

# INPLASY PROTOCOL

To cite: Ramírez et al. Potato zero-tillage and mulching is promising in achieving agronomic gain in Asia. Inplasy protocol 202260072. doi: 10.37766/inplasy2022.6.0072

Received: 16 June 2022

Published: 16 June 2022

**Corresponding author:**  
David Ramírez

d.ramirez@cgiar.org

**Author Affiliation:**  
International Potato Center.

**Support:** GIZ-i4Ag and CGIAR-RTB.

**Review Stage at time of this submission:** Completed but not published.

**Conflicts of interest:**  
None declared.

## Potato zero-tillage and mulching is promising in achieving agronomic gain in Asia

Ramírez, DA<sup>1</sup>; Silva-Díaz, C<sup>2</sup>; Ninanya, J<sup>3</sup>; Carbajal, M<sup>4</sup>; Rinza, J<sup>5</sup>; Kakraliya, SK<sup>6</sup>; Gatto, M<sup>7</sup>; Kreuzer, J<sup>8</sup>.

**Review question / Objective:** The objective of this review is to analyze the effect of zero-tillage and organic mulching (with emphasis on rice-straw) on several Key Performance Indicators (KPIs) related to productivity, resources-use efficiency, and soil health, as well as, C footprint, and weed control for growing potatoes in rice-based systems in Asia. Can zero-tillage and organic mulching increase agronomic gain in potatoes crop in Asia?

**Rationale:** Potato cultivation under zero-tillage and mulching (PZTM) between rice or rice-other crops projects a sustainable intensification of rice-based systems reducing mechanical soil disturbance with a concomitant increase of soil organic matter. However, collection, analysis, and synthesis of experiences in Asia, where this technology was mainly reported, is missing in the scientific literature. This effort, presented in this review, is crucial as a starting point for establishing if PTZM experiences have improved indicators related to productivity, resource use efficiency and soil health, and C footprint and weed management to achieve Agronomic Gain.

**INPLASY registration number:** This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 16 June 2022 and was last updated on 16 June 2022 (registration number INPLASY202260072).

### INTRODUCTION

**Review question / Objective:** The objective of this review is to analyze the effect of zero-tillage and organic mulching (with emphasis on rice-straw) on several Key Performance Indicators (KPIs) related to

productivity, resources-use efficiency, and soil health, as well as, C footprint, and weed control for growing potatoes in rice-based systems in Asia. Can zero-tillage and organic mulching increase agronomic gain in potatoes crop in Asia?

**Rationale:** Potato cultivation under zero-tillage and mulching (PZTM) between rice or rice-other crops projects a sustainable intensification of rice-based systems reducing mechanical soil disturbance with a concomitant increase of soil organic matter. However, collection, analysis, and synthesis of experiences in Asia, where this technology was mainly reported, is missing in the scientific literature. This effort, presented in this review, is crucial as a starting point for establishing if PTZM experiences have improved indicators related to productivity, resource use efficiency and soil health, and C footprint and weed management to achieve Agronomic Gain.

**Condition being studied:** Not applicable.

## METHODS

**Search strategy:** In this review, the Scopus, BASE, and Google Scholar databases were used. First, a naive search in the Scopus database was performed using the following search equation: TITLE-ABS-KEY("potato" AND ("zero till\*" OR "no till\*" OR "\*straw mulch\*" OR "organic mulch\*") OR "rice-wheat system\*"). Then, the R package "litsearchr" was used for an semi-automatic selection of search terms. After that, the following search equation for the Scopus database was obtained: TITLE-ABS-KEY ( ( "mulch\*" OR "organic mulch\*" OR "tillage with mulching" OR "paddy straw\*" OR "straw mulch\*" OR "no-till\*" OR "conservation tillage" OR "direct drilling" OR "direct seeding" OR "zero till\*" OR "zone till\*" OR "conventional tillage" ) AND ( "potato\*" OR "solanum tuberosum\*" ) ) For the BASE and Google Scholar database, the search equation suggested by the litsearchr package was adapted as follows:

**BASE:**

((conservation sustainable intensification) agriculture) (productivity efficiency) AND (((zero no minium) till) mulch rice) AND potato AND asia -europe doctype:( 122 13 14 15 16 17 18\* 19 1A )

**Google Scholar:**

potato\* + (mulch\* OR"organic mulch\*" OR"tillage with mulching" OR"paddy

straw\*" OR"straw mulch\*" OR"no-till\*" OR "zero-till\*" OR "zone till" OR"conservation OR"conventional tillage"OR"direct drilling" OR"direct seeding") +"asia".

**Participant or population:** Not applicable.

**Intervention:** Not applicable.

**Comparator:** Not applicable.

**Study designs to be included:** Not applicable.

**Eligibility criteria:** First, duplicated ones were removed. Then, a first screening in the titles was applied to select only 1) those studies performed in Asia, 2) that included terms “zero-till\*” and/or “mulch” (and related ones), 3) based on rice-wheat systems (and related crops) rotated with potatoes, 4) those ones that included a control (plots where zero tillage and/or mulching was not applied), and 5) available in English language. That was made for each database used (Scopus, EBSCO, and Google Scholar). After that, the potentially relevant records from the databases mentioned were joined together in one list for a second screening used in the abstracts and, when required, the complete text considering the same criteria (1-5).

**Information sources:** Scopus, BASE, and Google Scholar.

**Main outcome(s):** Not applicable.

**Additional outcome(s):** Not applicable.

**Data management:** The R package litsearchr was used for a semiautomatic selection of relevant terms for the searching query. The selection of potentially relevant studies for this review was made by 2 coauthors. We used the criteria mentioned in item 16 (studies performed only in Asia, that included terms “zero-till\*” and/or “mulch” (and related ones), based on rice-wheat systems (and related crops) rotated with potatoes, and available in English language). All data related to productivity (yield and

profitability), resource-use efficiency (water productivity and nutrient-use efficiency), soil health (soil organic carbon), C footprint, and weed control were extracted.

**Quality assessment / Risk of bias analysis:** Not applicable.

**Strategy of data synthesis:** To synthesize the data, a qualitative classification of the evidence level of all indicators analyzed (Key Performance Indicators, C footprint, and weed control) was performed according to Locatelli et al. (2020)'s methodology. Thus, four categories based on the level of coincidence among studies (LC) and the number of studies (NS) were defined as follows: i) "Consensus" (medium or high LC and high NS), ii) "Probable" (medium or high LC and few NS), iii) "Controversy" (low LC and high NS), and iv) "Knowledge gap" (low LC and few NS). Medium or high LC was considered when most of the studies coincided in their results (same increase/decrease trend in KPIs indicators), whereas 10% (or less) of the studies were considered as few NS. In addition, all extracted data related to productivity (yield and profitability), resource-use efficiency (water productivity and nutrient-use efficiency), soil health (soil organic carbon), C footprint, and weed control were compared against a control (plots where zero tillage and/or organic mulching was not applied). Thus, we determine the effects (increase or decrease) on the targeted variables (previously mentioned) of the agronomic practices of zero tillage and/or mulching. Locatelli, B.; Homberger, J.M.; Ochoa-Tocachi, B.; Bonnesoeur, V.; Román, F.; Drenkhan, F.; Buytaert, W. Impactos de las zanjas de infiltración en el agua y los suelos: ¿Qué sabemos?. (Doctoral dissertation). CGIAR Infraestructura Natural para la Seguridad Hídrica, Forest Trends, Lima, Peru, 2020. 16p. <https://www.forest-trends.org/wp-content/uploads/2020/05/Impactos-de-las-zanjas-de-infiltracin-en-el-agua-y-los-suelos.pdf>

**Subgroup analysis:** Not applicable.

**Sensitivity analysis:** Not applicable.

**Language:** Only available in English language.

**Country(ies) involved:** Peru, Germany, and India.

**Other relevant information:** In this review, we synthesize the evidence found about the effects of zero-tillage and mulching (PZTM) on potato crops cultivated under rice or rice-other crop-based systems. We selected only studies performed in Asia that included treatments of zero-tillage and/or organic mulching (and related ones) and a control, as well as, based on rice-wheat systems (and related crops) rotated with potatoes, and available in English language. Here, control plots are those plots where zero-tillage and/or organic mulching was not applied. Treatments (with zero-tillage and/or organic mulching) were compared against the control (for each study) to determine the effects (increase or decrease) of these agronomic practices on some key performance indicators related to productivity, resources-use efficiency, soil health, as well as, C footprint, and weed control. This information was summarized in a table and discussed in our manuscript. Also, our manuscript included the discussion of a simulation exercise performed to map how much area used for rice cultivation can be potentially intensified with potatoes, as well as future directions for scaling these agronomic practices were addressed. This review could serve stakeholders to promote the use and application of zero/minimum-tillage and/or organic mulching for potato crop cultivation as an essential component of climate mitigation and sustainable intensification.

**Keywords:** Conservation agriculture; *Solanum tuberosum*; Sustainable intensification; Rice-based system; soil health; C footprint.

**Dissemination plans:** The results of this review were summarized in a scientific manuscript and submitted to the

---

international, scientific, peer-reviewed, open-access journal MDPI.

**Contributions of each author:**

**Author 1 - David A. Ramírez -** Conceptualization, investigation, writing-original draft preparation, and visualization.

Email: d.ramirez@cgiar.org

**Author 2 - Cecilia Silva-Díaz -** Conceptualization, methodology, formal analysis, investigation, data curation, and writing-original draft preparation.

Email: silvadiaz.cc@gmail.com

**Author 3 - Johan Ninanya -** Conceptualization, methodology, software, formal analysis, investigation, data curation, writing-original draft preparation, and visualization.

Email: j.ninanya@cgiar.org

**Author 4 - Mariella Carbajal -** Software, formal analysis, writing-review and editing, and visualization.

Email: m.carbajal@cgiar.org

**Author 5 - Javier Rinza -** Investigation, and writing-review and editing.

Email: j.rinza@cgiar.org

**Author 6 - Suresh K. Kakraliya -** writing-review and editing.

Email: cip-gizconsultant@cgiar.org

**Author 7 - Marcel Gatto -** Resources, writing-review and editing, supervision, project administration, and funding acquisition.

Email: m.gatto@cgiar.org

**Author 8 - Jan Kreuze -** Resources, writing-review and editing, project administration, and funding acquisition.

Email: j.kreuze@cgiar.org