



# Double cropping in paddy fields of northern Iran: Current trends and determinants of adoption



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## ABSTRACT

Double cropping is an essential strategy for increasing crop productivity, promoting employment, satisfying food demands, and enhancing sustainability of production. However, much of the evidence on which farmers double crop (and if so, how often) is anecdotal. Factors affecting the adoption of double cropping were explored in Rasht County of Guilan Province in northern Iran. Most farmers (58.3%) practiced double cropping with one crop (i.e., ratoon rice, vegetables or pulses). Leafy vegetables, such as coriander (*Coriandrum sativum*), parsley (*Petroselinum crispum*), spinach (*Spinacia oleracea*), and garden cress (*Lepidium sativum*) as well as root vegetables, such as garlic (*Allium sativum*), carrot (*Daucus carota* subsp. *sativus*), and radish (*Raphanus sativus*) were the most common vegetables. Cranberry bean (*Phaseolus vulgaris*) and faba bean (*Vicia faba*) were the most common pulses. Almost a third of the farmers (32.5%) practiced double cropping with a combination of two crops (i.e., ratoon rice plus vegetables or ratoon rice plus pulses). Adopters of double cropping had a more positive attitude for this cropping practice (as expressed by perceptions of high profitability and sufficient satisfaction of household food demands), higher levels of social participation (i.e., participation in cooperatives, associations, unions) and cooperation with other farmers, more use of communication tools (i.e., TV, radio, internet, magazines), and higher income from rice farming than the non-adopters. A logistic regression model with predictive ability 72.8% showed that farmers' attitude towards double cropping had the greatest role in the prediction of its acceptance followed by attendance of education courses and farming experience. The results are of practical significance for policy-makers who seek the best options for greater farm productivity and well-being in developing countries. Training courses and discussion meetings, particularly targeted to young farmers, as well as the establishment of cooperatives to foster social participation could motivate adoption of double cropping.

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## 1. Introduction

Despite rapid developments of the recent decades, the world is still struggling with a food crisis. This is particularly important for regions facing considerable population growth (Gregory and Guttman, 2002), where the need for meeting the demands for safe food as well as for creating employment and income for the rapidly growing population is great. In these areas, boosting crop productivity is an important factor in the development of the agricultural sector (Spiertz, 2013). New cropping systems are needed that increase land productivity, but also maintain their resource

base (soil quality, soil health, ecosystem health) and facilitate biodiversity in agricultural landscapes (Spiertz, 2013). A strategy for increasing agricultural productivity is to exploit a piece of land more in a certain period of time by replacing monocropping with multiple cropping systems. Long growing season, favorable environmental conditions (temperature and precipitation) from the harvest of rice until its planting in the next year, and the occurrence of fertile soils are significant advantages making rice fields in Guilan Province a good candidate for multiple cropping (Tabrizi et al., 2015).

Double cropping is one practice in a suite of practices known as multiple cropping (Borchers et al., 2014). It refers to the harvest of two crops from the same field in a given year. Both economic and environmental concerns motivate the interest in double cropping (Searchinger et al., 2013; Siebert et al., 2010). For example, in some applications, double cropping can reduce fertilizer require-

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ments (Heggenstaller et al., 2008). Also, by reducing soil exposure between harvest periods, double cropping can help in protecting the soil from wind and water erosion and preserving the diversity of ground beetles (Groeneveld and Klein, 2015). However, in other cases, double cropping may require additional inputs, such as pesticides, fertilizers, irrigation water, or use of conventional tillage, which can have negative environmental impacts. Economic benefits of double cropping include the potential of additional revenue from a second crop on the same land base (Fouli et al., 2012; Andrade et al., 2015). Naddaf Fahmideh et al. (2015) reported that the adopters of second cropping in Guilan Province of northern Iran had a much higher income and gained much higher profit from the main cropping (rice) and second cropping than the non-adopters. Lowering immigration and unemployment was one of the most important social impacts of second cropping adoption. However, the fairly low adoption rate for double cropping suggests that economic barriers limit its use.

Guilan Province plays an important role in meeting rice consuming demands of Iran. However, most paddy fields are usually planted only once a year and farmers suffer from seasonal unemployment after rice harvest until the next year. On the other hand, the total area of paddy fields is limited and the common monocropping practices cannot support farmers' living (Amar et al., 2013). To improve land efficiency, farmers are often advised to adopt second cropping after the harvest of rice as a strategy to realize sustainable farming and to increase production, so that they can make more production by using the existing inputs without incurring extra expenses (Spiertz, 2013). The officials of Agriculture Organization of Guilan Province (Jahad-e-Keshavarzi) have extensively attempted to communicate the advantages of second cropping to farmers, so that they can increase production per unit area and improve income and lifestyle. Atghaei Kordkolaei et al. (2013) introduced the most appropriate crops for the development of double cropping to farmers and planners in Guilan Province of northern Iran. Root vegetables were the optimum among six studied crops: berseem clover, beans, faba beans, ratoon rice, and leafy vegetables. The recognition of factors affecting the adoption of post-rice second cropping and its application can be useful in finding a solution for the problem of adoption.

Although a second crop can provide additional revenue, it often lowers per-crop yields because of the potentially shortened growing time available for each crop, which can reduce the farm's total annual revenue potential (Egli and Bruening, 2000). In addition, production costs may increase when adding a second crop, and in some situations, double cropping may be riskier than growing a single crop. Double cropping depends on certain crucial factors besides good weather for success, including producers' managerial abilities. Researchers strive to refine double-crop systems for top-profit production. However, research on double cropping and factors affecting its adoption by farmers is limited. Much of the evidence on which farmers double crop (and if so, how often) is anecdotal. A previous study on the adoption of double cropping soybeans and wheat (Shapiro et al., 1992) found that the adoption decision was not influenced by human capital factors and the farmers who double-cropped appeared to do so both to achieve higher income and as part of a risk diversification strategy. Beyond technical and economic feasibility, farm-related and human capital factors are usually investigated in adoption studies with varying results (Arslan et al., 2014; Haghjou et al., 2014; Wildemeersch et al., 2015). The decision to double crop can vary from year to year, particularly in areas where growing conditions limit cropping possibilities. There are also important socio-cultural factors involved in the farmers' decisions on the type of cropping system to employ (Bradfield, 1986).

The main objective of the present study was to examine the current trends in double cropping in paddy fields and the fac-

tors affecting the adoption of second cropping after rice harvest in Pirbazzar Village Center in Rasht County of Guilan Province, Iran. We hypothesized that policy development efforts of the local authorities can influence double cropping adoption decisions more effectively if they take into account locally important factors that affect the decision-making process among farmers. The study aims at drawing attention to the potential of double cropping in paddy fields in the context of specific area of Guilan Province and it is expected to highlight potential similarities and contrasts for future comparisons with other areas under similar conditions. The specific objectives of the study was to provide an overview of double cropping adoption status and to study personal, economic, technical-agronomical, and social factors affecting the adoption of post-rice second cropping.

## 2. Methodology

### 2.1. Study area and selection of sample

The study area composed of Pirbazzar Village Center in Rasht County of Guilan Province, northern Iran. The statistical population was composed of 2,973 rice growers of Pirbazzar village, a part of which had never practiced second cropping and the rest had already practiced it. The sample size was estimated to be 351 farmers, using the equation for the least sample size given below (Bartlett et al., 2001):

$$n = \frac{\frac{z_{\alpha}^2 pq}{d^2}}{1 + \frac{1}{N} \left[ \frac{z_{\alpha}^2 pq}{d^2} - 1 \right]}$$

where  $n$  = sample size,  $N$  = population size (in this case  $N = 2,973$  farmers),  $p$  = estimated proportion of the population ( $p = 0.5$ ),  $q = (1 - p)$  (i.e.,  $q = 0.5$ ),  $d$  = one half of the desired interval width ( $d = 0.05$ ), and  $z$  = the value from the standard normal distribution for the selected confidence level of 95% ( $z = 1.96$ ). From the above equation, the sample size was calculated to be 351 farmers. This value was increased to 390 farmers to further enhance reliability.

### 2.2. Data collection

Following a review of the literature (Joshi and Pandey, 2005; Noorhosseini-Niyaki and Allahyari, 2010; Naddaf Fahmideh et al., 2015), previous experience in the area, and numerous meetings with experts, a questionnaire was designed as the main tool for the study. Data were collected via personal interviews with the farmers. For this reason, farmers' lists were taken from the local authorities and prospective farmers were randomly selected via stratified random sampling method. Finally, 360 questionnaires (including 240 questionnaires for farmers who had not practiced second cropping and 120 questionnaires for farmers who had) were studied as an acceptable sample. The validity of the questionnaire was confirmed by a panel of university professors and experts from the Agriculture Organization of Guilan Province (Jahad-e-Keshavarzi). The reliability of the questionnaire was estimated using the Cronbach's alpha. The values ranged between 0.70 and 0.86. Independent variables of this study included: demographic variables (i.e., gender, age, education, marital status, family size, farming experience, and rice farming experience), economic variables (i.e., livestock number, poultry number, rice yield, bank credits, and farm income), technical characteristics (i.e., land size, paddy land size, number of plots, farm-to-house distance, land ownership, water resources, access to machinery, and attendance of extension courses), and social characteristics (i.e., social participation and cooperation with other farmers, use of communication

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