



Symposium mini review



## No Organic or Chemical Input Crop Production (NOCh-CP) and Activities of the NPO No Organic or Chemical Input Crop Production Research Group

Terufumi TADA<sup>1,2,3</sup>, Masayuki KOBAYASHI<sup>1</sup>, Katsuya IBUKI<sup>1</sup>, Noritatsu SHIMODAIRA<sup>1</sup>, Zenta IEDA<sup>1</sup>, Jiro KURASHIMA<sup>1</sup>, Nobuhiro MARUTA<sup>1</sup>, Makoto MORI<sup>1</sup>, Masaki HAYASHI<sup>1</sup>, Mitsunao KUWADA<sup>1</sup>, Koki HOMMA<sup>4</sup>, Tatsuhiko SHIRAIWA<sup>1,2</sup> and Takeshi HORIE<sup>1</sup>

<sup>1</sup>NPO No Organic or Chemical Input Crop Production Research Group (NPO *Muhiken*)

<sup>2</sup>Graduate School of Agriculture, Kyoto University

<sup>3</sup>JSPS

<sup>4</sup>Graduate School of Agricultural Science, Tohoku University

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### Corresponding Author

Terufumi TADA,  
ttada@muhiken.or.jp

### Abstract

There is a growing concern regarding the impact of agriculture on both human health and the environment, and a unique approach named here as “no organic or chemical input” (NOChI) crop production (NOChI-CP) has gained attention. NOChI-CP avoids the use of fertilizers, pesticides, and even organic materials. This is rooted in a philosophy that allows the soil to fully express its inherent capabilities. Research efforts have been dedicated to exploring the intricacies of NOChI-CP, which NPO *Muhiken* currently promotes. This review provides an overview of NOChI-CP and outlines the group’s promotional activities. Several studies in rice have revealed that NOChI-CP exhibits a low, but stable and acceptable yield. Compared with conventional rice production, varieties with the “panicle weight” plant-type and late-maturing trait adapted better to NOChI conditions. It has been reported that some nutrient requirements are met by nutrients carried in irrigation water, but further study is required. NOChI rice is more resistant to blast diseases and brown planthoppers than conventionally fertilized rice. In a long-term survey of NOChI mulberry production, leaf yields had long been comparable to conventional practices. The leaves produced in NOChI-CP were significantly preferred by silkworm larvae over fertilized leaves, and silkworms raised on NOChI leaves showed higher resistance to carcinogenic substances. NPO *Muhiken*, No Organic or Chemical Input Crop Production Research Group, is active in four main areas: research, public relations, technical support, and certification. The research includes both practical and academic perspectives. The public relations include three major events (meetings, exhibitions, and excursions) and publish a periodic newsletter. Moreover, the staff periodically visits member farmers’ fields across Japan for technical support and certification.

### Introduction

Modern agricultural practices, once solely focused on productivity, are undergoing reevaluation. While the “Green Revolution” has significantly boosted crop yields, the adverse effects of chemical fertilizers and pesticides on the environment and human health have long been ignored. In

recent years, there has been a growing emphasis on human health and environmental conservation, leading to extensive research on the effects of organic and other environmentally friendly agricultural practices on soil and human health, and their complex interactions (Reeve *et al.*, 2016). However, some farmers choose to adopt alternative approaches, practicing crop production without resorting to chemical fertilizers or organic

materials, a method referred to as no-organic or chemical input crop production (NOChI-CP).

Mr. Mokichi Okada, the pioneer of NOChI-CP, asserted that soil inherently possesses the capability to yield edible plants sufficient for sustaining human life, a quality he termed “natural power” (Okada, 1984). NOChI-CP is a cultivation method designed to allow the soil to fully harness this natural power. While Okada (1984) initially referred to these methods as “nature farming”, we have opted to name it “NOChI-CP” to avoid confusion with the varied interpretations of “nature farming,” which can include organic agriculture, no-tillage cultivation, and other practices (also, in Japanese, “nochi” translates to agricultural field).

Although the number of published reports on NOChI-CP is limited, the advantages of crops produced under this system have become progressively recognized. Despite not yet achieving large-scale implementation, we are advocating adoption of this unique cultivation method for the benefit of environmental conservation and food safety.

The objective of this review article is to present overview and the state of the knowledge of NOChI-CP as well as the promotional activities of NPO *Muhiken*.

## **No organic or chemical input crop production (NOChI-CP)**

Experiments and field surveys were conducted to elucidate the nature of NOChI-CP, primarily in rice paddy fields. The yield of NOChI-CP rice ranged from 2 to 4 t ha<sup>-1</sup> in nine fields (Tada *et al.*, 2023). Notably, in the two of the nine fields located in Ritto, Shiga Prefecture, NOChI rice production was practiced from 1951 to 2006, consistently yielding approximately 4 t ha<sup>-1</sup> of grain (Hasegawa *et al.*, 1979). In a study comparing the growth of rice plants under NOChI and conventional fertilization, it was observed that the crop relative growth rate, especially in roots, decreased more slowly in the late grain filling stage in the NOChI field than that in the conventional field (Takeuchi *et al.*, 1979a). Takeuchi *et al.* (1979a) concluded that the dry weight of the roots of NOChI plants in the late grain-filling stage exceeded that of fertilized plants, suggesting that the “autumn vigor” type phenomenon observed in NOChI paddy fields may be attributed to these differences. Further experiments examining the varietal difference in the growth of rice under NOChI-CP and conventional fertilization have revealed that panicle weight-type varieties adapt favorably under these conditions (Okumura *et al.*, 1979). Additionally, the study suggested that late-maturing cultivars should be selected as planting varieties.

Few studies have been conducted to elucidate the mechanisms underlying sustained NOChI rice yields in terms of soil and water nutrition. Notably, the previous research by Hasegawa *et al.* (1979) and Takeuchi *et al.* (1979b) reported that a greater amount of irrigation caused a relatively high yield in the Ritto fields described above. In a quantitative analysis of nitrogen in the Ritto fields, Okumura (2002) demonstrated that 26%, 12%, and 62% of the nitrogen were supplied from irrigation water, biological fixation, and soil complex, respectively. Collectively, these contributions maintain stable grain production. However, Tataru *et al.* (2016) reported that nutrient supply with irrigation water was not always large. Further studies are required to comprehensively

elucidate the mechanisms underlying the stable yields of NOChI rice.

NOChI rice is resistant to plant diseases and pests, which has been extensively investigated. Notably, differences have been observed in a study focusing on blast disease resistance in rice plants grown under NOChI-CP. The percentage of silicate-accumulating cells in the leaves per unit area was smaller at the early growing stage but larger at the late growing stage in NOChI rice than in rice cultivated with fertilizers and chemicals. The larger percentage leads to lower grades of invaded cells and decreases fungal appressoria formation. Collectively, these findings suggest that NOChI rice displays higher resistance to blast disease than conventional rice (Hirai and Kimura, 1979). Additionally, Sugimoto *et al.* (1984) compared the degree of damage caused by brown planthoppers in two adjacent rice fields, one a NOChI field and the other a conventional field. This study revealed that damage rarely occurred in NOChI fields. This can be attributed to the greater tolerance to feeding by brown planthoppers in rice plants grown in the former fields, owing to the high C/N ratio in rice stems and leaves, an increase in the number of silicate cells in the late growth stage, and greater predation by spiders living at higher densities in NOChI fields.

In addition to rice, mulberry grown under NOChI conditions was investigated for productivity and interaction with silkworms, focusing on attractiveness and worm health. In a comparative study spanning 19 years between NOChI and fertilized mulberry fields, the yearly yield of fresh leaves from NOChI field remained stable, ranging from 1800 g m<sup>-2</sup> to 2000 g m<sup>-2</sup>, which was almost equivalent to the level observed in the fertilized field (Kuwada *et al.*, 2006). Annually, 17.5 g m<sup>-2</sup> of nitrogen was estimated as the input to the NOChI field from the natural environment, with the majority presumed to originate from the nitrogen pool in subsoil layers, the adjacent environment, and/or atmospheric nitrogen fixation (Kuwada *et al.*, 2006). Interestingly, the attractiveness of NOChI mulberry leaves to silkworm larvae was significantly higher than that of fertilized leaves, with nitrogen fertilizers demonstrating a tendency to decrease attractiveness (Kuwada and Horie, 2002). Furthermore, silkworm larvae raised on NOChI mulberry leaves exhibited approximately 10-fold stronger resistance to phloxine, a known carcinogenic substance, than those raised on fertilized leaves (Kuwada and Horie, 2004).

Although determining the direct effect of food on human health remains challenging, the significance of this task remains paramount. The Iwata Takeru Shoten store, which deals with NOChI products, has been receiving positive comments from the consumers. They underscore the importance of a scientific investigation on the potential health effects of NOChI products.

## **No Organic or Chemical Input Crop Production Research Group (NPO *Muhiken*)**

NPO No Organic or Chemical Input Crop Production Research Group is called NPO *Muhiken* in Japanese. The group was established in 2000 with the primary objective of studying and disseminating NOChI-CPs (website [in Japanese]: <https://muhiken.or.jp/>). As of December 31, 2023, the group comprised 119 regular members and 35 supporting members. Its activities are centered on four main

areas: research, public relations, technical support, and certification. Below, we provide a brief overview of each.

Research stands as the cornerstone of the group activities. The dedicated staffs of NPO *Muhiken* conduct experiments to establish effective cultivation methods for NOCh-CP. For example, they examined the impact of tillage treatments on rice and weed growth, as well as the effects of winter flooding and midseason drainage on rice growth in the unique production system. Collaborations with researchers from various fields, including Kyoto University, Kyoto Prefectural University, and Nara Institute of Science and Technology, contribute to the experiments, by providing diverse perspectives on the production system. Most of these experiments have been conducted in NOCh fields managed by the group (Fig. 1). The outcomes of these studies are presented annually and discussed at the meetings described below.

Public relations activities include research meetings, exhibitions, excursions, and the periodic publication of



**Fig. 1.** One of the no organic or chemical input (NOCh) paddy fields managed by our group (NPO *Muhiken*), located in Uji city, Kyoto.



**Fig. 2.** Our group's activities related to public relations: research meetings (a), exhibitions (b/c), reception after the meetings or the exhibitions (d), excursions (e), and newsletters "*Muhiken dayori*" (f).

newsletter, “*Muhiken dayori*.” As a major event, an annual research meeting takes place in March where researchers, producers, distributors, and consumers discuss the outcomes of the year’s research activities (Fig. 2a). Subsequently, a reception is held featuring a meal that showcased a variety of NOChI crops, fostering participant enjoyment and communication. Another significant event, the exhibition in November showcases crops and processed products from members across Japan (Fig. 2b/c), with participants enjoying lectures, panel discussions, and a tasting reception featuring a diverse array of NOChI products (Fig. 2d). Moreover, an annual excursion takes participants to various member fields, including rice paddies, tea plantations, and upland fields (Fig. 2e), offering firsthand experience and insights into different agricultural practices. The newsletter, “*Muhiken dayori*,” is published several times a year, providing updates on the group activities, introducing new farmer members, and more (Fig. 2f).

The group places a significant emphasis on technical support and certification within the NOChI-CP framework. To extend the technical expertise, the group staff travels extensively across regions from Hokkaido to Kyushu and Okinawa, delivering lectures and providing training to farmers and their successors in NOChI-CP techniques (Fig. 3a). This hands-on approach helps farmers manage their production practices. Certification is a vital component of the group activities, in which the staff confirms whether fields of the member farmers are managed according to the principles of NOChI-CP. Products from certified NOChI fields or processed products made from such products are distinguished by special seals based on the duration of NOChI-CP continuity. Products with 10 years or over of NOChI-CP earn gold seals, those with three years or over receive silver seals, and those less than three years are marked with green seals (Fig. 3b). As of December 31, 2023, the area of fields registered as NOChI fields totaled 62.5 ha, distributed across various categories. This includes 28.8 ha of rice fields managed by 39 farmers, an upland field area of 28.3 ha managed by 26 farmers, a tea field

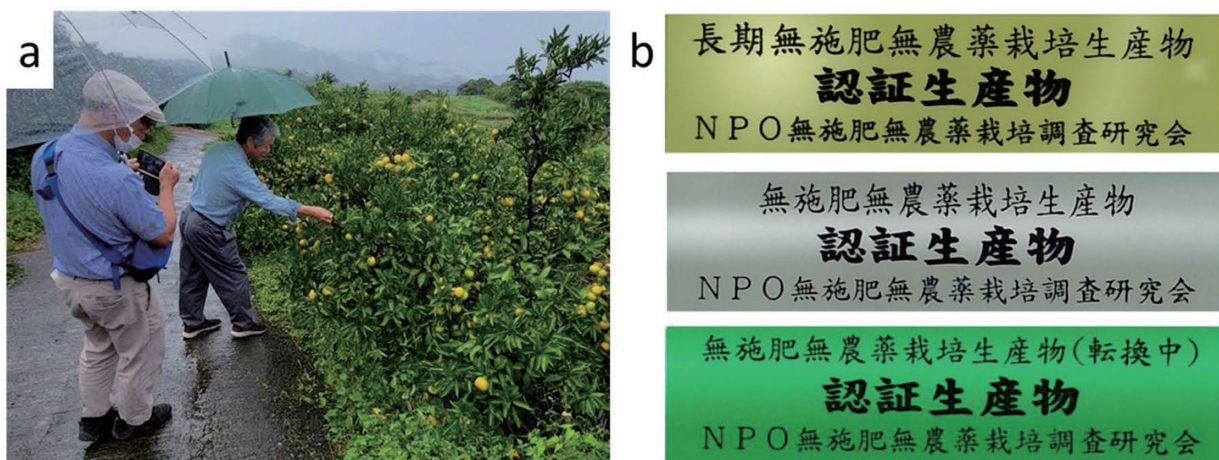
area of 1.0 ha managed by four farmers, and an orchard area of 4.4 ha managed by eight farmers. This widespread adoption reflects the successful integration and management of NOChI-CP practices among member farmers.

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**Fig. 3.** Our staff travels across the region for technical support and certification (a). Products from the certified fields with 10 years or over of no organic or chemical input crop production (NOChI-CP) earn gold seals, those with three years or over receive silver seals, and those less than three years are marked with green seals (b).

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