For review article

Response to Reviewer 2 Comments

1. Summary

Thank you very much for your time and effort in reviewing our manuscript. We greatly appreciate your insightful comments and suggestions. We have carefully considered each of your points and have made the corresponding revisions, which are highlighted in the re-submitted files. Please find our detailed responses below.

Thank you once again for your valuable feedback.

2. Questions for General Evaluation	**Reviewer's Evaluation**	**Response and Revisions**
Does the introduction provide sufficient background and include all relevant references?		*[Please give your response if necessary. Or you can also give your corresponding response in the point-by-point response letter. The same as below]*
Is the research design appropriate?		
Are the methods adequately described?		
Are the results clearly presented?		
Are the conclusions supported by the results?		

3. Point-by-point response to Comments and Suggestions for Authors

Comments 1: In the abstract, it should be stated that Deep Vertical Rotary Tillage in soil properties, crop growth characteristics, water use efficiency, and crop yields have had an impact.

Response 1: Thank you for pointing this out. We agree with your suggestion. As a result, we have rewritten the abstract accordingly. Below is the revised version:

Soil tillage methods are crucial to contemporary sustainable agriculture, playing a vital role in enhancing soil quality, increasing crop yields, and maintaining ecological balance. As global food security faces increasing threats and arable land continues to diminish, innovative tillage techniques like Deep Vertical Rotary Tillage (DVRT) have become increasingly important for improving soil health and ensuring a stable food supply. To enhance soil structure, nutrient availability, and microbial diversity, further exploration of advanced tillage

technologies is imperative. This paper aims to review the concept and benefits of DVRT, highlighting its key role in promoting soil health and enhancing agricultural sustainability. It systematically summarizes how DVRT improves soil properties, promotes crop growth and development (including root systems and photosynthesis), increases water use efficiency, and boosts crop yields. The paper emphasizes the necessity of future research aimed at optimizing tillage methods with a focus on improving soil quality. The objective is to provide comprehensive guidance for incorporating advanced tillage techniques into soil quality improvement strategies, thereby promoting sustainable agriculture and ensuring food security.

Comments 2: In lines 54-57, there is no reference support.

Response 2: Thank you for pointing this out. We agree with your suggestion and have accordingly added relevant references to support the content in the appropriate sections.

Comments 3: In the third paragraph of Introduction, the author only emphasized the influence of Deep Vertical Rotary Tillage on soil water, without other content mentioned in this paper.

Response 3: Thank you for pointing this out. We agree with your suggestion and have revised the entire section accordingly. Below is the specific content of the modifications:

In recent years, the intensification of global warming has exacerbated the uneven temporal and spatial distribution of rainfall, while extreme weather events, including typhoons, torrential rains, and unprecedented heatwaves, have surged in frequency. [20,21]. These climate alterations have directly impaired crop productivity, heightened the climate sensitivity of crops, diminished their resilience, and consequently impacted overall grain yields (Fig. 2). Among these, extreme drought, high temperatures, frost events, and intense rainfall are widely recognized as having severe impacts on crop growth and development. Drought is regarded as one of the most severe threats to global food security, with its impact on crop yields potentially surpassing the combined effects of other extreme weather events. Thus, enhancing the storage capacity of natural rainfall and optimizing water use efficiency in agricultural production has become a pivotal factor in boosting agricultural productivity. To address this challenge, China has developed an array of methods for collecting and storing rainfall, thereby im-proving the utilization of natural precipitation. [21]. For instance, the implementation of DVRT [4,5], along with the application of plastic film [22]or straw mulching[23], has significantly curtailed soil moisture evaporation, alleviated crop water deficits, and enhanced soil water retention, thereby fostering a conducive soil environment for root development. These interventions not only enhance the absorption and utilization of water and nutrients by crops but also promote their growth and development, ulti-mately leading to improved yield and quality[24,25].

Comments 4: In "2.1. The form of DVRT", the author introduced the advantages of the two machines, but there are no specific statistics. Has any relevant research been published?

Response 4: Thank you for pointing this out. We agree with your suggestion and have

added relevant references to support our claims. All instances of DVRT in the text refer to one of these two methods, which should serve as appropriate data support.

Comments 5: This study discussed the improvement effect of Deep Vertical Rotary Tillage on soil properties and crop yield, but there was no specific data support. How much was increased? By how much? With which tillage methods were these conclusions compared?
Response 5: Thank you for pointing this out. As shown in Tab 1, the comparison is made with traditional rotary tillage and deep tillage, and the table also includes notes on soil types and yield increase rates.

Tab. 1 Yield and WUE of crop grown in DVRT compared with RT.

Tillage method	Control method	Cropping system	Experimental site	Soil type	Yield(%)	WUE(%)	References
DVRT20 DVRT40 DVRT50	RT	Potato	Ningxia	Sandy loam	8.56 12.31 13.21	54.76 70.32 71.85	[**Error! Reference source not found.**]
DVRT	RT	Potato	Ningxia	Sandy loam	23.3	29.7-39.8	[**Error! Reference source not found.**]
DVRT	RT	Maize	Ningxia	Sandy loam	13.6	19.6	[**Error! Reference source not found.**]
DVRT30 DVRT50	SS/RT	Maize	Hebei	Loam	4.21-9.80 7.04-12.78	21.65-31.11 19.07-28.33	[**Error! Reference source not found.**]
DVRT	PT	Cotton	Xinjiang	Sandy loam	49.5	-	[**Error! Reference source not found.**]
DVRT	RT	Rice	Guangxi	Clay	23.87	-	[**Error! Reference source not found.**]
DVRT	RT	Wheat	Henan	Sandy loam	34.13	-	[**Error! Reference source not found.**]
DVRT20 DVRT40	RT SS	Sugarcane	Guangxi	Silt loam	2.49-24.89 3.71-8.73	- -	[**Error! Reference source not found.**]

DVRT25					10.45-14.64	-	[**Error! Reference source not found.**]
DVRT40	RT	Peanut	Henan	Loam	21.42-21.67	-	
DVRT20					89.18	-	[**Error! Reference source not found.**]
DVRT30	RT	Sweet Potato	Jiangxi	Loam	104.33	-	
DVRT40					116.88	-	
DVRT20					7.59	-	[**Error! Reference source not found.**]
DVRT30	RT	Tobacco	Hunan	Loamy sand	17.06	-	
DVRT40					13.16	-	
DVRT30					8.30	-	[**Error! Reference source not found.**]
DVRT50	RT	Sorghum	Ningxia	Loam	8.70	-	
DVRT40	RT	Cassava	Guangxi	-	29.22-63.78	-	[**Error! Reference source not found.**]

DVRT, Deep vertical rotary tillage, with numbers indicating the tillage depth.

RT, Traditional rotary tillage at 20cm depth.

SS, Deep Tillage at 40cm depth.

Comments 6: In lines 73-84, the specific site and soil type were not specified.

Response 6: Thank you for pointing this out. We believe that when focusing on these two forms of DVRT in this section, it is not necessary to reference specific locations or soil types.

Comments 7: In lines 101-108, what is the cause of salt land? What's the relationship with the last paragraph?

Response 7: Thank you for pointing this out. This section does not discuss the causes of saline-alkaline soils but rather demonstrates how DVRT contributes to the improvement of such soils. The focus of this subsection is on analyzing the impact of DVRT on soil physicochemical properties, with the previous paragraph addressing its effects on physical properties, and this paragraph focusing on its effects on chemical properties.

Comments 8: In Part 2.4, the reasons why Deep Vertical Rotary Tillage has an impact on Photosynthesis are not explained.

Response 8: Thank you for pointing this out. We believe that DVRT increased the activity of photosynthesis-related enzymes (NADP-MDH, PEPC, RuBPC), elevated the maximum photochemical efficiency (Fv/Fm), and enhanced both the primary light energy conversion efficiency and the actual photochemical efficiency of PS reaction centers (φPSⅡ). All these factors contribute to augmenting the photosynthetic capacity of plant leaves, which represents the internal mechanism. Additionally, DVRT also supports deeper root growth

and improved water and nutrient absorption, which collectively promote crop growth and development.

Comments 9: Combined with the Part 2.5, Water Use Efficiency should belong to "2.2. Soil Properties of DVRT".
Response 9: Thank you for pointing this out. After reviewing a substantial amount of literature and considering various factors, we have determined that it is more appropriate to separate this section from "2.2. Soil Properties of DVRT."

Comments 10: In line 188, there's no punctuation.
Response 10: Thank you for pointing this out. We have reviewed the entire manuscript and corrected similar instances accordingly.

Comments 11: The section "2.7. Others" has been introduced.
Response 11: Thank you for pointing this out. In response to this issue, I have made the necessary deletions of content in the preceding sections that may overlap with "2.7. Others."

Comments 12: In the part of "3. Prospects", the shortcomings of Deep Vertical Rotary Tillage at present are not clear, and how to solve these problems concretely, this part lacks reference support.
Response 12: Thank you for pointing this out. I have added the relevant references in the "3. Outlook" section.

Comments 13: The conclusions did not clearly express the specific advantages of Deep Vertical Rotary Tillage on soil properties and crop yield.
Response 13: Thank you for pointing this out. I have rewritten the conclusion section to better meet the requirements. The revised content is as follows:
Deep Vertical Rotary Tillage (DVRT) is a promising and sustainable agricultural practice with significant potential to enhance soil quality, optimize water use efficiency, and increase crop yields across diverse ecological and agronomic conditions in China. By altering soil structure, improving soil properties, and promoting robust root de-velopment, DVRT effectively addresses the challenges of soil compaction, shallow plow layers, and uneven water distribution prevalent in traditional tillage methods. While its extensive application across various crops and regions demonstrates adapta-bility and efficacy, the relatively low nationwide adoption rate highlights the need for further research to refine its theoretical framework and develop tailored strategies that align with local conditions. Integrating DVRT with other agronomic practices, such as plastic film mulching, drip irrigation, and straw return, can further optimize soil health and agricultural sustainability. Advancing DVRT machinery design, supported by policy measures like subsidies and nationwide promotion, is essential for reducing energy consumption and enhancing operational efficiency. In conclusion, DVRT offers a viable pathway towards sustainable agriculture in China, contributing to improved soil quality, enhanced crop yields, and ensuring food security, with continued research, innovation, and policy support being crucial for its broader adoption and

success.