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# Development of Integrated Farming Businesses Based on Zero Waste Agriculture in Parigi Moutong Regency

**Burhanuddin Haji Nasir[1*], Irwan Lakani[2], Najamudin[3], Sitti Sabariyah[4], Sri Anjar Lasmini[5], Moh. Syahrul Asdar[6], I Putu Suci Astawa[7], Ilham Akbar[8], I Kadek Duis Tiana[9]**

[1,2,5,6,7,8]Program Studi Agroteknologi, Fakultas Pertanian, Universitas Tadulako
[3]Program Studi Peternakan, Fakultas Peternakan dan Perikanan, Universitas Tadulako
[9]Program Studi Agribisnis, Fakultas Pertanian, Universitas Tadulako
Jalan Sukarno-Hatta Km 8, Palu-Sulawesi Tengah, Indonesia, 94118
[4]Program Studi Peternakan Fakultas Pertanian Universitas Alkhairaat Palu
Jalan Diponegoro No. 39, Palu-Sulawesi Tengah, Indonesia 94221

**Correspondence:** Burhanuddin Haji Nasir (burhajinasir@gmail.com)
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**Abstract.** Zero waste agriculture is an agricultural concept oriented around the decomposition cycle of organic materials which integrates agricultural and livestock systems to reprocess waste material. Agricultural waste is used as animal feed while livestock waste/excrement is reprocessed into organic fertilizers. The Regional Partnership Service Program (PKW) aims to assist farmers in developing integrated farming businesses based around zero waste agriculture. PKW was held between May and July 2021 in Tindaki Village, South Parigi District, Parigi Moutong Regency. The implementation of this regional partnership program was carried out through a Participatory Action Programs approach, where partners are directly involved in the adoption and application of the various skills that had been developed. The procedure for activity implementation was carried out through several stages, namely: (a) counseling on zero waste agriculture, (b) training in and application of zero waste agriculture technology in the form of demonstration plots for the application of technological products, (c) coaching and mentoring, and (d) the utilization stage of technology product. The findings from the implementation concluded that the agricultural development training based on zero waste agriculture was a success, and the technology had been adopted by the community, marked by the ability to make and develop compost and liquid organic bio-urine fertilizers. Both types of organic fertilizers had been applied in the demonstration plots to assess their effectiveness in reducing the use of inorganic fertilizers. Rice production is equivalent to 5.6 tons/ha and 6 tons/ha in conventional land. These results show potential benefits for farmers, particularly regarding lower production costs compared to the usage of conventional land. Zero waste agriculture is a method of farming and livestock raising that utilizes their waste products for energy production.

**Keywords**: Livestock feces, agricultural-livestock waste, cow urine, zero-waste agriculture

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## INTRODUCTION

The integrated farming system is a farming system that combines various agricultural practices in such a way that creates continuity between production and utilization of natural resources. In an integrated farming system, all potential resources within each farming component are utilized optimally under the zero-waste principle. In other words, no waste or by-products are wasted.

Agricultural and livestock wastes include farming resources that have not been properly utilized and can be a source of environmental pollution (Hayati et al., 2018). To reduce environmental hazards, the wastes can be repurposed to have some form of economic value. Management of agricultural and livestock waste can also reduce spendings as it makes use of by-products that would otherwise have no economic value (Yuwono & Ichwan, 2013).

South Parigi District is one of several sub-districts in Parigi Moutong Regency. The majority of the population works in the agricultural sector, both in food crops production and plantations. The area covers 396.42 km$^2$ or 6.36% of the total area of Parigi Moutong Regency, 8 km from the district capital, with the sub-district capital located in Dolago Village. Geographically, South Parigi District is located between 4$^0$40' North Latitude and 0$^0$14' South Latitude, and 119$^0$45' and 121$^0$06' East Longitude. The regional boundaries to the north is bordered by Olaya Village and Kayuboko Village, Parigi District; the east is bordered by Tomini Bay; the south is bordered by Tanalanto Village, Torue District; and the west is bordered by Donggala Regency (South Parigi District in Numbers, 2020).

Potential resources in South Parigi District include land resources in the form of rice fields, plantations, and livestock raising of cattle. Both types of resources and their by-products have the potential to improve the community's standard of living if managed optimally. However, such potential has not been noticed by farmers or ranchers.

Many farmers manage side businesses as breeders, but these businesses are still employing conventional practices. In addition to producing rice paddy, the farmers are also producing agricultural waste in the form of straws. Straw was directly used as cattle feed without going through feed processing technology resulting in poor quality. Farmers also produce wastes in the form of feces and urine, but the feces are only used as fertilizer without going through processing, while urine is disposed of. For this reason, the concept of agriculture and animal husbandry integration is needed in the context of implementing zero waste production management to diversify the farmers' source of income.

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Integrated farming systems can support the availability of manure for agriculture. By applying the principles of zero waste agriculture, by-products of agricultural cultivation can become animal feed and livestock waste/manure can be processed into organic fertilizers. Integration between livestock and crops can increase economic benefits and can improve soil fertility. The application of zero waste agriculture concept is expected to be a potential alternative for environmentally friendly agricultural land management.

Hilimire (2011) states that agriculture-livestock integration can improve soil quality, increase yields, diversify food production and improve land-use efficiency. The benefits of agriculture-livestock integration can be synthesized into: (1) agronomic aspects, namely increasing soil capacity for agriculture, (2) economic aspects, namely product diversification, higher yields and quality, and lowering of costs, (3) ecological aspects, namely pest and erosion control and the use of pesticides, and (4) social aspects, namely more equitable distribution of income. Furthermore, (Tipraqsa et al., 2007) stated that integrated agriculture can also create new jobs in rural areas and reduce urbanization.

The utilization of livestock manures as organic fertilizer, in addition to being able to reduce the reliance on inorganic fertilizers, is also able to improve the structure and availability of soil nutrients. This effect is observable through an increase in land productivity. Adnyana (2003) showed that the CLS (Crops Livestock System) model employed in East and Central Java was able to reduce the use of inorganic fertilizers by 25-35% and increase rice productivity by 20-29%. The CLS model applied by farmers in Bali was also able to reduce spendings on fertilizers by around 25.2% and increase farmers' income by 41.40% (Sudaratmadja et al., 2004). The regional partnership program (PKW) service program aims to assist farmers in developing integrated farming businesses based on zero waste agriculture to increase financial income and maintain, improve, and preserve environmental quality at the same time.

## PROBLEM

The problem in developing sustainable integrated agriculture among farmers, especially in Tindaki Village, South Parigi District, is the relatively low level of education which affects their mindset. In addition, there is a high dependency on the use of chemical fertilizers and pesticides. Shifting such habits into the use of environmentally friendly organic materials will require time. Thus, practical and easily implementable technologies are needed to ease its adoption by the community. This technology is a form of waste-free farming by producing compost and liquid organic fertilizers.

## METHOD OF IMPLEMENTATION

The regional partnership program (PKW) service program was carried out from May to July 2021 in Tindaki Village, South Parigi District, Parigi Moutong Regency. The implementation of this regional partnership program was carried out using a Participatory Action Programs approach where partner farmers who were involved in the program directly follow and apply the various skills that had been provided by the implementation team. The implementation procedure was carried out in several stages, namely: (a) zero-waste agriculture counseling, (b) zero-waste agriculture technology training, (c) zero-waste agriculture technology application in the form of demonstration plots for technology product applications, (d) coaching and mentoring, and (e) the stage of utilizing the resulting technological product in the form of organic fertilizers.

## RESULT AND DISCUSSION

### A. Counseling and training on the use of cattle waste

Improving the knowledge and attitudes of partner farmers towards the zero-waste concept is done by carrying out a series of activities in the form of training, demonstration plot applications, and mentoring. The training was carried out in the Tindaki Village Head Office Hall, with resource personnel from the implementation team and lecturers from the Faculty of Agriculture of Untad University. Also attending the counseling and training activities were the Head of the Tindaki Village and the Regional Development Planning and Research Agency (BAPPELITBANGDA) team of Parigi Moutong Regency as the partner implementation team, namely the Head of the Economics Division and the Head of the Sub-Division of Economics I (Figure 1). The implementation of counseling and training aims to provide knowledge and skills to partner farmers regarding the potential and importance of processing and utilizing cattle waste into products of economic value in the form of compost and liquid organic fertilizers. With such training, it is hoped that there will be a mindset change amongst the partner farmers.

From the material presented by the resource person, it was conveyed that organic fertilizers, including compost and liquid organic fertilizers, have several advantages, namely improving the physical and chemical properties of soil, which are characterized by an increase in the soil's c-organic, providing comprehensive macro and micronutrients so as to reduce the use of inorganic fertilizers, increasing the diversity and population of soil organisms, as well as being safe for usage and the environment. The presentation was followed by training on the making and development of compost and liquid organic fertilizers.


**Figure 1.** The atmosphere during counseling and training.

Compost development activities begin with the collection of materials needed for the development of compost, namely dry (ripe) cow dung, rice straws, plant stoves, rice bran and husks, and EM-4 bioactivators. Afterward, the compost-making practice was carried out (Figure 2).

**Figure 2.** The series of compost development implementation.

For the creation of compost, the ingredients were first mixed and stirred evenly. The EM-4 bioactivator solution was then slowly added into the mix and stirred a second time.

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The bioactivator serves to accelerate the composting process (Sasaki et al., 2016; Zhou et al., 2015). To keep the humidity at 30-40%, the mixture was clenched until it clumps together without releasing water. A considerate amount of water would be added if the humidity was too low. The compost material was then tightly sealed using tarpaulin or plastic and left to sit for 7–28 days. Fermentation temperature was controlled to stay at temperatures between 40-50˚C maximum. If the maximum temperature was exceeded, stirring the mixture using a shovel can reduce it. After 28 days, organic fertilizers are usually formed and ready to be used.

### B. Bio-urine liquid organic fertilizer development

The development of bio-urine liquid organic fertilizer is intended to utilize cow urine obtained during the process of cow feces collection. Cow urine that was collected from cattle pens in bucket containers is put in a plastic storage container with a capacity of 100-150 liters and can then be used as liquid bio-urine fertilizer (Figure 3). The results of the study on the use of bio-culture and bio-urine as liquid fertilizers as reported by Santosa et al. (2015), Lasmini et al. (2018), Ohorella (2012), Nurtika et al. (2008). The results of this study indicate that bio-culture liquid fertilizers and bio-urines can improve soil's physical and biological properties (Pradhan et al., 2018), by acting as growth triggers and antimicrobials (Jandaik et al., 2015) and, in turn, increase crop yield growth (Lasmini et al., 2015, 2019a, 2019b; Oliveira et al., 2009). Thus, bio-urine liquid organic fertilizer is an alternative product that can be used to support organic farming activities (Nasir et al., 2020).

**Figure 3.** The atmosphere during training on the making of bio-urine liquid organic fertilizer.

The utilization of cow feces and urine as liquid organic fertilizers, in addition to reducing environmental pollution, can also provide farmers with the medium that is becoming increasingly expensive and difficult to obtain in the market. By developing their own organic fertilizers, farmers will benefit in terms of production needs as well as from a financial perspective.

### C. Demonstration plot for the use of agricultural and livestock wastes as alternative energy

A demonstration plot for the reprocessing of agricultural and livestock waste into energy, in this case, the compost application that had previously been made, was carried out in the rice fields owned by one of the training participants. In the previously treated fields, compost was applied at a dose of 10 tons/ha by scattering evenly on the fields one week before planting (Figure 4). Afterward, rice planting was carried out in accordance with the local government's recommendations. Plant maintenance is carried out by removing weeds while pest and disease control was carried out preventively and curatively if signs of pests and symptoms of diseases are detected.

**Figure 4.** Techniques for applying compost to paddy fields.

A demonstration plot for the reprocessing of agricultural and livestock waste into energy, in this case, the compost application that had previously been made, was carried out in the rice fields owned by one of the training participants. In the previously treated fields, compost was applied at a dose of 10 tons/ha by scattering evenly on the fields one week before planting (Figure 4). Afterward, rice planting was carried out in accordance with the local government's recommendations. Plant maintenance is carried out by removing weeds while pest and disease control was carried out preventively and curatively if signs of pests and symptoms of diseases are detected.

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The results from the demonstration plot showed that rice plants treated with compost at a dose of 10 tons/ha or liquid organic fertilizer bio-urine at a dose of 500 l/ha produced 5.6 tons/ha of rice while conventional ones produced 6 tons/ha of rice. If production costs are calculated, with the assumption that to make 1 tonne of compost, the cost of collecting raw materials and EM-4 bioactivator is Rp. 200,000, - then every 10 tons requires a fee of Rp. 2,000,000., - meanwhile, inorganic fertilizers in the form of compound NPK fertilizer, require around 275-300 kg/ha with a price of Rp. 12,000/kg and an additional fee of Rp. 3,600,000. There is a discrepancy in operational costs by Rp. 1,600,000/ha, which makes organic fertilizers more profitable for farmers. In addition, the use of organic fertilizers has a positive impact on the continuity and sustainability of farming because agricultural land will recover from organic matter shortages.

Lasmini et al. (2015) and Santosa et al. (2015) suggested that compost and liquid organic fertilizers contain macronutrients and micronutrients needed by plants to produce yields. This means, with the addition of compost and liquid bio-culture fertilizer, plants will be able to grow optimally and produce high yields. Results from the analysis chemical composition of bio-urine liquid fertilizer (dry-based analysis), showed a pH value of 6.86, organic-C content of 17.25%, nitrogen of 2.25%, phosphorus of 0.67%, and potassium of 1.32% (Matheus et al., 2019).

## D. Guidance and mentoring

The next stage is to assist each partner in product utilization. The products produced by the target partners during training activities are compost and bio-urine liquid fertilizers. The two products have been utilized by partner members for their farming activities. The implementation team provided periodical guidance and assistance to members of partner farmer groups in improving production techniques including product packaging and labeling as well as improving the application of the method, particularly regarding dosage and concentrations to maximize the obtainable results. Guidance and mentoring are also provided for the construction of example cages and organic fertilizer production houses (Figure 5).

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**Figure 5.** Assistance activities and demonstration plots for the application of zero waste agricultural technology

## CONCLUSION

Through the implementation of the PKW program, it can be concluded that the implementation of integrated farming development training based on zero waste agriculture went well, and the relayed technology can be adopted by the community, which is marked by the community's ability to make and develop compost and liquid organic bio-urine fertilizers. Both types of organic fertilizers were applied in the demonstration plots to determine how much they reduce the need for inorganic fertilizers. Rice production in the demonstration plot area was equivalent to 5.6 tons/ha, while in conventional land, the yield was 6 tons/ha. These results show potential benefits for farmers where production costs are lower when compared to data findings from conventional land.

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**Original Title:**
Pengembangan Usaha Tani Terpadu Berbasis *Zero Waste Agriculture* di Kabupaten Parigi Moutong

**Abstrak.** *Zero waste agriculture* merupakan konsep pertanian yang berorientasi pada siklus penguraian makhluk hidup dengan mengintegrasikan sistem pertanian dan peternakan sehingga tidak ada limbah yang terbuang. Limbah budidaya pertanian akan menjadi pakan ternak dan limbah/kotoran ternak akan digunakan sebagai bahan pembuatan pupuk organik. Program pengabdian kemitraan wilayah (PKW) bertujuan untuk mendampingi petani dalam pengembangan usaha tani terpadu berbasis *zero waste agriculture*. PKW dilaksanakan pada bulan Mei sampai dengan Juli 2021 di Desa Tindaki Kecamatan Parigi Selatan Kabupaten Parigi Moutong. Pelaksanaan program kemitraan wilayah ini dilakukan dengan pendekatan *Participatory Action Programs,* yakni petani mitra yang terlibat secara langsung mengikuti dan menerapkan berbagai ketrampilan yang telah diberikan. Prosedur pelaksanaan kegiatan dilakukan dengan beberapa tahapan, yaitu: (a) penyuluhan *zero waste agriculture*, (b) pelatihan teknologi dan penerapan teknologi *zero waste agriculture* berupa demplot aplikasi produk teknologi, (d) pembinaan dan pendampingan, serta (e) tahap pemanfaatan produk teknologi yang dihasilkan. Hasil pelaksanaan disimpulkan bahwa pelatihan pengembangan usaha tani berbasis *zero waste agriculture* berlangsung dengan baik dan teknologi yang disampaikan dapat diadopsi oleh masyarakat, ditandai dengan kemampuan dalam membuat dan mengembangkan kompos dan pupuk organik cair biourin. Kedua jenis pupuk organik telah diaplikasikan di lahan demplot untuk menentukan efektivitasnya dalam mengurangi pemakaian pupuk anorganik. Produksi padi diperoleh hasil setara 5,6 ton/ha sedangkan di lahan konvensional diperoleh 6 ton/ha. Hasil tersebut sangat menguntungkan petani karena biaya produksi lebih rendah dibandingkan di lahan konvensional. Zero waste agriculture merupakan suatu cara bertani dan beternak yang memanfaatkan limbah pertanian dan limbah peternakan menjadi energi.

**Kata kunci:** Feses kotoran ternak, limbah pertanian-peternakan, urin sapi, zero waste agriculture