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Emerging new global soil governance structure in agrifood systems: Taking the "4 per 1,000" initiative as an example

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Food systems emit 21%-37% of the global greenhouse gases (GHGs). Soil degradation, accelerated by global warming, poses a threat to over 40% of the land surfaces, threatening food security. Keeping soils alive and healthy could not only play a part in food security, but also in sequestrating GHGs for climate mitigation. In 2015, the "4 per 1,000" Initiative was launched in Paris COP21, indicating that a "4‰" annual growth rate of the soil organic carbon sequestration could hold the temperature increase within 1.5°C–2°C. However, major GHG emitting countries haven't signed the 4‰ Initiative at national level. Political willingness need to be encouraged though institutional innovations in the global soil governance (GSG). This article conducts a comprehensive policy review for the 4‰ Initiative and attempts to develop the concept of global soil governance from an aspect of New Common But Differentiated Responsibility. The SOC sink targets reveal that countries like China, India, the UK, the US, and France take more pains than those like Australia, Russia, and Canada. A new "soil carbon rich" and "soil carbon poor" divide is perceived, which needs to be taken into the GSG as a restructuring motivation for setting a more practical and integrated framework. In that sense, some developed countries face similar challenges as the developing countries do, but could contribute more in finance and technology. Bandwagon of applying sustainable agricultural land management (SALM) methodology in carbon markets implies that soil-climate co-benefits get greater practical momentum with quantified trading platforms, which may stimulate potentiality if embodied in Article 6 of *the Paris Agreement*.

KEYWORDS

the "4 per 1,000" initiative, agrifood systems, soil organic carbon (SOC) sink, global soil governance (GSG), New Common But Differentiated Responsibility (NCBDR)

1. "4 per 1,000": An initiative to mitigate warming by increasing soil organic carbon

Agrifood system is not only the carbon source of greenhouse gas (GHG) emission, but the carbon sink through afforestation, biomass energy and soil carbon sequestration. According to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) of the United Nations Framework Convention on Climate Change

(UNFCCC), agricultural GHG emissions are the third largest carbon source after energy and transportation. However, due to the carbon sink[1] of agriculture, the low-carbon contribution it could make on GHG emission reduction is second only to new energy industries (Arias et al., 2021).

About 21–37% of GHG emissions comes from agricultural food systems, mainly from farmland crops and livestock activities (about 9–14%), land use changes (including deforestation and degradation, accounting for about 5–14%) and food supply chain (including harvesting, storage, transportation, processing and production about 5–10%). If human beings don't intervene in GHGs emitted by agrifood systems, by 2050, their emissions will account for 30–40% of the total global emissions. If we can reduce emissions from the supply side of agrifood system, capture carbon through soil carbon fixation and biomass, and build a sustainable farming system, by 2050, the global GHG emissions will be reduced by 2.3–9.6 billion tons of carbon dioxide equivalent (tCO_2e) annually. By adopting a healthy and nutritious diet, the global annual emission reduction can reach 7–8 billion tCO_2e (Mbow et al., 2019). It has been found that about 20% of the CO_2 released from the biosphere into the atmosphere mainly flows to the carbon sink of terrestrial ecosystem, which is contained in the two carbon pools of vegetation and soil (Fang and Guo, 2007). Soil organic carbon (SOC) sequestration and sink enhancement could enable a buffer period of 10–20 years for the goal of "carbon neutrality" (Wang and Wang, 2021).

On the occasion of signing the *Paris Agreement* by COP21 of the United Nations Framework Convention on Climate Change (UNFCCC) in 2015, the French Ministry of Agriculture issued "4 per 1,000 initiative: Soils for food security and climate" in the *Lima Paris Agenda for Action (LPAA)*. It indicates that if the global 2-meter-deep soil contains 2,400 billion tones of organic carbon, then 4‰ more carbon will be reserved from the air annually, for the GHG emission from fossil carbon represent 8.9 billion tons of carbon each year (Agence de l'Environnement et de la Maitrise de l'Energe (Ademe), 2015). If the soil carbon storage in the depth of 30–40 cm can be increased by 4‰ annually, the atmospheric CO_2 concentration related to human activities, can be significantly reduced (Ministry of France, 2022a). The plan aims to increase soil carbon sink through participants' actions, so as to develop sustainable climate-friendly agriculture and achieve win-win goals of climate mitigation and soil quality improvement. At present, 38 governments and over 600 international actors have signed this plan, including 24 high-income economies and 16 developing countries (see Table 1) (Ministry of France, 2022b). However, main GHG emitters, including China, the US, and India haven't signed at national level.

1 Carbon sinks indicate area or ecosystem that absorbs more CO_2 than it releases. Carbon sources refer to process, area, or ecosystem that releases more carbon dioxide than it absorbs. See National Geographic Society, "Carbon Sources and Sinks," https://education.nationalgeographic.org/resource/carbon-sources-and-sinks (accessed on October 11, 2022).

2. Why not comply? Challenges for global soil governance and ways ahead

SOC stock refers to the total carbon storage in the system, including ground and underground biomass, litter, dead wood and soil organic matter (Zhu and Zhang, 2016). With the increasingly urgent requirements of climate governance and food security, SOC sequestration is very likely to become a key solution to mitigate carbon source and to enhance sustainability of agricultural farming. However, there are still gaps to be filled to promote the "4 per 1,000" Initiative into a really global soil governance (GSG) mechanism.

First, the international legal system is "soft" in binding power. As a global response to the devastating famines took place in the developing countries, like China between 1959 and 1961 (Meng et al., 2015) and East Bengal in 1971 (Singer, 1972) arising from both natural and institutional causes (Kung and Lin, 2003), the First World Food Conference in 1974 held by the United Nations Food and Agriculture Organization (FAO) reached consensus on a World Soil Charter in 1981, for optimal use of the soil resources of the world (FAO, 1982; UN FAO, 2015a). It was revised in June 2015 with respect to new issues like soil pollution and urban sprawl impacts on soil availability and functions (UN FAO, 2015b). Based on the survey of SOC stock estimates and sequestration potentials from 20 regions in the world (New Zealand, Chile, South Africa, Australia, Tanzania, Indonesia, Kenya, Nigeria, India, China Taiwan, South Korea, China Mainland, United States of America, France, Canada, Belgium, England and Wales, Ireland, Scotland, and Russia), it's found that under best management practices, such as collaboration and communication between scientists, farmers, policy makers, and marketeers, the aim of 4 per 1,000 or even higher sequestration rates (up to 10 per 1,000) can be accomplished (Minasny et al., 2017). However, among the 195 nation states members of FAO, political willingness is yet to be explored. By analyzing rules and other measures adopted at the international governance level, Bodle (2022) found that sovereign nation states are not playing as practical roles as the addressees, so as to fulfill obligation or commitment. The cropping farmers are still key actors. For them, disruptive technologies, collaboration and communication among scientists and marketeers are more needed (Minasny et al., 2017).

Second, mass reaction on soil carbon sequestration knowledge needs to be mobilized. As for the administrative measures, co-benefits between soil governance and other fields of the SDGs, such as air, climate, biodiversity, water and pollutants (Bodle, 2022), are yet to be valued and recorded. Discussion has been carried out to fully utilize 9 SDGs among the 17 as a New Instrument for Global Action Against Soil Degradation (Ehlers, 2017). Based on the key strategic framework implementation practices in Germany for achieving the SDGs, Wunder and Bodle suggest making "land degradation neutrality (LDN)"—target 15.3 of the SDGs—a guiding element for national planning, with indicators, steps, and soil quality values, using land use categories as a possible proxy indicator to differentiate likely impacts on soil (Wunder and Bodle, 2019). Though increased SOC storage could improve cereal productivity and farmers' income (Pan and Smith, 2009), which could sustain for generations with SOC additions,

TABLE 1 State and international organization parties signing the "4 per 1,000" initiative.

State actors	
High-income economies* (above $13,205)	Australia, Canada, Chile, Croatia, Estonia, Finland, France, Germany, Hungary, Ireland, Japan, Latvia, Lithuania, Netherlands, New Zealand, Norway, Poland, Portugal, Slovenia, Spain, Sweden, United Kingdom, Uruguay
Upper-middle-income economies ($4,256–$13,205)	Argentina, Bulgaria, Costa Rica, Mexico
Lower-middle income economies ($1,086–$4,255)	Cambodia, Iran, Côte d'Ivoire, Lebanon, Morocco, Philippines, Senegal, Nigeria, Tunisia, Ukraine, Vietnam
Low-income economies (below $1,085)	Ethiopia
International organizations and multilateral financial institutions	
Multilateral financial institutions	French Development Agency (AFD)
	Asian Development Bank (ADB)
	World Bank (WB)
	German International Cooperation Agency (GIZ)
International organizations	**Organizations under the United Nations**
	(1) United Nations Food and Agriculture Organization (UN FAO)
	(2) United Nations Convention to Combat Desertification (UNCCD)
	Sector-specific organizations
	(3) Consultative Organization for International Agricultural Research (CGIAR)
	(4) International Rice Research Institute (IRRI)
	(5) Global Environment Facility (GEF)
	(6) Global Green Growth Institute (GGGI)
	(7) Global Research Alliance (GRA)
	(8) Global Water Partnership (GWP)
	(9) International Agroforestry Research Center (ICRAF)
	(10) International Office of Vine and Wine (OIV)
	Regional organizations
	(11) New Partnership for Africa's Development (NEPAD)
	(12) Asian Local Government of Organic Agriculture (ALGOA)
	(13) West African Economic Community (CEDEAO)
	(14) International Research Center for Advanced Agriculture in the Mediterranean (CIHEAM)

Source: Ministry of France getting involved with the "4 per 1,000" initiative [EB/OL].2021.12. https://4p1000.org/understand (accessed January 13, 2022).
*Classification of countries is based on: The World Bank Group, World Bank Country and Lending Groups. https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups.

fertility benefits and technical feasibility (Lord and Sakrabani, 2019), they remain largely unquantified. Scientific data and access, spatially-explicit modeling, and large-scale experimentation are required for decision-making on real benefits trade-offs (Chabbi et al., 2017). As for the incentive mechanisms, financial support is insufficient. Experts from the developing countries have expressed worries that inappropriate goals-setting might create weaker national image or cause higher costs (Cheng and Pan, 2016).

Third, GSG needs recognition from both the Global North and South. Though high-quality soil is an essential factor for food production, water management and environmental protection, GSG is given neither the focus it deserves nor the coherent and holistic approach it requires. Rumpel, Lehmann, and Chabbi expressed their concern in *Nature* that it was not right that the "4 per 1,000" Initiative was even not formally discussed at the Bonn COP23 meeting in 2017, appealing both public and private stakeholders to cooperate to recognized the great value of soil as natural capital (Rumpel et al., 2018). Lago, Plant, and Jacobs, by analyzing how "soil security" and related concepts might operate in jurisdictional agenda setting of New South Wales (NSW), Australia, expressed views on the necessity of re-politicizing soils into the global agenda, emphasizing that social science insights about framing and agenda setting, with a more explicitly articulated and implemented trans-disciplinary approach, could be a starting point (Lago et al., 2019). Existing structures have produced only a patchwork set of governance and instruments, for governments are inclined to see land and soil as issues of sovereignty, and are reluctant to consider soil health and productivity as matters requiring international solutions, for which they should pay "for others" (Töpfer Müller Gaßner GmbH

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(TMG), 2021). Transformations of GSG in the agrifood systems could only be possible when a comprehensive performance-based system with integrated policies addressing soil-related issues is constructed (TMG, 2021). Indigenous knowledge is also needed to attract more actors, both in tropical and temperate climate zones, academically and practically, of various soil types and production systems. Farming capabilities needs to be built to serve the interests of both the North and South through common objective to increase SOC contents, and benefit through the consumer supply chains (Chabbi et al., 2017).

As Joseph Nye pointed out, global governance is featured by "regime complex" between deeply integrated mechanisms and fragmented clusters, nation states are still core entities in complying international laws as the binding global institutions (Nye, 2014). National approval is considered as the first gate keeper of the international norms to be diffused locally. Though the "4 per 1,000" Initiative are open to non-state actors, national consensus is crucial for the holistic transformation taking local soil issues into the general picture of SDGs. Therefore, there still need to be more institutional innovation to enable nations to optimize the GSG as a global public good.

3. Potential inner motivation of major emitters in GSG

It has been found that the geographical location defined by latitude is positively related with 30 cm SOC stock level of 20 representative regions in the world. Tropical zones have less SOC stock than temperate zones, and temperate zones have less SOC stock than the frigid zones (Minasny et al., 2017). This finding somewhat conforms with Willy Brandt's visual depiction of the North-South divide based on GDP per capita in the 1980s. The latitude of 30°N called "the Brandt Equation" passes between North and Central America, north of Africa and India, with Australia and New Zealand in the Northern side (Quilligan, 2002). The North-South division aimed to set out a comprehensive strategy for food, aid, environment, trade, etc., so as to guide global negotiations to implement those objectives. There established a North-South Commission, or the Brandt Commission, which invested US$1.1 million as financial support (Centre for Global Negotiations, 2010).

According to the Global Soil SOC Stocks map and Table 2, it could be observed that by taking into the soil-related elements, the North-South divide is narrowing. The US, and some European countries, such as the UK and France, are also faced with challenges to achieve the SOC sequestration goal under the global protocol (Minasny et al., 2017). By dividing the annual national SOC stock by annual national fossil fuel emission, we could find that how much gap a country needs to fill, to achieve the sequestration target set in the "4 per 1,000" Initiative. By comparing these targets with the "4 per 1,000" Initiative target of "0.4%," with 24,000 giga tons of 2-m SOC stock to absorb 8.9 giga tons of GHG emitted annually in 2015, there will be a ratio (see Table 2, Figure 1), showing how hard it is for the country to achieve the sequestrating goal.

The SOC stock and fossil fuel emission data from 2013 to 2021 is referred to see the changes the relative position of countries in the "4 per 1,000" Initiative arena. Figure 1 shows the landscape with soil carbon sink target as the y-axis, GDP per capita as the x-axis,

TABLE 2 Soil carbon sequestration target gap among relevant countries (2013–2021) (Cheng and Pan, 2016; Tang et al., 2019; The World Bank Group, 2022a,b,c,d).

Country	Centroid latitude	Annual 0–2 m SOC stock (100 mts)	Annual fossil fuel emission (100 mts)	Soil carbon sequestration target (%)	GDP/capita (US$10,000)	Agriculture, forestry, and fishing, value added (% of GDP)	Arable land/capita (ha)
China	36.591	900	26.12–100.1	2.9–11.1	0.88–1.26	7.3	0.08
India	22.932	225–240	6.53–24.3	2.7–10.8	0.14–0.23	16.8	0.11
UK	53.163	52–57.24	1.3–3.87	2.5–6.8	4.37–4.73	0.6	0.09
US	45.625	650	15.05–52.1	2.3–8	5.33–6.93	1.1	0.48
France	46.531	69–69.1	1.01–3.37	1.5–4.9	4.26–4.35	1.6	0.27
Global average		126.98	0.47–1.91	0.4–1.5	1.08–1.23	3.9–4.3	0.19–0.18
Australia	−25.848	490	1.09–4.14	0.2–0.9	6.82–5.99	2.3	1.19
Russia	61.699	2920	4.43–16.5	0.2–0.6	1.6–1.22	4.3	0.84
Canada	62.5	550–2,623	1.52–5.72	0.1–1	5.26–5.21	1.7	1.01
Global total		15,000–24,000	89–361	-	-	-	-

Note: The global average data is calculated on the basis of 189 member states of the World Bank.

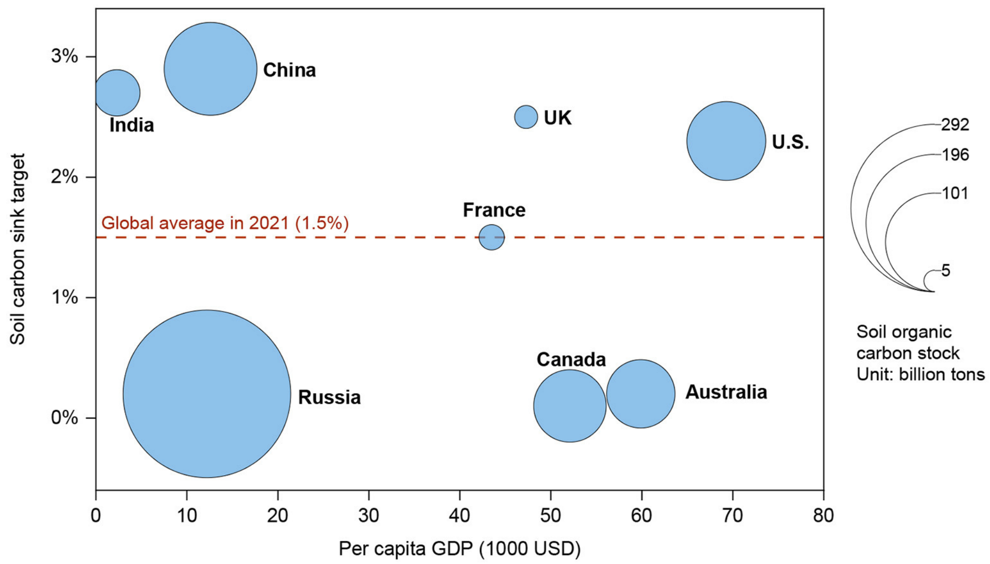

FIGURE 1
Relative position of nation states in the "4 per 1,000" initiative landscape (2021). Source: Drawn by authors on the basis of data in Table 2.

and the size of current SOC stock represented by the areas of blue circles. It could be seen that in the past 8 years of GSG, nation states ranking structure of emerging in 2013 is relatively stable. A new "soil carbon poor" and "soil carbon rich" divide could be perceived within this coordinate.

Based on the global SOC data collected from relevant literature, it could be seen that countries like China, India, the United Kingdom, the United States, Belgium, Indonesia, South Korea, South Africa, and Nigeria, take more pains than countries like Australia, Russia, Canada, New Zealand, Tanzania, Chile, and Kenya (Stockmann et al., 2015; Cheng and Pan, 2016). France was in the upper half in 2013, but have been optimized and become congruent with the global average target in 2021. Some formerly Global North members are now in the "soil carbon poor" side, altering the structure of GSG with different perspectives. The three major GHG emitting countries' SOC policies and practices are analyzed in the following part to discuss potentialities in the newly emerging structure of GSG.

3.1. China

China has been the most populous country with the least arable land per capita, and has been low and making slow progress in its SOC sequestration rate. In the 1980s, the 20 cm SOC of China was only 26.6–32.5 tC/ha (Song et al., 2005; Qin et al., 2013), while the average SOC value in the US and Europe at the same period had been 43.7 tC/ha (Guo et al., 2006) and 40.2 tC/ha (Smith et al., 2000). With the agricultural management level increasing, there have been great progress made in crops yield productivity and straw returning to field. In 1999, China issued "Ban on Straw Burning and Regulations on Comprehensive Straw Utilization" and the rate of straw return raised from 25% to 39.7% in 2010, and the 20 cm SOC of cropland increased to 32.34–33.47 tC/ha, when the European countries' average level was 46.8 tC/ha (Zhao et al., 2018). Since 2005, China invested 8 billion RMB yuan to implement the "Formula Fertilization by Soil Testing" Project for 200 million farmers and about 1.5 billion *mu* of farms, increasing the utilization rate of fertilizer by 5%, reducing 10 million tons of fertilizer and over 25 million tCO_2e, while achieving higher crop yield by 6%−10% (Lord and Sakrabani, 2019; Tang et al., 2019; Cheng and Pan, 2021; The World Bank Group, 2022,a,b,c,d). Appropriate agricultural technologies have been found useful in lifting SOC sink, such as hybrid usage of organic and inorganic fertilizer, thermal decomposition of biomass, crop rotation, and appropriate irrigation, for which there have been best practices selected by UN Environment Programme (UNEP) (Cao et al., 2016). The "Two Mountains (*shan*) Theory" advocating that lucid waters and lush mountains are invaluable assets just like gold and silver mountains, proposed by President Xi Jinping in 2017 further promoted "Five Green Agriculture Actions," including livestock and poultry manure utilization, replacement of chemical into organic fertilizers for fruits, vegetables and tea, straw treatment in Northeast China, plastic film recycling, and aquatic organism protection of the Yangtze River. With field practices improved, collaborative scientific research increased dramatically (Liu et al., 2021).

Chinese Academy of Agricultural Sciences (CAAS) has joined the "4 per 1,000" Initiative, which has been a signal to show that China has been making great efforts domestically to conform with the protocol aims. In 2020, China issued "Action Plan for Conservation Tillage[2] of Black Land in Northeast China (2020–2025)," agricultural production of corn, soybeans, wheat, etc., is encouraged to apply and disseminate non-tillage in provinces

2 "Conservation tillage" is a modern farming technology system with crop straw mulching, no (less) tillage and sowing as main contents, which can effectively reduce soil wind erosion and water erosion, increase soil fertility, preserve soil moisture and drought resistance, and improve agricultural ecology and economic benefits.

of Liaoning, Jilin, Heilongjiang, and cities of Chifeng, Tongliao, Xing'an League and northeast Hulunbeier, aiming to achieve 140 million *mu* of it by 2025, accounting for about 70% of the total cultivated land in Northeast China (Ministry of Agriculture Rural Affairs Ministry of Finance, 2020). In 2022, the first SOC sequestration project in China was landed in Chunhua, Jiangning, Jiangsu Province, led by China Academy of Science (CAS), for which Jiangsu Provincial Government funded 20 million RMB yuan to absorb 10% of the fossil fuel emission between the year 2030 and 2060 (Wang, 2022). Although the SOC of farmland in China has been increasing for nearly 30 years, there is still great need for finance, technology dissemination, and collaborative research with both the developed and developing countries.

3.2. The US

Most soil carbon loss through land use in the US took place in the 19th and early 20th centuries. Now, efforts are focused on how existing stocks could conquer the global warming, increasing nitrogen deposition, and improve soil management (Guo et al., 2006).

Agriculture emits 142 Mt C from all sources in the US, mainly as CH_4 and N_2O, principally from livestock and soil nutrient management (USEPA, 2015). In the past three decades, the 20–30 cm SOC of the US was about 25.5–78 tC/ha (Minasny et al., 2017). Advanced datasets for soil observation and analysis has been built in the US, most of which are transformed to that of the NLCD using the ARC/INFO software (Environmental Systems Research Institute, 1999). At present, the US has not signed the "4 per 1,000" Initiative, but there are 82 US non-state actors involved, including two local governments or ministries, Barrington in Illinois and California Food and Agriculture Department (Kung and Lin, 2003). The US Senate is the main obstacle in approving the US President to sign international agreements, just like its withdrawal from *the Kyoto Protocol* and *the Paris Agreement* (Li and Liu, 2020). The US has been the pioneer in global carbon emission trading system design and establishment, however, with the pressure of the European Union, *the Kyoto Protocol* set a 50% ceiling for developed countries in Annex I to make actual efforts to reduce CO_2 emissions, instead of resort to carbon emission reduction credits trading (Pring, 2001). The principle of "additionality" in forestry carbon sink indicated that the vast forests in rural areas of the US could not play their roles in fulfilling the US carbon neutrality commitment (Soroos, 2004). In 2020, the standing stock of forests in the US was about 4.13 billion cubic meters, which was about 1.7 times that of the 27 countries in the European Union (FAO, 2020). However, the 50% limit dampened the enthusiasm of the US, and it was one of the main reasons for the US withdrawal from *the Kyoto Protocol* in 2001.

Based on the situation that the US has been initiating and promoting carbon trading mechanism under the *Kyoto Protocol*, it is possible that the US, as a "soil-carbon-poor" country in Table 2, is faced with challenges in achieving the goals in "4 per 1,000" Initiative. To remove the 50% limit of carbon trading under the Article 6 of Paris Agreement might be an incentive to stimulate inner motivations of developing countries to play a more important role in the global climate and soil governance arena.

3.3. India

As the biggest developing country in South Asia, India has been one of economies with the fastest growth rate and the 2nd largest population of 1.393 billion in the world. With about half of its population living in rural areas, India has been making great progress in reducing its share of extreme poverty from 10.98% in 1977 to 0.24% in 2021, according to the international poverty line of $1 per day (Our World In Data, 2022). For India, sustaining the economic growth rate and poverty reduction performance are priorities for this developmental state.

In July, 2022, the core agricultural project in West Bengal, India, submitted an application for verification of soil carbon sequestration and sink enhancement to VERRA, the world's largest voluntary carbon trading mechanism headquartered in Washington D.C. West Bengal Organic Planting Cooperative plans to improve SOC in 42,343 hectares of farmland through conservation tillage, crop covering, crop rotation improvement, agroforestry management, etc., will be utilized to reduce GHG emissions, especially CO_2, methane and nitrous oxide. The World Bank developed Sustainable Agricultural Land Management (SALM, VM0017) methodology, so that the SOC sink could be priced and exchanged in carbon markets by voluntary carbon trading (VCS) (VERRA, 2011). In the West Bengal case, it is estimated that GHG emission will be reduced by 308,918 tCO_2e annually, and the project will totally reduce the GHG emissions by 12,356,704 tCO2e in the planting cooperative's 40-year life cycle. If the project is approved, it might be priced at $\$10/tCO_2e$ for trading, and will generate about $3 million in carbon sequestration revenue every year will play a positive role in improving farmers' income, improving soil and slowing down climate change.

Indian annual 30 cm SOC sink is about 9.55 Gt, and its 1-meter SOC stock is about 24 Gt. According to the ratio of the target of SOC sequestration to global average goal, India (6.53) is between the US (5.17) and China (7.18) (Minasny et al., 2017). If SALM methodology could help further reduce poverty and bring prosperity, soil governance issue will be likely to be taken into the national agenda priorities.

4. Discussion

Agriculture-climate nexus is crucial for the UN in systematic reformation, narrowing North-South divide. The idea of "soil-carbon" North-South divide with New CBDR emphasizing "soil-carbon" capacity building, green development cooperation, and South-South and Triangular cooperation will be more inclusive and issue-specific. Introducing carbon trading mechanism into "4 per 1,000" Initiative, may serve as a pilot trial for integrating *the World Soil Charter* under Article 6, exploring potentiality of using carbon trading mechanism as a quantifiable platform to gain binding power for GSG. It also abides by the newly advocated systematic perception on SDGs of food, nutrition, climate, health, etc., to save the SDG 2 of "zero hunger," which is hard to be achieved by 2030 (Caprile, 2021).

New CBDR will benefit the world by closing the gap between the Global South and North. Though China, the US, and India didn't sign the "4 per 1,000" Initiative at the national level, domestic policy and research progress have been made. For traditional agricultural countries, such as China and India, finance, manpower, technology, and knowledge sharing are in great need to manage the soil nutrient for smallholder farmers in tropical, temperate, and frigid climate zones. For modern agricultural countries, like the US, concerns are concentrated on whether their institutional advantages, like the financial derivative innovation of carbon markets, could be transformed into global norm for great international influence, providing buffer zones for domestic industrial reshuffling. Besides, the developed countries may also face difficulty in achieving SOC sequestration targets. Therefore, the new "soil-carbon" North-South divide may focus on specific problem-solving (Xiu et al., 2015). It's focuses on low-political issues, but the epistemic communities based on specific technology expert will increase more solidarity, which will bring multiple stakeholders into a peer-learning dynamic in a natural manner. "Soil Funds" and "Green Agricultural Technology Demonstration Stations" could be established in North-South and South-South "paired assistance" models, so as to achieve food security and climate mitigation aims through SOC sequestration action being connected with carbon markets in a "co-benefit" manner.

SALM enables the process toward the systematic reformation goal, which can link local SOC sink with carbon trading mechanism. For example, an organic agricultural enterprise Zhenggu (Beijing) Agricultural Development Ltd. Co., established in 2007, has established standard organic farms of over 30 producing areas in over 10 countries, cooperating with UNEP, World Wildlife Fund (WWF), International Federation of Organic Agriculture Movement (IFOAM) and others, providing organic foods such as Danish cheese, Greek olive oil, Colombian rose coffee, etc., to the global market. At the same time, it offsets carbon emission by investing in renewable energies in Sandaoqing Wind Power Project in Chuxiong Prefecture (Zhenggu, 2021). Later, they will also apply methodologies of soil nutrition, no fertilizer application, adoption of Forest Management Committee (FSC) paper,[3] utilization of soybean ink, etc. Such carbon neutral products manufacturing could also be found in South-South cooperation like China-Brazil agricultural trade, mainly from Mato Grosso State in Brazil (Brazilian Agricultural Research Corporation, 2016), facilitated by Beijing-based local NGO of Global Environmental Institute (GEI) (Yan, 2022).

5. Conclusion

For a long time, small farmers have been the main body in the cultivation and maintenance of land. With the development of urbanization, the "hollowing out" of villages is serious. The profound wisdom in SOC sink contains the idea of harmonious symbiosis and mutual benefits between urban and rural areas, and among various species. The agricultural practices of "Maize with soybeans, nine years of harvests" (Zhu et al., 1995), or the Cooperative-Dominated Conservation Tillage "Lishu Model" (Liao et al., 2022), or the biodiversity management mode of organic agriculture of Jiang Gaoming Research Team, CAS (Jiang, 2021), or the "Little Donkey" Citizen Farm in Sujiatuo of Beijing (Yan and Wen, 2022), are all practices the Global South has carried out, promoting "new farmers" to make contributions to green agriculture (Wen, 2016). Agriculture can play a more and more key role in the process of realizing the SDGs, achieving co-benefits among soil, carbon, climate, nutrition, through collaborative innovative mechanisms to tackle sustainability challenges.

To integrate those collaboration potentiality into the "4 per 1,000" Initiative, there need to be a new perspective observing the "soil carbon rich" and "soil carbon poor" nations states scenarios. It should be pointed out that this observation may present a "soil-specific" North-South divide to us, in which some developed countries in the Global North might be in the "soil carbon poor" side, while some in the Global South might be in the "soil carbon rich" side. For developing countries, like China and India, which are also "soil carbon poor" countries, they are still making unremitting efforts to achieve the aims of sustainable agriculture and food security, for their large population on scarce soil. Therefore, funding, technologies, soil carbon trading mechanisms and platforms are urgently needed to provide incentives and build capacities for their active participation. For developed countries, like the US and the UK, which are also categorized into the "soil carbon poor" side, for their soil carbon sink targets are also challenging, comparing with the global average level. Thus, a New Common but Differentiated Responsibilities (New CBDR) principle is proposed to appeal for reconciliation for a broader view of carbon trading system, based on Article 6 of the *Paris Agreement*, to be included to promote SOC sequestration. Transnational and cross-sector collaborative research on SOC sequestration need to be funded, new land management methodologies need to be explored, and more public supports from the UN system through South-South and Triangular Cooperation (SSTrC) need to be encouraged, so as to fill the gap between the new North-South divide, making full use of agricultural carbon sink for sustainability goals possible again.

Author contributions

LL has proposed the theme and research question and providing general editing for the paper. XS has been searching the data and information for the 4 per 1,000 Initiative signing parties and calculation and ranking of representative national data. YL has provided the India voluntary carbon trading proposal case to incorporate sustainable agricultural land management (SALM, VM0017) into VERRA carbon markets. LC has been providing guidance for the paper adjustments and agrifood system analysis focuses. All authors contributed to the article and approved the submitted version.

3 FSC paper refers to paper made from forest resources that are regulated by the Forest Stewardship Council, legal and allowed to be cut, and contribute to sustainable development.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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