The "PATBO SUPER" technology innovation to increase rice production in rainfed rice fields

R Sari*, N Sutrisna, Y Surdianto and Liferdi
The Assessment Institute for Agricultural Technology of West Java, Indonesian Agency for Agricultural Research and Development, Ministry of Agriculture, Jl. Kayuambon No. 80, Lembang, West Bandung, Indonesia

Corresponding author: emailratnasari@gmail.com

Abstract. SUPER PATBO technology is adoption from IPAT-BO technology with some enhancements to make it suitable for rainfed areas. It has been adapted in several locations. There are five main components of PATBO SUPER technology, namely: (1) New Superior Varieties of the amphibian group; (2) Water management at the macro and micro levels; (3) The use of in situ organic matter and biological fertilizers; (4) An effective and efficient weed control; and (5) Agricultural machinery application. The results of the several studies show that the PATBO SUPER technology has a good performance in several locations, namely in Ujungjaya District, Sumedang District and Palasah District, Majalengka Regency. Rice productivity in Ujungjaya Subdistrict increased by 33.51%, from 5.64 t/ha with the technology commonly applied by farmers to 7.53 t/ha with SUPER PATBO technology. In Palasah District, Majalengka Regency, it can increase rice productivity by 20%, from 5.70 t/ha to 6.84 t/ha. The application of PATBO SUPER technology is also financially profitable as indicated by a BC Ratio of 1.49 and an MBCR of 14.18. The dissemination of PATBO SUPER technology can be accelerated by establishing a field laboratory in each development target area.

1. Introduction
Food availability, especially rice, is an important aspect of realizing food security. Rice is the staple food for around 95% of Indonesia's population. Every year the government is required to always increase rice production to meet the needs of the population, which continues to increase every year. Besides, the government must ensure that the rice supply is always available, is evenly distributed, and that the price is stable and affordable.

Java island is one of the rice production centres. The area of irrigated rice fields is wider and more fertile than other islands, causing the island of Java to have many rice-producing areas. In 2015, Java Island contributed 50% to the national rice production with a total of 38,970,026 tons. However, in Java island, the availability of irrigated rice fields is decreasing every year due to the conversion of functions for non-agricultural purposes, thus threatening the national rice production. Therefore, to increase rice production, apart from intensifying rice cultivation, it is also necessary to expand the planting area. One of the potential areas for rice cultivation is rainfed rice fields which are widely available in Indonesia. Thus, rice production is not only fixed on irrigated rice fields.
Rice intensification program in rainfed rice fields has been implemented but the results have not been optimal. This program has been implemented since 2008 through the National Rice Improvement Program (P2BN). The rice productivity in rainfed rice field has only reached an average of about 5.74 t/ha of Harvested Dry Grain (HDG) [1], whereas the potential yield could be > 7 t/ha. This productivity is also lower compared to the research results of IRRI-CRIFC which have reached 6.5-7.5 t/ha. Moreover, the Cropping Index (CI) is only 2 times a year at maximum. Therefore, rice cultivation in rainfed rice fields, technological innovation is needed to increase the productivity and cropping index into 3 times a year. West Java AIAT (Assessment Institute for Agricultural Technology) has produced the PATBO SUPER technology. The PATBO SUPER technology was created to optimize the resources of rainfed rice fields to become a rice production centre. This technology is the result of a two-year study, namely in 2016 and 2017. The results of the study show that productivity has increased > 30%, from an average of 5.74 to 7.65 t/ha (HDG), even the potential yield could reach 8.4 t/ha HDG.

PATBO SUPER technology has also been applied in several locations and growing seasons, both in assessment and pilot study. The results show positive results and that PATBO SUPER technology deserves to be promoted. Therefore, the authors wrote this paper intending to accelerate the spread of PATBO SUPER technology innovation so it can be immediately recognized and adopted by technology users.

This paper will convey the following: (1) Potential and characteristics of rainfed rice fields for rice business, (2) Existing conditions and problems in rice business in rainfed rice fields, (3) Innovation in rice business technology in rainfed rice fields, and (4) Strategies to accelerate the adoption of PATBO SUPER technology innovation in rainfed rice fields.

2. Potential and characteristics of rainfed rice fields for rice farming

Indonesia has quite extensive agricultural land resources, which is around 62.48 million ha [2]. The land resources that have been utilized optimally are irrigated rice fields, while rainfed rice fields have not.

The rainfed rice field is rice field which irrigation water source depends on or comes from rainfall, without permanent irrigation structures. The rainfed area in Indonesia is around 2.02 million ha or 24% of the total wetland area, spread across the islands of Java (777,029 ha), Sumatra (550,940 ha), Kalimantan (339,705 ha), Sulawesi (279,295 ha), Bali and Nusa Tenggara (70,673 ha) [2]. In West Java, according to data from [4], the total area of rice fields was 936,529 ha of which around 187,146 ha or 20% are rainfed rice fields. These rainfed areas spread across several districts/cities, especially in the central and southern parts of West Java.

The main characteristic of rainfed rice fields is the availability of water, which is very dependent on rainfall, thus the field experiences dryness in the dry season (low rainfall). The cropping index (IP) averages twice a year with the cropping pattern rice-rice-fallow or rice-secondary crops-fallow. Even the areas in the climate zone type D1 to E2, the cropping pattern is only once a year, namely rice-fallow.

The rainfed rice field is generally less fertile (nutrient-poor) but is still more fertile than the dryland. In rainfed fields, the rainwater can be optimally utilized by collecting the rainwater on the field. Therefore, the yield of rice that grown in rainfed is usually higher than the upland rice that is grown in the dryland area.

Changes in soil chemical properties caused by inundation on rice fields, greatly affect the dynamics and availability of nutrients for rice. When the rice field is inundated, the water and the oxygen contained in the pores of the soil are consumed by soil microbes, thus causing an anaerobic state. This inundation resulted in chemical changes to rainfed rice fields[5], including:

- Decreased oxygen levels in the soil
- Reduction in redox potential
- Changes in soil pH
- Reduction of iron (Fe) and manganese (Mn)
• Increased nitrogen supply and availability
• Increased phosphorus availability.

3. Existing conditions and problems of rice farming in rainfed rice fields
The international community in the rice research classifies rainfed rice fields as high-risk ecosystems. First, they are physically threatened by drought, flood or salinity. The anticipation of these risks is pursued through plant breeding, cultivation techniques and nutrients management [6]. Besides physical risk, rainfed ecosystems are threatened by pests, diseases and weeds. This condition causes the farmers to be reluctant or hesitant to apply intensive technology and keep using traditional technologies. Therefore, the yield of rainfed rice fields is still low, at the range of 1.8-3.1 t/ha [7] and the cropping index is twice a year with the cropping pattern of rice-rice-fallow, rice-second food crops-fallow and even in some area are only once a year with cropping pattern rice/second crops-fallow.

Technology developments in rainfed rice fields are not as rapid as in irrigated rice fields. Researchers from various research institutions paid less attention to rainfed areas because the intensification program of rice production was more focused on irrigated rice fields. To date, the technology for rice cultivation on rainfed areas that have been used including: (1) the GORA system (upland variety), (2) Organic matter management, (3) N fertilization based on Leaf Color Chart (BWD) and (4) Weed control using herbicides.

Technology improvements in rice cultivation in rainfed were able to increase productivity to 4.0-5.0 t/ha HDG. This shows that rainfed rice field has enough potential to support the programs in increasing rice production. If the soil and crops are properly managed, rice productivity can be increased. So, it will be able to support the target achievement of food self-sufficiency and turn Indonesia into a world food barn by 2045.

4. Innovation of PATBO SUPER technology to increase rice productivity in rainfed rice fields

4.1. PATBO SUPER technology
PATBO SUPER is the result of an assessment by assembling and perfecting the Organic Based of Controlled Aerobic Rice Intensification Technology (IPAT-BO) produced by [8] from the Faculty of Agriculture, Padjadjaran University. IPAT BO technology is recommended for irrigated rice fields with the aim of intensification and has succeeded in increasing productivity. The results of the research by [9], on irrigated rice fields in Tunggul Wulung, Malang City, showed that the application of IPAT_BO technology in irrigated rice fields was able to increase productivity > 50%, from 6.0 t/ha to 9.1 t/ha (HDG).

Based on its success, IPAT-BO technology was studied in rainfed rice fields through the Location-Specific Agricultural Research and Assessment Partnership (KKP3SL) activity in 2016. The study was conducted in Sukamulya Village, Ujungjaya District, Sumedang Regency, West Java Province. The results of the study showed that IPAT-BO technology was able to increase rice productivity by 14.11%, from 5.74 to 6.55 t/ha GKP [10].

Several components of the IPAT-BO technology have been enhanced for increasing rice productivity to > 20%. The enhancement was based on the results of research by Makarim and Las (2005), innovative technology in the Integrated Crop Management (PTT) component, which can contribute to increasing productivity, namely the use of superior varieties, organic matter implementation and site-specific nutrient fertilization. Moreover, weed control and agricultural machinery are costly components that reduce farm income. Therefore, three technology components were added, namely: (1) superior rice varieties used are Amphibian, (2) pre-growth herbicides to control the weed seeds so they do not grow before the soil is cultivated and (3) agriculture machinery that controls the weeds rapid growth in the early growth phase.

With the addition of several technology components, the IPAT-BO technology was changed to PATBO SUPER. PATBO stands for Organic Based on Controlled Aerobic Rice. PATBO SUPER is a special rice cultivation technology package for rainfed rice fields based on water management and
organic matter application to produce high productivity and has the potential to increase the Cropping Index (CI).

The main components of PATBO SUPER are (1) superior varieties of amphibian groups, (2) water management at macro and micro levels, (3) utilization of in situ organic matter and biological fertilizers, (4) weed control, and (5) use of agricultural machinery for addressing farmworkers scarcity. Other components of cultivation technology are adapted to local conditions, including: (1) seed selection and treatment, (2) seedling age 10-20 days after seeding and population 2-3 per planting hole, (3) legowo row planting system, (4) fertilization according to plant needs and availability of nutrients in the soil, and (5) environmentally friendly of pest control

4.1.1. The use of superior varieties of rice from the amphibian group. Site-specific superior rice varieties are one of the main components that can increase rice productivity. The specific superior varieties of rainfed rice fields are classified as amphibious varieties however, there are several other wetland superior rice varieties which can adapt to rainfed rice fields.

There are 14 superior varieties of the amphibious group, namely: Limboto, Batutegi, Towuti, Situ Patenggang, Situ Bagendit, Inpari 10 laeya, Inpago 4, Inpago 5, Inpago 6, Inpago 7, Inpago 8, Inpago 9, Inpago 10, Inpago 11, Inpari 31, Inpari 32, Inpari 38 A Patenggang, Situ Bagendit, Inpari 10 laeya, Inpago 4, Inpago 5, Inpago 6, Inpago 7, Inpago 8, Inpago 9, Inpago 10, Inpago 11, Inpari 31, Inpari 32, Inpari 38 Agritan, Inpari 39 Agritan, Inpari 40 Agritan, and Inpari 41 Agritan. These varieties are high yielding and able to withstand dry conditions as well as upland rice with groundwater potential (pF) up to 2.90. Moreover, they are also able to survive and produce well in flooded conditions like wetland rice. Apart from the varieties already mentioned, there are wetland rice varieties that have been adapted and produce high yields in rainfed rice fields, namely Inpari 42, Siliwangi, Padjdjaran, and Cakrabuana.

4.1.2. Water management at micro and macro levels. Rice is not an aquatic plant but a plant that needs water. Therefore, it is necessary to regulate the provision of water both at the micro and macro levels according to the needs of the plants.

The principle of water management is the application of water-saving technology that reducing unproductive flows such as seepage, percolation and evaporation, as well as maintaining the transpiration flow. The water management must be conducted starting from land preparation, planting, and then during plant growth. In detail, as follows:

1) Macro-level water management, by utilizing the potential of available water resources (rivers, reservoirs, etc.) as efficiently as possible to increase CI.

2) Micro water management, by providing water in rice fields according to plant needs basing on plant growth phases.
   - During the vegetative period, until 10 days after sowing (DAS), the field is drained to the condition of field capacity. If there is continuous rain, the field is drained so the rice field is not flooded/saturated (aerobic condition).
   - Entering the reproductive phase, especially at grain filling, the field is inundated by closing the drainage channel. Sources of water can come from rivers, reservoirs, or shallow wells that are pumped or rainwater. Inundation is conducted to prevent the formation of new tillers for at least 4 days. Then, the water condition is maintained at moist until the milking phase.
   - At 7-10 days before harvest, the rice fields are dried

One of alternative technology in water management is alternate wetting and drying (AWD) or dry wet irrigation (PBK). This technology has been adapted in rice-producing countries such as China, India, Philippines and Indonesia. In general, the application of this technology does not cause a decrease in yields and can increase water efficiency [11].

The steps of making AWD: (1) prepare a PVC pipe with a length of 35 cm and diameter of 3-5 cm; (2) make small holes around the 20 cm of the pipe height; and (3) burying the holed pipe into the rice field.

How to install and observe AWD: (1) AWD is installed before or just after planting and immersed at the depth of 20 cm from the soil surface, so about 15 cm of the pipe is above the surface (Figure 1);
(2) after installation, remove the soil inside the pipe; and (3) measurements are started at 7-10 DAS and conducted by monitoring the water level every two days. If the water level in the pipe is less than 5 cm, the rice fields need to be immediately flooded (Figure 2).

Figure 1. AWD installation

Figure 2. Water level measurement

4.1.3. Utilization of in situ organic matters and biological fertilizers. The priority is using in situ organic matter by decomposing the rice straws using a decomposer and then ploughing the field using a hand tractor. The technique of decomposing the straws as a source of in situ organic matter (Figure 3) is as follows:

Figure 3. Straw processing with puddler (using a decomposer)

Hay and husk waste are the main materials for producing in situ organic fertilizer. Each hectare of rice yields produces about 2-5 tons of straw compost and 500-1000 kg of husk charcoal.

The basic principle of producing the in situ organic fertilizer is that all the straw or husk waste is returned to the rice fields as organic ameliorant. Firstly, the straw is composted directly on the field (in situ composting) using a decomposer with an aerobic method to improve the quality of the compost and control the pathogens contained in the straw.

The composting technique on the rice fields (Figure 3) can be explained in detail as follows:

1. Increased fertilizer efficiency, N 25% and K > 75%.
2. Accelerated planting time
3. Improved soil structure

| Nutrients | % Content  |
|-----------|------------|
|           | Before     | After     |
| N         | 0.64       | 1.5-2.0   |
| P         | 0.05       | 2.0-3.0   |
| K         | 2.08       | 1.5-2.0   |
| Ca        | 0.29       | 1.5-2.0   |
| Mg        | 0.14       | 0.5       |
| Zn        | 0.02       |           |
| Si        | 8.50       |           |

Increased fertilizer efficiency, N 25% and K > 75%.
Accelerated planting time
Improved soil structure
(2) To accelerate weathering, decomposers such as M-Dec that have anaerobic active ingredients are sprayed.

(3) Rice fields are flooded for one week, so the decomposer is spread evenly, and the soil is loosen.

(4) The soil is ploughed using a tractor with a puddler until it becomes muddy, then it is levelled using a rake.

(5) The soil that is already muddy, is left for 1-2 weeks before planted with rice.

Composting along with soil processing (in situ) is very practical and inexpensive. Moreover, rice straw can be composted directly without being chopped and turned regularly as in composting in general. A consortium of biodegradable microbes (ABG Degra) is used to increase the rate of composting, improve the compost quality and reduce the presence of disease-causing agents (pathogen). In situ composting technology and the use of bio-fertilizers have been adopted in 2010 in a sustainable rice field health and fertility program in 8 provinces (West Java, Banten, Central Java, East Java, South Sumatra, West Sumatra and South Sulawesi) through the BLP program (Direct Fertilizer Assistance), known as the Program Bio decomposers.

Inorganic fertilizers provide nutrients quickly, but the continuous application will damage the soil health. Therefore, there is an urgency of biological fertilizers application that can maintain the balance of nutrients in the soil. The balance of nutrients in the soil obtained from the application of organic and biological fertilizers will improve the soil quality and environmental characteristics that lead to high productivity and sustainability [12]. Application of biological fertilizers minimize soil damage into a tolerable limit, so the soil can be utilized sustainably.

![Figure 4. Biological fertilizer](image)

Various types and brands of biological fertilizers have been produced by several research institutions, universities, and companies both public (BUMN) and private, and are already circulating in the market. “Kayabio” is one of the biological fertilizer brands that is produced by a private company while "AGRIMENTH" is a product from the Soil Research Institute, a government research institute (Figure 4). Even though many types and brands of biological fertilizers are circulating in the market, the content of microorganisms in some types and brands is almost the same, namely *paenibacillus*.

4.1.4. Weeds management. Weeds are one of the dominant pests in rainfed rice field since the field is rarely flooded. Weeds can be controlled in two ways, namely: (1) chemically by using herbicides and (2) mechanically by using or tools or manually.

Herbicides application has been widely practised by farmers, but if they are not properly used, they cause disturbances to the crop. Manually using hands and gasrok (a traditional weeder) are also a common method however, the reduction in farm workers is a problem for using these methods on rainfed rice fields.

New technology has been produced to manage the weeds, namely the Power Weeder (Figure 6). The machine is a result of the research by the Center for Agricultural Mechanization, in Serpong and has been licensed by PT. Prison. Power Weeder is very suitable for rainfed rice fields where the soil mud is shallow.
4.1.5. Agricultural machinery. Agricultural machinery is needed to overcome the farmworkers scarcity. There are a lot of machinery types that are suitable for rainfed rice fields, but the most needed are:

- Hand tractor; indispensable for soil cultivation and at the same time processing straw into organic fertilizer with puddler.
- Jarwo Transplanter; its use depends on the physical condition of the soil. Jarwo Transplanter is not recommended for rainfed rice fields if the mud is deep. If the mud is deep, rice planting in legowo row can be done manually using caplak, a tool to make a seed laying mark.
- Power Weeder in combination with selective herbicides
  - Controlling by using selective pre-grown herbs. Herbicide application is maximum 1 (one) week after planting. The function of the pre-grown herbicide is to prevent the growth of weed seeds.
  - Power Weeder is used to controlling the weeds that already grown. This machine is used not more than 4 (four) weeks after planting.
- Combine harvester; A combine harvester is a site-specific machine thus not all rainfed rice fields can be harvested using a combine or mini combine. Before using the machine, a survey, a study or identification must be conducted to know which locations are appropriate for the combine harvester.

| No  | Description    | Volume    | Unit Price (Rp) | Total (Rp) |
|-----|----------------|-----------|----------------|------------|
| 1.  | Time           | 8 Hours   |                |            |
| 2.  | Farm Worker    | 2 Working Days | 100,000     | 200,000   |
| 3.  | Fuel          | 7 liter    | 12,000         | 84,000    |
|     | TOTAL         |           |                | 284,000   |
| 4.  | Farm Worker    | 20 Working Days | 50,000      | 1,000,000 |
| 5.  | Efficiency     |           |                | 716,000   |
|     |                |           |                | 71.6%      |

Source: Primer data
4.2. Performance of “PATBO SUPER” technology on increasing rice productivity in rainfed rice fields in sumedang and majalengka regencies

A broader scale study was conducted to find out the performance of PATBO SUPER. The study was conducted at the second growing season in 2017. IPAT-BO and PATBO SUPER was implemented in a 20 ha demonstration farm (Demfarm) at the same location, namely in Sukamulya Village, Ujung Jaya District, Sumedang Regency, West Java Province. The study was conducted not only to find out the performance of PATBO SUPER but also to allow the farmers directly compare the application of IPAT-BO with PATBO SUPER. Thus, they can make their own decisions on whether technology is beneficial or not.

The performance of the PATBO SUPER technology in the study has positive results as indicated by an increase in productivity. The productivity increased up to 33.51% or an increase from 5.64 t / ha in the technology commonly applied by farmers, namely PTT (Ciherang variety) to 7.53 t / ha with PATBO SUPER technology (Inpari 31 variety). PATBO SUPER is also financially profitable as shown by a BC Ratio of 1.49 and an MBCR of 14.18 [14].

The PATBO SUPER technology has been tested at different seasons and locations at the second growing season in 2018 and 2019 to find out its performance stability. Location of the study in 2018 was Kebon Cau Village, Ujung Jaya District, Sumedang Regency, while in 2019, was in Palasah Village, Palasah District, Majalengka Regency. The results show that PATBO SUPER technology increased rice productivity by an average of about 13% (Tables 2 and 3).

Table 2. The effect of PATBO SUPER technology application on rice productivity in Ujung Jaya District, Sumedang Regency in 2018.

| No | Variety | Productivity (t/ha) | HDG | Increase |
|----|---------|---------------------|-----|----------|
|    | PATBO SUPER |                     |     |          |
| 1  | Inpari 30 | 6.75                | 1.81 |
| 2  | Inpari 32 | 7.05                | 6.33 |
| 3  | Inpari 33 | 7.62                | 14.93|
| 4  | Inpari 39 | 7.20                | 8.60 |
| 5  | Inpari 42 | 9.00                | 35.75|
| 6  | Inpari 43 | 7.56                | 14.03|
|    | Control  |                     |     |          |
| 1  | Ciherang | 6.63                |      |          |

Source: [14]

Table 3. The effect of PATBO SUPER technology application on rice productivity in Palasah District, Majalengka Regency in 2019.

| No | Variety | Productivity (t/ha) | HDG | Increase |
|----|---------|---------------------|-----|----------|
|    | PATBO SUPER |                     |     |          |
| 1  | Inpari 39 | 6.46                | 15.36|
| 2  | Cakrabuana| 6.84                | 22.14|
| 3  | Rindang-1 | 5.88                | 5.00 |
| 4  | Luhur-1   | 6.21                | 10.89|
| 5  | Inpago-11 | 6.31                | 12.68|
|    | Control   |                     |     |          |
| 1  | Ciherang  | 5.60                |      |          |

Source: [15]
4.3. Strategy for accelerating the adoption of PATBO super technology in rainfed rice fields

The strategy to accelerate the adoption of food crops (rice, corn, and soybean) cultivation technology innovation on rainfed and dry land is crucial to achieving food self-sufficiency and towards Indonesia as a world food barn. Accelerating the adoption of technology innovation is not an easy task because the process of adopting innovation is a mental process that occurs when facing an innovation. The mental process is a process of implementing a new idea from the time it is known or heard until the new idea is implemented. Also, the adoption process goes through several stages, namely awareness, interest, evaluation, trial, adoption and confirmation [16]. The process of adoption by the introduction of an innovation (introduction) to society, then a mental process occurs to accept or reject the innovation. If the result of this mental process is a decision to accept innovation, the innovation will be adopted [17].

Each technology component in PATBO SUPER technology is specifically added by considering the condition of the rainfed area. Moreover, these technology components are flexible and can be customized according to the location where the technology is applied. For example, rice straws or husk as a source of organic matter can be obtained from other areas. Thus, PATBO SUPER technology has the potential to be widely adopted.

A strategy is needed in planning and implementing activity to accelerate the adoption rate of PATBO SUPER technology. Moreover, with an appropriate strategy the process of adopting it, can be carried out properly. To accelerate the adoption process of PATBO SUPER technology, several strategies must be implemented, namely:

a. Choosing appropriate agricultural innovations (good innovation). In the process of adoption and diffusion, innovation is a product that will be delivered to farmers (consumers). For consumers (farmers) to be interested in using PATBO SUPER technology, the PATBO SUPER components must be applied accordingly with the problems of consumers (farmers).

b. Choosing an effective extension method (good extension method). A good innovation, if the method of selling it is not right, it will hinder the adoption. So, the next step is to choose an appropriate extension method. The strategy for choosing the right extension method must consider two things, namely the content of the message to be conveyed (general or specific community) and the aimed target (for limited or general circles).

c. Empowering the extension agents optimally (good extension agents). The next stage is to select the extension officers and empower their role as extension workers as optimally as possible. Extension agents as agents of innovation have a quite tough mission namely, to change the mental, attitude and behaviour of farmers to adopt innovations to improve their welfare and if possible, created a champion farmer that can influence other farmers. This tough task requires extension agents who have high motivation and dedication, do not give up easily, are willing to sacrifice, and have empathy for the fate of farmers.

In addition to these strategies, the technology innovations in water management and rice cultivation in rainfed rice field can be accelerated by introducing them through the government program. For example, JARWO technology is adopted at a fast rate because it was introduced to the farmers by the local government (province and district) through the School of Integrated Rice Management (SL-PTT) programs. However, other commodities such as corn, the availability of seeds of the superior variety, plays a very big role in accelerating the adoption of corn cultivation technology innovation. Farmers will not apply technology innovations if the corn varieties grown are local varieties (non-superior). Therefore, it is necessary to empower breeder farmers in each region.

5. Closing

Innovation is a term that has been used widely in various fields, including industry, marketing, services and agriculture. At a more operational level of understanding, the innovations produced by the IAARD can take the form of technology, institutions, and policies. Technology innovations that will be rapidly adopted by farmers must have characteristics that are highly adaptable to the biophysical, social, economic, and cultural conditions that are available on the farm.
There are so many agricultural technology innovations that have been invented. However, only a few of these technology innovations were adopted by the farmers. This condition occurs because the technology innovations produced are not based on farmers’ needs. The farmers will accept and then adopt an innovation if they are sure that innovation is beneficial. Innovation will become a necessity if it can solve the problems that are being faced by farmers. Thus, there are at least two reasons that the correct identification of the farmers’ problem becomes crucial, namely: (a) something that we consider a problem, is not necessarily a problem for the farmers, (b) even though the problem is indeed a problem for the farmers’, the solution does not necessarily fit the farmers’ condition.

Technology is so dynamic that technological innovation will continue to develop. There are still many problems that have not been resolved, both in rainfed and dryland so that it requires innovation. Rice cultivation in rainfed still requires innovation in the efficiency of water use and rat pest control. In dryland, innovative technology that is still needed is the provision of water, superior variety of upland rice or maize that are resistant to drought and blast disease.

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