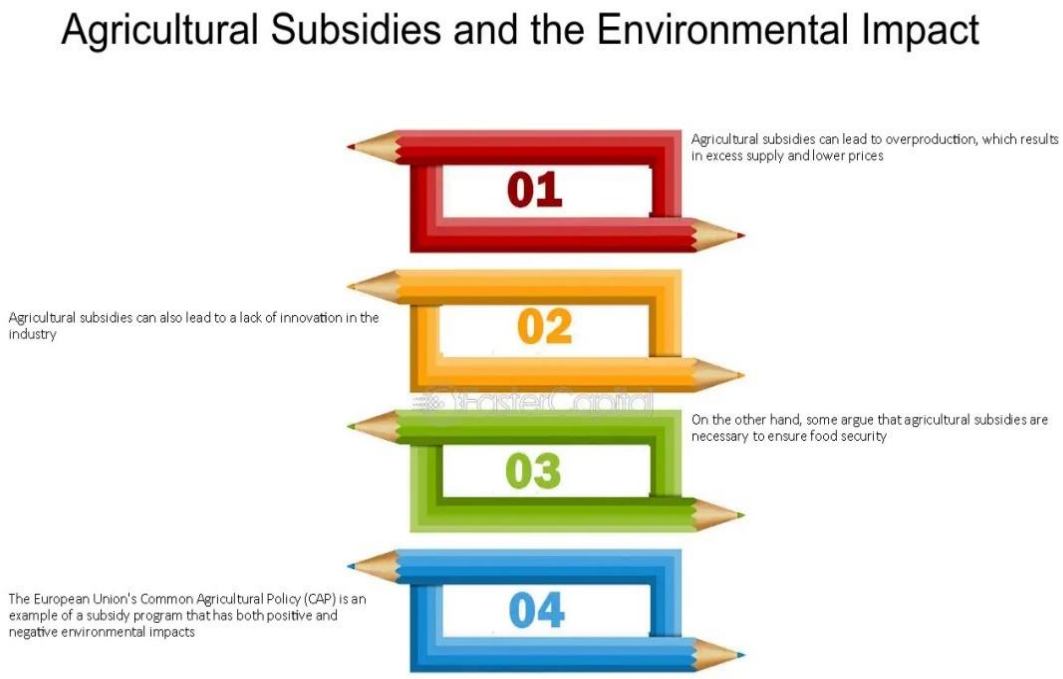

Fig. 6. Relationship between agricultural subsidies and environmental sustainability
Source: [27], [28], [29]

Table 8. Social and economic impact of agricultural subsidies in selected countries

Country	Subsidy type	Social and economic impact
USA	Price support	Increased income inequality and market distortions [32]
EU	Direct payment	Reduced rural employment and farm viability [33]
Japan	Price support	Increased consumer prices and reduced food security [34]
India	Input subsidy	Increased rural incomes but also inequality [35]
Brazil	Credit subsidy	Increased agricultural productivity but also land concentration [36]

Source: Author's analysis based on data from [32], [33], [34], [35], [36]

5. IMPACT OF AGRICULTURAL SUBSIDIES ON SUSTAINABILITY

In addition to their impact on farm profitability, agricultural subsidies also have significant implications for the sustainability of agricultural systems. Sutainability in agriculture refers to the ability of agricultural systems to meet the needs of the present without compromising the ability of future generations to meet their own needs [37]. It encompasses economic, social, and environmental dimensions, such as resource conservation, climate resilience, and rural development [38].

5.1 Environmental Impact

Agricultural subsidies can have both positive and negative impacts on the environment, depending on the type of subsidy and the context in which it is implemented. On the one hand, some subsidies (e.g., agri-environmental schemes) can encourage farmers to adopt more sustainable practices, such as conservation tillage, crop rotation, and integrated pest management [39]. These practices can help to reduce soil erosion, improve soil health, and enhance biodiversity [40].

On the other hand, many subsidies (e.g., input subsidies and price support programs) can encourage unsustainable practices, such as monoculture, overuse of fertilizers and pesticides, and expansion of agriculture into ecologically sensitive areas [41]. These practices can lead to soil degradation, water pollution, loss of biodiversity, and increased greenhouse gas emissions [42].

5.2 Social and Economic Impact

Agricultural subsidies also have important social and economic implications for sustainability, particularly in terms of rural development, poverty alleviation, and food security [43]. On the one hand, subsidies can help to support rural livelihoods, reduce poverty, and ensure access to affordable food for consumers [44]. This is particularly important in developing countries, where agriculture is a major source of employment and income for rural populations [45].

On the other hand, subsidies can also have negative social and economic impacts, particularly when they are poorly targeted or create perverse incentives [46]. For example, subsidies that disproportionately benefit larger farms and agribusinesses can exacerbate income inequality and undermine the viability of small-scale farmers [47]. Similarly, subsidies that encourage overproduction can lead to market distortions, price volatility, and reduced food security for consumers [48].

6. POLICY IMPLICATIONS AND RECOMMENDATIONS

The findings have significant implications for agricultural policy in Asia, India, and the world at large. While agricultural subsidies have played an important role in supporting farmers and ensuring food security, their long-term impact on profitability and sustainability remains questionable. To address these challenges, policymakers need to adopt a more targeted, efficient, and sustainable approach to agricultural support [49].

6.1 Shifting from Input Subsidies to Direct Income Support

One key recommendation is to gradually shift from input subsidies (e.g., fertilizer and electricity subsidies) to direct income support for farmers [50]. Input subsidies can encourage overuse of resources and lead to environmental degradation, while direct income support can provide a more stable and equitable form of support for farmers [51]. This shift can also help to reduce market distortions and improve the efficiency of resource allocation in the agricultural sector [52].

6.2 Investing in Research, Development, and Extension Services

Another important recommendation is to increase investment in agricultural research, development, and extension services [53]. These investments can help to develop more sustainable and resilient agricultural practices, improve crop yields and quality, and enhance the competitiveness of the agricultural sector [54]. Extension services can also play a crucial role in disseminating knowledge and technology to farmers, particularly small-scale farmers who may have limited access to information and resources [55].

6.3 Promoting Agri-environmental Schemes and Ecosystem Services

Policymakers should also promote agri-environmental schemes and ecosystem services to encourage more sustainable agricultural

Table 9. Policy recommendations for sustainable agricultural support

Policy recommendation	Key benefits
Direct income support	Reduced market distortions and improved equity [56]
Research and extension	Increased productivity and sustainability [57]
Agri-environmental schemes	Enhanced biodiversity and ecosystem services [58]
Market access and value chains	Improved farmer incomes and rural development [59]

Source: [56], [57], [58], [59]

practices [60]. These schemes can provide incentives for farmers to adopt practices such as conservation tillage, crop rotation, and integrated pest management, which can help to reduce environmental impacts and enhance biodiversity [61]. Ecosystem services, such as carbon sequestration and watershed protection, can also provide additional income streams for farmers while promoting environmental sustainability [62].

6.4 Enhancing Market Access and Value chain Development

Finally, policymakers should focus on enhancing market access and value chain development for farmers, particularly small-scale farmers in developing countries [63]. This can involve investments in infrastructure, such as roads and storage facilities, as well as support for farmer organizations and cooperatives [64]. Value chain development can also help to improve the quality and traceability of agricultural products, increase farmer incomes, and promote rural development [65].

7. CONCLUSION

This article has assessed the impact of agricultural subsidies on farm profitability and sustainability across the world, with a specific focus on Asia and India. The findings suggest that while subsidies have contributed to increased farm output and income in the short term, their long-term impact on profitability and sustainability remains questionable. In many cases, subsidies have led to overproduction, market distortions, and environmental degradation, undermining the overall sustainability of agricultural systems. To address these challenges, policymakers need to adopt a more targeted, efficient, and sustainable approach to agricultural support. This can involve a gradual shift from input subsidies to direct income support, increased investment in research and extension services, promotion of agri-environmental schemes and ecosystem services, and enhancement of market access and value chain development. By adopting these policy recommendations, countries can promote a more sustainable and resilient agricultural sector that supports farmer livelihoods, ensures food security, and contributes to broader economic and social development goals. However, implementing these reforms will require political will, stakeholder engagement, and a long-term commitment to sustainable agriculture.

As the world faces increasing challenges related to climate change, resource depletion, and population growth, it is crucial that we rethink our approach to agricultural support and prioritize sustainability alongside profitability. Only by adopting a holistic and integrated approach to agricultural policy can we ensure a secure and sustainable future for farmers, consumers, and the planet as a whole.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. FAO. The State of Food and Agriculture 2021: Making Agri-food systems more resilient to shocks and stresses. Food and Agriculture Organization of the United Nations; 2021.
   Available:https://doi.org/10.4060/cb4476en
2. OECD. Agricultural Policy Monitoring and Evaluation 2021. Organisation for Economic Co-operation and Development; 2021.
   Available:https://doi.org/10.1787/2d810e01-en
3. Amadeo K. Farm subsidies with pros, cons, and impact. The Balance; 2021.
   Available:https://www.thebalance.com/farm-subsidies-4173885

4. European Commission. The common agricultural policy at a glance; 2021. Available:https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/cap-glance_en
5. Searchinger T, Waite R, Hanson C, Ranganathan J, Dumas P. Creating a sustainable food future: A menu of solutions to feed nearly 10 Billion People by 2050. World Resources Institute; 2019. Available:https://www.wri.org/research/creating-sustainable-food-future
6. OECD. Agricultural support estimates; 2020. https://data.oecd.org/agrpolicy/agricultural-support.htm
7. FAO. Asia and the Pacific Regional Overview of Food Security and Nutrition 2018: Accelerating progress towards the SDGs. Food and Agriculture Organization of the United Nations; 2018. Available:https://doi.org/10.4060/CA0950EN
8. Huang J, Wang X, Rozelle S. The subsidization of farming households in China's agriculture. Food Policy. 2013; 41:124-132. Available:https://doi.org/10.1016/j.foodpol.2013.04.011
9. Gale F. Growth and Evolution in China's Agricultural Support Policies (Economic Research Report No. 153). U.S. Department of Agriculture, Economic Research Service; 2013. Available:https://www.ers.usda.gov/publications/pub-details/?pubid=45117
10. Wu Y, Xi X, Tang X, Luo D, Gu B, Lam SK, Vitousek PM, Chen D. Policy distortions, farm size, and the overuse of agricultural chemicals in China. Proceedings of the National Academy of Sciences. 2018;115(27):7010-7015. Available:https://doi.org/10.1073/pnas.1806645115
11. Guo J, Hu X, Gao L, Xie K, Ling N, Shen Q, Hu S, Guo S. The rice production practices of high yield and high nitrogen use efficiency in Jiangsu, China. Scientific Reports. 2017;7(1):2101. Available:https://doi.org/10.1038/s41598-017-02338-3
12. Gulati A, Narayanan S. The subsidy syndrome in Indian agriculture. Oxford University Press; 2003.
13. Chand R, Pandey LM. Fertilizer growth, imbalances and subsidies: Trends and implications (Policy Brief No. 35). National Centre for Agricultural Economics and Policy Research; 2008. Available:http://www.ncap.res.in/upload_files/policy_brief/pb35.pdf
14. Kishore A, Sharma B, Joshi PK. Putting agriculture on the take off trajectory: Nurturing the seeds of growth in Bihar, India. International Food Policy Research Institute; 2014. Available:https://www.ifpri.org/publication/putting-agriculture-takeoff-trajectory-nurturing-seeds-growth-bihar-india
15. Sharma VP. Dismantling fertilizer subsidies in India: Some issues and concerns for farm sector growth (Working Paper No. 2012-09-01). Indian Institute of Management Ahmedabad; 2012. Available:https://ideas.repec.org/p/iim/iimawp/11076.html
16. Fuglie K, Gautam M, Goyal A, Maloney WF. Harvesting prosperity: Technology and productivity growth in agriculture. World Bank Publications; 2020. Available:https://doi.org/10.1596/978-1-4648-1393-1
17. López R, Galinato GI. Should governments stop subsidies to private goods? Evidence from rural Latin America. Journal of Public Economics. 2007;91(5-6):1071-1094. Available:https://doi.org/10.1016/j.jpubeco.2006.10.004
18. Mamun A, Martin W, Tokgoz S. Reforming agricultural subsidies for improved environmental outcomes. IFPRI Discussion Paper 1891. International Food Policy Research Institute; 2019. Available:https://doi.org/10.2499/p15738coll2.133517
19. Glauber JW. Agricultural trade aid: Implications and consequences for US global trade relationships in the context of the world trade organization. American Enterprise Institute; 2018. Available:https://www.aei.org/research-products/report/agricultural-trade-aid-implications-and-consequences-for-us-global-trade-relationships-in-the-context-of-the-world-trade-organization/
20. Laborde D, Lallemant T, McDougal K, Smaller C, Fousseini T. Transforming agriculture in Africa and Asia: What are the policy priorities? International Institute for Sustainable Development and

International Food Policy Research Institute; 2019.
Available:https://www.iisd.org/publications/transforming-agriculture-africa-asia-what-are-policy-priorities

21. Huang J, Wang X, Zhi H, Huang Z, Rozelle S. Subsidies and distortions in China's agriculture: Evidence from producer-level data. Australian Journal of Agricultural and Resource Economics. 2011;55(1):53-71.
Available:https://doi.org/10.1111/j.1467-8489.2010.00527.x
22. Fan S, Gulati A, Thorat S. Investment, subsidies, and pro-poor growth in rural India. Agricultural Economics. 2008;39(2):163-170.
Available:https://doi.org/10.1111/j.1574-0862.2008.00328.x
23. Warr P, Yusuf AA. Fertilizer subsidies and food self-sufficiency in Indonesia. Agricultural Economics. 2014;45(5):571-588.
Available:https://doi.org/10.1111/agec.12107
24. Kirwan BE. The incidence of U.S. agricultural subsidies on farmland rental rates. Journal of Political Economy. 2009;117(1):138-164.
Available:https://doi.org/10.1086/598688
25. Rizov M, Pokrivcak J, Ciaian P. CAP subsidies and productivity of the EU farms. Journal of Agricultural Economics. 2013;64(3):537-557.
Available:https://doi.org/10.1111/1477-9552.12030
26. Fane G, Warr P. Agricultural protection in Indonesia. Bulletin of Indonesian Economic Studies. 2008;44(1):133-150.
Available:https://doi.org/10.1080/00074910802001587
27. Claassen R, Langpap C, Wu J. Impacts of federal crop insurance on land use and environmental quality. American Journal of Agricultural Economics. 2017;99(3):592-613.
Available:https://doi.org/10.1093/ajae/aaw075
28. European Court of Auditors. Biodiversity on farmland: CAP contribution has not halted the decline. Special Report 13/2020; 2020.
Available:https://www.eca.europa.eu/en/Pages/DocItem.aspx?did=53892
29. Zhang X, Davidson EA, Mauzerall DL, Searchinger TD, Dumas P, Shen Y. Managing nitrogen for sustainable development. Nature. 2015;528(7580):51-59.
Available:https://doi.org/10.1038/nature15743
30. Abrol YP, Adhya TK, Aneja VP, Raghuram N, Pathak H, Kulshrestha U, Sharma C, Singh B. (Eds.). The Indian Nitrogen Assessment: Sources of Reactive Nitrogen, Environmental and Climate Effects, Management Options, and Policies. Elsevier; 2017.
31. Garrett RD, Koh I, Lambin EF, le Polain de Waroux Y, Kastens JH, Brown JC. Intensification in agriculture-forest frontiers: Land use responses to development and conservation policies in Brazil. Global Environmental Change. 2018;53:233-243.
Available:https://doi.org/10.1016/j.gloenvcha.2018.09.011
32. Key N, Roberts MJ. Government payments and farm business survival. American Journal of Agricultural Economics. 2006;88(2):382-392.
Available:https://doi.org/10.1111/j.1467-8276.2006.00865.x
33. Matthews A. Greening agricultural payments in the EU's Common Agricultural Policy. Bio-Based and Applied Economics. 2013;2(1):1-27.
Available:https://doi.org/10.13128/BAE-12179
34. Yamashita K. The agricultural development of Japan: A case study of the impact of policies and programs (1945-2000). In Agricultural Development and Economic Transformation. Palgrave Macmillan, London. 2006;137-155.
Available:https://doi.org/10.1057/9780230502239_7
35. Gaiha R, Kulkarni V. Anthropometric failure and persistence of poverty in rural India. International Review of Applied Economics. 2005;19(2):179-197.
Available:https://doi.org/10.1080/02692170500031713
36. Helfand SM, De Rezende GC. The impact of sector-specific and economy-wide policy reforms on the agricultural sector in Brazil: 1980-98. Contemporary Economic Policy. 2004;22(2):194-212.

Available:https://doi.org/10.1093/cep/byh015

37. WCED. Our Common Future. World Commission on Environment and Development. Oxford University Press; 1987.
38. FAO. Transforming Food and Agriculture to Achieve the SDGs: 20 interconnected actions to guide decision-makers. Food and Agriculture Organization of the United Nations; 2018.
    Available:https://doi.org/10.4060/CA1647EN
39. Pe'er G, Lakner S, Müller R, Passoni G, Bontzorlos V, Clough D, Moreira F, Azam C, Berger J, Bezák P, Bonn A, Hansjürgens B, Hartmann L, Kleemann J, Lomba A, Sahrbacher A, Schindler S, Schleyer C, Schmidt J, Sirami C. Is the CAP Fit for purpose? An evidence-based fitness-check assessment. German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig; 2017.
    Available:https://www.idiv.de/fileadmin/content/iDiv_Files/Documents/peer_et_al_2017_cap_fitness_check_final_report.pdf
40. Alliance Environnement. Evaluation of the impact of the CAP on habitats, landscapes, biodiversity. European Commission, Directorate-General for Agriculture and Rural Development; 2019.
    Available:https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/evaluation-policy-measures/sustainability/impact-cap-habitats-landscapes-biodiversity_en
41. Henderson B. CopyRetryClaude's response was limited as it hit the maximum length allowed at this time. Claude does not have internet access. Links provided may not be accurate or up to date. BSTART AFTER Alliance Environnement. Evaluation of the impact of the CAP on habitats, landscapes, biodiversity. European Commission, Directorate-General for Agriculture and Rural Development; 2019.
    Available:https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/evaluation-policy-measures/sustainability/impact-cap-habitats-landscapes-biodiversity_en Edit
    Henderson B, Lankoski J. Evaluating the environmental impact of agricultural policies. OECD Food, Agriculture and Fisheries Papers, No. 130. OECD Publishing, Paris; 2019.
    Available:https://doi.org/10.1787/add0f27c-en
42. Angelsen A. Policies for reduced deforestation and their impact on agricultural production. Proceedings of the National Academy of Sciences. 2010;107(46):19639-19644.
    Available:https://doi.org/10.1073/pnas.0912014107
43. FAO, IFAD, UNICEF, WFP and WHO. The State of Food Security and Nutrition in the World 2020. Transforming food systems for affordable healthy diets. FAO; 2020.
    Available:https://doi.org/10.4060/ca9692en
44. Pingali PL. Green Revolution: Impacts, limits, and the path ahead. Proceedings of the National Academy of Sciences. 2012;109(31):12302-12308.
    Available:https://doi.org/10.1073/pnas.0912953109
45. Christiaensen L, Demery L, Kuhl J. The (evolving) role of agriculture in poverty reduction—An empirical perspective. Journal of Development Economics. 2011;96(2):239-254.
    Available:https://doi.org/10.1016/j.jdeveco.2010.10.006
46. Brooks J. Policy coherence and food security: The effects of OECD countries' agricultural policies. Food Policy. 2014;44:88-94.
    Available:https://doi.org/10.1016/j.foodpol.2013.10.006
47. Anríquez G, Stamoulis K. Rural development and poverty reduction: Is agriculture still the key? ESA Working Paper No. 07-02. FAO, Agricultural Development Economics Division; 2007.
    Available:http://www.fao.org/3/a-ah885e.pdf
48. Barrett CB, Maxwell DG. Food Aid after fifty years: Recasting its role. Routledge; 2005.
49. Winters LA, Martuscelli A. Trade liberalization and poverty: What have we learned in a decade? Annual Review of Resource Economics. 2014;6(1):493-512.
    Available:https://doi.org/10.1146/annurev-resource-110713-105054

50. Glauben T, Prehn S, Pies I, Will MG, Loy JP, Balmann A. Index of direct payments to farmers: Instrument of a sustainable agricultural policy? In Sustainable Agriculture. Springer. Cham. 2015;395-405.
Available:https://doi.org/10.1007/978-3-319-17813-4_23

51. OECD. Innovation, Agricultural Productivity and Sustainability in China. OECD Food and Agricultural Reviews. OECD Publishing, Paris; 2018.
Available:https://doi.org/10.1787/9789264085299-en

52. World Bank. Future of food: Shaping a climate-smart global food system. World Bank Group; 2015.

53. Beintema N, Stads GJ, Fuglie K, Heisey P. ASTI global assessment of agricultural R&D spending: Developing countries accelerate investment. International Food Policy Research Institute; 2012.
Available:https://www.asti.cgiar.org/publications/global-assessment-2012

54. Alston JM. Reflections on agricultural R&D, productivity, and the data constraint: Unfinished business, unsettled issues. American Journal of Agricultural Economics. 2018;100(2):392-413.
Available:https://doi.org/10.1093/ajae/aax094

55. Swanson BE, Rajalahti R. Strengthening agricultural extension and advisory systems: Procedures for assessing, transforming, and evaluating extension systems. Agriculture and Rural Development Discussion Paper 45. World Bank; 2010.
Available:https://openknowledge.worldbank.org/handle/10986/23993

56. Tangermann S. Direct Payments in the CAP post 2013. European Parliament, Directorate General for Internal Policies, Policy Department B; 2011.
Available:https://www.europarl.europa.eu/thinktank/en/document/IPOL-AGRI_NT(2011)438624

57. Pardey PG, Alston JM, Ruttan VW. The economics of innovation and technical change in agriculture. In handbook of the economics of innovation. North-Holland. 2010;2:939-984.
Available:https://doi.org/10.1016/S0169-7218(10)02006-X

58. Burton RJ, Schwarz G. Result-oriented agri-environmental schemes in Europe and their potential for promoting behavioural change. Land Use Policy. 2013;30(1):628-641.
Available:https://doi.org/10.1016/j.landusepol.2012.05.002

59. Gabre-Madhin EZ, Haggblade S. Successes in African agriculture: Results of an expert survey. World Development. Copy Retry Claude does not have internet access. Links provided may not be accurate or up to date. Claude can make mistakes. Please double-check responses. 3 Opu. 2004;32(5):745-766.
Available:https://doi.org/10.1016/j.worlddev.2003.11.004

60. Engel S, Pagiola S, Wunder S. Designing payments for environmental services in theory and practice: An overview of the issues. Ecological Economics. 2008; 65(4):663-674.
Available:https://doi.org/10.1016/j.ecolecon.2008.03.011

61. Baylis K, Peplow S, Rausser G, Simon L. Agri-environmental policies in the EU and United States: A comparison. Ecological Economics. 2008;65(4):753-764.
Available:https://doi.org/10.1016/j.ecolecon.2007.07.034

62. Power AG. Ecosystem services and agriculture: Tradeoffs and synergies. Philosophical Transactions of the Royal Society B: Biological Sciences. 2010;365(1554):2959-2971.
Available:https://doi.org/10.1098/rstb.2010.0143

63. Swinnen J, Kuijpers R. Value chain innovations for technology transfer in developing and emerging economies: Conceptual issues, typology, and policy implications. Food Policy. 2019;83:298-309.
Available:https://doi.org/10.1016/j.foodpol.2017.07.013

64. Barrett CB, Bachke ME, Bellemare MF, Michelson HC, Narayanan S, Walker TF. Smallholder participation in contract farming: Comparative evidence from five countries. World Development. 2012; 40(4):715-730.
Available:https://doi.org/10.1016/j.worlddev.2011.09.006

65. Reardon T, Barrett CB, Berdegué JA, Swinnen JF. Agrifood industry transformation and small farmers in developing countries. World Development. 2009;37(11):1717-1727. Available:https://doi.org/10.1016/j.worlddev.2008.08.023

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/120362