

Review Article

Developing Integrated Crop-Livestock Farming System as a Strategy for Green Growth in Low Income Countries: A Brief Review

Julian Witjaksono^{1,*}, Suharyanto², Rita Indrasti³¹Socio Economic and Policy Analysis Division, The Assessment Institute for Agricultural Technology of Southeast Sulawesi, Kendari, Sulawesi Tenggara, Indonesia²Socio Economic Division, The Assessment Institute for Agricultural Technology of Bangka Belitung, Pangkal Pinang, Indonesia³Farming System Division, Indonesian Centre for Agricultural Technology Assessment and Development, Bogor, West Java, Indonesia**Email address:**

julian_witjaksono@yahoo.com (J. Witjaksono)

*Corresponding author

To cite this article:Julian Witjaksono, Suharyanto, Rita Indrasti. Developing Integrated Crop-Livestock Farming System as a Strategy for Green Growth in Low Income Countries: A Brief Review. *Animal and Veterinary Sciences*. Vol. 6, No. 1, 2018, pp. 12-16. doi: 10.11648/j.avs.20180601.13**Received:** March 13, 2017; **Accepted:** December 17, 2017; **Published:** January 26, 2018

Abstract: Today, low income countries around the world are promoting sustainable development through sustainable agricultural practices which will help them in addressing socio economic as well as environmental issues simultaneously. Integrated farming systems hold special position as in this system nothing is wasted, the byproduct of one system becomes the input for other. A green growth approach is the chance for emerging and developing countries to leapfrog unsustainable and inefficient production and consumption patterns. This paper explores crop-livestock farming system pattern drawn from developing countries as the green growth approach in order to push agriculture more sustainable in the future.

Keywords: Integrated, Sustainable, Farming System, Crop, Livestock

1. Introduction

In the simplest sense, agricultural sustainability connotes the maintenance of the quantity, as well as the quality of agricultural produce over very long periods of time without signs of fatigue [1]. Modern agriculture now feeds 6,000 million people and by 2050, global population is projected to be 50% larger than at present and global grain demand is projected to double [2]. Indeed, the human population, particularly in developing countries, is growing at an exponential rate. There is also the coexistence of unsustainable life styles and unacceptable poverty. Consequently, human kind has been facing serious ecological and social problems: growing damage to basic life support system of land, water, forests, biodiversity, oceans and the atmosphere [3]. There is a general consensus that agriculture has the capability to meet the food needs of 8–10 billion people while substantially decreasing the proportion of the

population who go hungry [4,5] but there is little consensus on how this can be achieved by sustainable means. Sustainability implies both high yields that can be maintained, even in the face of major shocks, and agricultural practices that have acceptable environmental impacts [6].

High population growth, rising rural population density, improved transport and better access to markets means that much of not only in Africa but also in Asia such Indonesia has moved beyond extensive cultivation with fallowing and shifting fields. While pressure on natural resources may be unwelcome, transport costs to markets may fall, and intensification may see complementarities between factors of production that increase the rate of return to investment on farms [7]. Since the 1990s, many studies [8, 9] have listed the benefits of crop-livestock systems of better exploiting the resources of specific biophysical conditions. Nutrient cycling and soil fertility can be improved at field and farm levels by animal-waste recycling and by including grasslands in

field-crop systems [10]. Moreover, diversification of production may reduce economic risks [11]. Crop-livestock integration may represent a model of sustainable farming according to principles of nutrient recycling and efficient use of land and resources [12]. For most low-income countries, agricultural growth may be an initial source of growth, or a necessary adjunct to the growth of other sectors, or both. Indeed, agriculture has been shown to be highly effective in reducing poverty in low-income countries [13], while it seems that both overall economic growth and the effectiveness of that growth in reducing poverty are hindered by high initial levels of poverty [14].

The concept of green growth has emerged amid concerns over increasingly evident resource constraints and growing economic and environmental risk and uncertainty that threaten the continued stability and prosperity of the region. Green Growth is the pathway to inclusive and sustainable growth [15]. This paper shortly discuss the concept of crop livestock farming practices in sustainable manner based on the body evidences. Then we briefly green growth strategies as an alternative development pathway towards green economy particularly for poor-resource farmers in developing countries.

2. Integrated Farming System and Sustainable Agriculture

The conceptual framework developed to analyze and design integrated crop-livestock explicitly distinguishes the metabolic functioning (inputs and outputs of nutrients and energy) and ecosystem services of farming systems, which are two types of improvement mechanisms, and the socio-economic coordination between stakeholders necessary to initiate or modify them [16]. Crop-livestock integration is seen as a socio-ecological system combining biotechnical and social innovations [17]. An integrated farming system consists of a range of resource-saving practices that aim to achieve acceptable profits and high and sustained production levels, while minimizing the negative effects of intensive farming and preserving the environment [18]. A recent study shows the future of agriculture in India and several other developing countries such Indonesia and emerging countries in Africa depends upon their ability to enhance the productivity of small holdings without damage to their long-term production potential [3]. Thus integrated crop-livestock farming system is the critical way to be implemented particularly in low income countries.

In this case, integrating crops and livestock serves primarily to minimize risk and not to recycle resources. In an integrated system, crops and livestock interact to create a synergy, with recycling allowing the maximum use of available resources [19]. Crop residues can be used for animal feed, while livestock and livestock by-product production and processing can enhance agricultural productivity by intensifying nutrients that improve soil fertility, reducing the use of chemical fertilizers [10, 11, 12, 20]. Develop strategies and promote crop livestock synergies and interactions that aim to (a) integrate crops and livestock effectively with careful land use; (b) raise the

productivity of specific mixed crop-livestock systems; (c) facilitate expansion of food production; and (d) simultaneously safeguard the environment with prudent and efficient use of natural resources. Devise measures (for instance, facilitating large-scale dissemination of bio-digesters) to implement a more efficient use of biomass, reducing pressures on natural resources; and develop a sustainable livestock manure management system to control environmental losses and contaminant spreading [21, 22, 23, 24].

A case study from Africa shows that at farm level, livestock provide not only part of the family food, but are also useful for crops through the use of manure and draught power. Importantly, livestock also provide an income to the economy of pastoral households, ensuring a means for saving, insurance and legacies. Livestock are therefore essential to the security and reproduction of the systems. Locally, such system contribute more and more to salary employment [25]. Moreover, talking about the benefits of integrated farming system, a previous study reported that in Western Kenya the importance of two functions of crop livestock farming practices (integrated crop-cows farming system) have shown that the number of dairy cows and the quantity of manure used in the farm have a significant influence on crop production in Western Kenya [26]. Livestock were components of systems with long term sustainability. For example, with the keeping of livestock was essential for survival in divergent systems such as those of the pastoralists in Africa, and those on peat soil pastures of the low income countries and on mountain range unsuitable for cropping [27]. Thus study literature shows that crop-livestock farming system can play a positive role in sustainability system.

3. Green Growth Strategy Through Integrated Crop-Livestock Farming System

The livestock sector is increasingly organized in long market chains that employ at least 1.3 billion people globally and directly support the livelihoods of 600 million poor smallholder farmers in the developing world [28]. Keeping livestock is an important risk reduction strategy for vulnerable communities, and livestock are important providers of nutrients and traction for growing crops in smallholder systems. Currently, livestock is one of the fastest growing agricultural subsectors in developing countries. Its share of agricultural GDP is already 33 per cent and is quickly increasing. This growth is driven by the rapidly increasing demand for livestock products, this demand being driven by population growth, urbanization and increasing incomes in developing countries [29]. Most of the poor in developing countries live in rural areas. They depend on agriculture and allied activities for their livelihood. Thus a rapid growth in agriculture and rural development is crucial for reducing poverty. Livestock fit well in this scheme of poverty reduction. They play the role of enhancing livelihoods of the poor. Livestock generate a continuous flow of income, enabling the

poor to meet their daily cash requirements and other contingency expenditures. Livestock are natural capital assets with self-accumulative capability through reproduction [29, 30]. This implies that the greater the accumulation of livestock wealth, the greater is the flow of income. Livestock also act as a cushion against income shocks from crop failure and help consumption smoothening during times of crisis. For most low-income countries, integrated crop-livestock farming system of agricultural growth may be an initial source of growth, or a necessary adjunct to the growth of other sectors, or both. Indeed, crop-livestock in agriculture system has been shown to be highly effective in reducing poverty in low-income countries [13], while it seems that both overall economic growth and the effectiveness of that growth in reducing poverty are hindered by high initial levels of poverty [30]. That indicates that crop-livestock growth, by reducing poverty and thereby stimulating overall growth, may be particularly effective in contributing to economic growth as well as poverty reduction in low-income countries.

The green growth model recognizes that steps to protect and conserve environmental resources can be a driver for national and global economic progress. Economic growth is a necessary if not sufficient – condition to address many of the social and equity concerns faced by societies. Environmental protection not only enhances long-term economic performance through a more sustainable use of the resource base, but can also contribute to equity: natural resource and environmental degradation impacts most heavily on the poor [31]. Moreover, the relationship between agriculture and green growth is complex. The food and agricultural sectors can generate both environmental harm and conserve ecosystem services. This is because the sector both depends on and impacts natural resources (land, water, and biodiversity) in the production process. Moreover, resource endowments and environmental absorptive capacities vary widely across countries and regions, and impacts can differ in the short and long run and at different stages of production and consumption. Thus the context is critical.

In recent years there has been a substantial growth of interest in production methods that can be termed conservation or integrated agriculture. These are methods that try as far as possible to only use the amount of inputs that will produce commodities in ways that are respectful of the environment. Defined sustainable agriculture as capable of maintaining its productivity and usefulness to society indefinitely [32]. Such an agriculture must use farming systems that conserve resources, protect the environment, produce efficiently, compete commercially and enhance the quality of life for farmers and society overall. What is increasingly clear is that no one farming system can be identified as sustainable, and there is no single path to sustainability. All farming systems from intensive conventional farming to organic farming to something that falls between the two extremes have the potential to be environmentally-sustainable [33]. Therefore, developing an environment favoring innovation can contribute to green growth in agriculture. Notable examples of innovation such

farming systems innovations with green potential different ways of organizing agricultural production may involve the use of one or more specific technological innovations as defining characteristics, or it may be purely to do with how production and marketing is organized, or a combination of the two. Integrated farming system is one of the example of this. It is important to note that some of the innovations offer win-win potential: production benefits and environmental benefits. For example green technologies, such as Integrated Pest Management, conservation tillage and integrated crop-livestock farming system can increase productivity and farm profitability, all the while reducing environmental degradation and conserving natural resources [34].

An important component of a green growth strategy is further reforming and decoupling agricultural support from output and input levels [35]. As part of the transition to green growth, governments can promote rural development based on ecosystem services, conservation agriculture practices, diversification of farming activities from commodity production to the processing of agricultural [36]. Where environmentally and economically viable, land can be converted to biomass production including for bio-fuels [37, 38]. Thus integrated crop-livestock farming system is the critical way to be implemented particularly in low income countries as the strategy towards to the green growth implementation [39, 40].

4. Conclusion

Within the broad concept of sustainable agriculture “Integrated Farming Systems” hold special position as in this system nothing is wasted, the by-product of one system becomes the input for other. Moreover, for the low income countries, the system help poor-resource farmers, who have very small land holding for crop production and a few heads of livestock to diversify farm production, increase cash income, improve quality and quantity of food produced and exploitation of unutilized resources.

The increase in demand for livestock products presents opportunities for small farmers who can increase livestock production and benefit from related income. However, in terms of environmental impact, the growing number of livestock and the increase in livestock processing can have a negative impact on natural resources unless actions are taken to identify farming practices that are economically and ecologically sustainable. Thanks to the dynamic interaction of its various components, the highly improved integrated crop-livestock system can guarantee more sustainable production and therefore constitutes a valid new approach in order to forward a green growth development in low income countries.

References

- [1] Kesavan PC, Swaminathan MS. Strategies and models for agricultural sustainability in developing Asian countries. *Phil. Trans. R. Soc. B* 2008; 363: 877–891. doi:10.1098/rstb.2007.2189

- [2] Tilman D, Kenneth G. Cassman, Pamela A. Matson, Rosamond N, Polasky S. Agricultural sustainability and intensive production practices. *Nature* 2002; 418: 671-677.
- [3] Kesavan PC, Swaminathan MS. Achieving the sustainable development goals. *Current Science* 2016; 110:1 27-128.
- [4] Kates RW. Ending hunger: current status and future prospects. *Consequences* 1996; 2: 3-12.
- [5] Plucknett DL. International agricultural-research for the next century. *Bioscience* 1993;43:432-440
- [6] Reganold JP, Glover JD, Andrews P, Hinman HR. Sustainability of three apple production systems. *Nature* 2001; 410: 926-930. doi:10.1038/35073574.
- [7] Jayne TS, Chamberlin J, Muyanga M. *Emerging Land Issues in African Agriculture: Implications for Food Security and Poverty Reduction Strategies*. Paper presented as part of Stanford University's Global Food Policy and Food Security Symposium Series, sponsored by the Center for Food Security and the Environment and the Freeman Spogli Institute for International Studies Stanford: California; 2012.
- [8] Russelle MP, Entz MH, Franzluebbers AJ. Reconsidering integrated crop-livestock systems in North America. *Agronomy Journal* 2007; 99: 325-334.
- [9] Hendrickson JR, Hanson JD, Tanaka DL, Sassenrath GF. Principles of integrated agricultural systems: introduction to processes and definition. *Renewable Agriculture and Food Systems* 2008; 23: 265-271.
- [10] Ryschawy J, Choisis N, Choisis JP, Joannon, Gibon A. Mixed croplivestock systems: an economic and environmental-friendly way of farming? *Animal* 2012; 6: 1722-1730.
- [11] Wilkins, RJ. Eco-efficient approaches to land management: a case for increased integration of crop and animal production systems. *Philosophical Transactions of the Royal Society B* 2008; 36: 517-525.
- [12] Moraine M, Duru M, Nicholas P, Leterme P, Therond O. Farming system design for innovative crop-livestock integration in Europe. *Animal* 2012; 8 : 1204-1217. doi:10.1017/S1751731114001189
- [13] Christiaensen L, Demery L, Kuhl, J. *The (Evolving) Role of Agriculture in Poverty Reduction. An Empirical Perspective*. Working Paper No. 36. Helsinki: UNU Wider; 2010.
- [14] Ravallion M. 'Why Don't We See Poverty Convergence?' *American Economic Review* 2012; 102: 504-523, <http://dx.doi.org/10.1257/aer.102.1.504>
- [15] Kate R, Sarah W, Steve B. Securing social justice in green economies: A review and ten considerations for policymakers. *IIED Issue Paper*. IIED: London; 2014.
- [16] Green K, Vergragt P. Towards sustainable households: a methodology for developing sustainable technological and social innovations. *Futures* 2002; 34: 381-400.
- [17] Ostrom E. 2009. A general framework for analyzing sustainability of socioecological systems. *Science* 2009; 325: 419-422.
- [18] Vinod G, Pradeep KR, Risam KS. Integrated Crop-Livestock Farming Systems: A Strategy for Resource Conservation and Environmental Sustainability. *Indian Research Journal of Extension Education* 2012; 2: 1-49.
- [19] FAO. *Mixed Crop-Livestock Farming: A Review of Traditional Technologies based on Literature and Field Experience*. Animal Production and Health Papers 152. Rome: FAO; 2001.
- [20] Horlings LG, Marsden TK. Towards the real green revolution? Exploring the conceptual dimensions of a new ecological modernisation of agriculture that could "feed the world". *Global Environmental Change* 2011; 21: 441-452.
- [21] Sumberg J. Towards a dis-aggregated view of crop-livestock integration in Western Africa. *Land Use Policy* 2003; 20: 253-264.
- [22] Peyraud JL, Taboada M, Delaby L. Integrated crop and livestock systems in Western Europe and South America: a review. *European Journal of Agronomy* 2014; 1-12. doi:10.1016/j.eja.2014.02.005.
- [23] Russelle MP, Entz MH, Franzluebbers AJ. Reconsidering integrated crop-livestock systems in North America. *Agronomy Journal* 2007; 99: 325-334.
- [24] International Fund for Agricultural Development. (IFAD). *Integrated Crop-Livestock Farming System, Burkina Faso*; Rome: 2005.
- [25] Wane A, Touré I, Ancy V. Assets of the market, assets of the rural world: Pastoral market income distribution in the Senegalese Sahel (Ferlo). *Journal of Income Distribution* 2009; 18: 232-248.
- [26] Frédéric B, Moti J, Oriama O, Asheber. Conservation agriculture in African mixed crop-livestock systems: Expanding the niche. *Agriculture, Ecosystems and Environment* 2014; 187: 171-182.
- [27] Schiere, Ibrahim M, Van K. The role of livestock for sustainability in mixed farming: criteria and scenario studies under varying resource allocation. *Agriculture, Ecosystems and Environment* 2002; 90: 139-153.
- [28] Thornton P. Livestock production: recent trends, future prospects. *Phil. Trans. R. Soc. B* 2010; 365:2853-2867. doi:10.1098/rstb.2010.0134
- [29] Rao P, Birthal, PS. *Livestock in mixed farming systems in South Asia*. National Centre for Agricultural Economics and Policy Research, New Delhi, India; International Crops Research Institute for the Semi-Arid Tropics; India: 2008.
- [30] Delgado C, Rosegrant M, Steinfeld H, Ehui S, Courbois C. *Livestock to 2020: the next food revolution*. Food, Agriculture and Environment Discussion Paper 28. International Food Policy Research Institute; USA: 1999.
- [31] OECD. *A green growth strategy for food and agriculture*; Preliminary report: 2011.
- [32] Ikerd J. Two related but distinctly different concepts: organic farming and sustainable agriculture, *Small Farm Today* 1993; 10: 30-31.
- [33] OECD. *Adoption of Technologies For Sustainable Farming Systems*: Wageningen Workshop. Proceedings, OECD; Paris: 2001.
- [34] Lemaire G, Franzluebbers A, Carvalho PC, Dedieu B. Integrated crop-livestock systems: strategies to achieve synergy between agricultural production and environmental quality. *Agriculture, Ecosystems and Environment* 2013; 14:1-5. doi:10.1016/j.agee.2013.08.009.

- [35] Griggs D, Stafford-Smith M, Gaffney O, Rockström J, Öhman MC, Shyamsundar P, Steffen W, Glaser G, Kanie N, Noble I. Sustainable Development Goals for People and Planet. *Nature* 2013; 495: 305–307.
- [36] Jupesta J, Boer R, Parayil G, Harayama Y, Yarime M, Puppim de Oliveira, JA, Subramanian SM. Managing the transition to sustainability in an emerging economy: Evaluating green growth policies in Indonesia. *Environmental Innovation and Societal Transitions* 2011; 1: 187–191.
- [37] Martin Jänicke. ‘Green growth’: From a growing eco-industry to economic sustainability. *Energy Policy* 2012; 48: 13–21.
- [38] John M Reilly. Green growth and the efficient use of natural resources. *Energy Economics* 2012; 34: 585–593
- [39] Wei YP, White RE, Chen D, Davidson BA, Zhang JB. Farmers’ Perception Of Sustainability For Crop Production On The North China Plain, *Journal Of Sustainable Agriculture* 2007; 30: 129 – 147.
- [40] Powell JM, Pearson RA, Hiernaux PH. Crop-livestock interactions in the west african drylands. *Agronomy Journal* 2004; 96: 469-483.