



ISSN Print: 2664-844X
ISSN Online: 2664-8458
IJAFS 2025; 7(1): 43-47
www.agriculturaljournals.com
Received: 17-11-2024
Accepted: 19-12-2024

Nija George
Vocational Teacher (Small Poultry Farmer), GVHSs for Girls, BP Angadi, Tirur, Kerala, India

Raj Kamal PJ
Professor and Head (Rtd.), Department of Vety. & AH Extension, CVAS, Mannuthy, Kerala Veterinary and Animal Sciences University, Pookode, Wayanad, Kerala, India

Reeja George P
Professor, Department of Vety. & AH Extension, CVAS, Mannuthy, Kerala Veterinary and Animal Sciences University, Pookode, Wayanad, Kerala, India

Corresponding Author:
Nija George
Vocational Teacher (Small Poultry Farmer), GVHSs for Girls, BP Angadi, Tirur, Kerala, Kerala, India

Prioritizing sustainability strategies for duck farming: The consensus Delphi approach

Nija George, Raj Kamal PJ and Reeja George P

DOI: <https://doi.org/10.33545/2664844X.2025.v7.i1a.237>

Abstract

Exploring the sustainability concerns and the solutions there of was the objective of this study. Anonymous opinions from all the stockholders and consensus on the practices to be stopped, that can be continued and need to be taken up afresh was drawn through a three stage Delphi methodology. The important constraints of duck farming as observed in Delphi analysis were those associated with health care management, general management, social, economic, marketing, policies and environmental in nature. The solutions for these constraints gave an insight into the strategies to be adopted for attaining sustainability. These strategies were discussed from three important perspectives of sustainability analysis *viz.* practices to be stopped, practices that can continue and new practices to be taken up. The important practices to be stopped were the unscientific health care, unorganized credit system and environmental practices. The practices that can continue were the training initiatives in duck farming, promotional programmes on organic farming and integrated farming, maintaining duck farmer registry and strengthening the government hatcheries. The new practices to be taken up were mandatory vaccination, strict surveillance and monitoring, forming a labour pool, organized market system, converting farm and slaughter waste into bio-fertilizer, and establishing a full-fledged disaster management cell.

Keywords: Duck farming, income generation, labour utilization pattern, Kuttanad ecosystem

Introduction

Kuttanad wetland ecosystem has its own unique agrarian culture centred around the rice cultivation. Fruitfully integrated with this major crop, lies the livestock, poultry and other crop systems. The foraging duck flocks has been the backbone and most trusted component of this integrated system. The flourishing back water tourism in Kuttanad has a major role to play in increasing the demand of duck products and thereby making the same an ever evolving component. Even though duck industry in Kuttanad is being commercialized with changing agricultural patterns of the region, the traditional nomadic and foraging systems of farming is preferred due to their high economic feasibility. In these circumstances, the sustainability issues raised by this customary livelihood system need to be addressed. A sustainable production system can neither be organic production nor one contradicting the intensive production practices. Its emphasis is rather on achieving optimum productivity centered around the concepts of minimum dependence on inputs, judicious use of resources and their recycling, animal welfare, environmental viability and social well-being of the communities dependent on it. So much so empirical data on very many crucial aspects of this farming system especially, that pertaining to its sustainability in Kuttanad is the need of the hour. Such data will be relevant for future policy decision when those are coming from stakeholders themselves. With this idea, a study was conducted to identify the constraints faced by duck farming in Kuttanad and to arrive at solutions for achieving sustainability of duck farming.

Materials and Methods

FAO has recognized the “Below sea level farming of Kuttanad” as globally important agricultural heritage farming system. Farming practices include rice cultivation, aqua culture, buffalo rearing, duck farming and prawn culture. Seventy five per cent of the duck farming in Kerala is carried out in and around Vembanadu Lake and Kuttanad region, and hence this region was purposively selected for the study.

Since the objective was identifying constraints and arriving at solutions to achieve sustainable duck farming in Kuttanad, Consensus Delphi method was used. Delphi is a forecasting methodology used for deriving policy decisions by arriving at consensus among stakeholders. This two-stage approach lead progressively towards a consensus of opinion and, because the experts never meet, a consensus that is unlikely to be biased by the force of individual personalities. A three round Delphi analysis was used. In the first round the selected panel of respondents was asked to give their opinions on constraints to duck farming system in the area from their experiences and judgments. In the second round, a copy of the collective list of constraints developed by compiling the responses of first round was presented to each expert seeking agreement or disagreement. The responses collected in Round II were analyzed and the rating for each statement was done by calculating per cent of agreement. The third questionnaire included the list, the ratings indicated, and the consensus, if any. This was administered to the panel along with ratings done in second stage to give their agreement or disagreement to the constraints and for suggesting solutions. This round gave Delphi panelists an opportunity to make further clarifications of both the information and their judgments considering the relative importance of the items. From the responses to third questionnaire, conclusions were drawn on the duck farming practices in the area which are to be stopped, that can continue and to be taken up new.

A panel of 30 respondents was identified. This panel comprised of representatives of various stakeholders of duck farming in Kuttanad region such as Veterinary Surgeons, farmers, office bearers of farmers unions of the area, officers of Government duck farm, representatives of NGOs and environmental activists. The panel comprised of stakeholders from Kuttanad area including farmers, veterinary officers, extension agents, NGO representatives etc. The respondents were representative persons with the knowledge and skill pertaining to the broad area of concern selected out of a pilot study and by the method of key informant identification.

Results and Discussion

1. Constraints faced by duck farming in Kuttanad

An outcome of Delphi analysis was an insight into the constraints, solutions and strategies to be adopted to ensure sustainability of duck farming in Kuttanad. The important constraints of duck farming as observed in Delphi analysis were those associated with health care management, general management, social, economic, marketing, policies and environmental in nature. The major health care management constraints were associated with the prevention of diseases due to incomplete vaccination and also with the indiscriminate use of antibiotics. In this regard, Rahman reported that various technical constraints to duck production in Bangladesh included insufficient preventive healthcare practices due to lack of knowledge of parasitic and infectious diseases among other management problems. Important constraints related to general management were over dependence on traditional practices by the farmers as well as diminishing land for foraging. AVF (2006) ^[3] reported that majority of the Vietnamese duck farmers had trust in the traditional medicine rather than scientific practices and therefore only a few utilized the health care services of a para-vet and preventive vaccination. However,

unlike the results of present study, the farmers of Vietnam according to AVF (2006) ^[3] practiced non-mingling of the flocks during foraging to prevent the spread of disease. The social constraints centered around the inadequacy of training as well as information dissemination and the low level participation of younger generation in the traditional duck farming systems. These are much crucial constraints. Abraham and Raveendran, (2009b) ^[2] reported that training was very crucial to improve the knowledge base of farmers in improving the productivity of the duck farming system in the Aroor region of Kuttanad. Important economic constraints were high cost of medicines, supplements and feed, loss due to diseases and the difficulties in availing compensation from insurance. The present findings were partially in agreement with that of Chang and Villano (2008) ^[5] reporting that high cost of feed and unavailability of feed resources were the major weakness of duck production in Philippines. Regarding marketing, the seasonal fluctuation in the demand of duck products, price fluctuations and the exploitation by middlemen were the important constraints. Further the policy constraints to be addressed were those associated with credit availability, insurance coverage and inadequacy of promotional schemes on duck farming. Chang *et al.* (2003) ^[6] also reported that the crucial weaknesses of the duck industry in Philippines were unavailability of quality replacement stock, less accessibility to credit facility, seasonal fluctuations in market demand, absence of technical knowledge and ineffective market information system. Environmental constraints of importance were the pollution caused by foraging duck flocks and also due to improper waste management from duck farms and associated activities. In this regard, Gbotosho and Burt (2013) ^[11] reported that in Ohayo state of Nigeria, improper disposal of the poultry farm waste was causing environmental issues leading to health problems for the people. This improper disposal practice according to Gbotosho and Burt (2013) ^[11] was due to farmers lack of knowledge of scientific waste management and inadequate trainings in this regard.

2. Strategies for sustainability

These strategies were discussed from three important perspectives of sustainability analysis *viz.* practices to be stopped, practices that can continue and new practices to be taken up. These strategies were consolidated after perusing the solutions to constraints that were suggested by the stakeholders.

2.1. Practices to be stopped

Disease prevention is more important as infectious and contagious diseases have been a threat to duck farming in Kuttanad. Mandatory vaccination is the only solution and vaccinated birds must only be permitted to be maintained in the households. In this context, the present practices of keeping unvaccinated birds, taking them to the field for foraging and the practice of introducing unvaccinated new birds to the flock whenever there is a high market demand have to be stopped immediately.

The indiscriminate use of antibiotics by the farmers, need to be stopped since periodic infections even multiple infections are a common in the area probably due to antibiotic resistance acquired.

It has been a practice among duck farmers to vaccinate the ducks themselves which need to be stopped since the

farmer-vaccinators are not trained in the science of doing it. This situation has arisen by virtue of the scarcity of vaccinators for this purpose in the veterinary institutions besides it being cheap and convenient for the farmers to vaccinate their birds themselves.

A majority of duck farmers who are either marginal or even landless solely depend on paddy fields and water bodies to raise their flocks. These foraging fields are but declining in area since there has been indiscriminate land conversion and use for other purposes including tourism industry. So also, the construction of Tanneermukam bund has resulted in waterlogging and the explosive growth of invasive plant species. Therefore, the conversion of paddy fields has to be stopped enforcing policies. That apart, the fields have to be cleared of the invasive water plants to provide a space for duck movement and foraging, in many places. As a consequence of these menaces, farmers were forced to quit duck farming or to take up relatively more expensive intensive systems of rearing. Tamizhkumaran *et al.* (2013)^[15] also reported that the scarcity of water bodies and land for foraging was an important constraint to duck farming in Puducherry region. Extensive burning of the stubble is another practice that has compounded the aforesaid situation further. The rice cultivators must be discouraged from burning the stubble since it burns the left over grains in the post-harvested fields and also the small creatures there that the ducks feed on.

Farmers in the region are traditional and therefore still depend on indigenous practices and wisdom acquired over generations. This has however, resulted in the reluctance to accept scientific management practices. Hence the over dependency on indigenous practices and wisdom relegating to the background the scientific recommendations need to be stopped. A way out perhaps is melding those rational indigenous practices with scientific recommendations. Thakur *et al.* (2013)^[16] reported that the adoption of scientific management practices in housing, feeding and health care had a positive effect on the sustainability of backyard poultry units in Himachal Pradesh. Using farm science centres and government extension agencies can help to encourage scientific farming practices. Beruah *et al.* (2024)^[4] observed that the technology transfer efforts by KVKs have proved fruitful in improving adoption of scientific rearing practices among poultry farmers of Arunachal Pradesh.

The socio-cultural transformation of Kuttanad has resulted in hired labour replacing family labour. This has rendered duck farming less cost-effective and hence the over-dependency on hired labour needs to be stopped.

Credit is an important area requiring immediate intervention. Duck farmers still depend on the money lenders for credit. The exorbitant interest charged by them can make the farmers indebted lifelong. Hence, farmers must be discouraged from availing credit from money lenders. In this context Tamizhkumaran *et al.* (2013)^[15] reported that even though the income obtained from duck farming for the nomadic farmers of Puducherry was enough for repaying the investments by contractors, due to their illiteracy and less knowledge of market situations the farmers were exploited by the contractors and they continued in debt season after season. It is worth mentioning here that the farmer's dependence on the private lenders is due to their inability to avail loans from nationalized banks. These banks demand collateral security which the poor

farmers might not be able to provide. Therefore, the requirement of collateral security now being demanded must be stopped.

Farm waste, slaughter waste and even the birds that die of diseases are at present not safely disposed. This has resulted in the pollution of land and water bodies around. Hence, this unhygienic practice must be stopped immediately. FAO (2010)^[10] reported that duck-fish production system of China was facing the challenge of increased public concern of pollution due to poorly managed duck farms located near water bodies and the overall environmental ill effects. Another important practice that has to be stopped is the indiscriminate use of chemicals *viz.* fertilizers, pesticides and weedicides in agriculture. This practice according to the farmers has reduced the availability of small creatures including the crustaceans edible to ducks. Pervin *et al.* (2013)^[14] reported that there were chances of foraging duck in Bangladesh being affected by the pesticides applied in neighboring fields.

2.2. Practices that can continue

Strengthening further the existing training initiatives making them more need-based and accessible to all is a practice to be continued considering the fact that duck farmers still depend on indigenous knowledge and not scientific recommendations. In this context Chang and Villano (2008)^[5] opined that policy implication for improving technical economics and productivity of duck farming in Philippines should focus on need based assistance to farmers in terms of technical support, extension service and training for well-targeted group to support the change of subsistence to commercial farming. Since, organic production systems and resource recycling is gaining importance, the promotional programmes on organic farming and integrated farming is of great significance and hence further strengthening and continuing these programmes will be beneficial. The 'Kumarakom model' of integrated farming now being tried incorporating fish, duck and rice is an excellent model that must continue and adopted widely. Integration is beneficial since by-products can be utilized as duck feed and that ducks act as agents of biological pest control.

The prevailing practice of supplying vaccines through the local veterinary institutions must be continued. So also the supply of essential medicines like antibiotics, sulpha drugs and dewormers must also continue. Supply of vaccines and essential medicines on demand can lessen the economic burden of the duck farmers. The present practice of periodic monitoring of health status of duck must also be continued but with more vigil. To enable disease monitoring and for other welfare purposes duck farmer registry is maintained at present by the local veterinary institutions and this practice of mandatory registration must continue. AVF (2006)^[3] suggested that for effective management of duck production system in Vietnam, the market access should be limited to the registered duck farmers.

Since government hatcheries are still being preferred over private hatcheries for ducklings their services in the sector must definitely continue strengthening them further. This is for the reason that government hatcheries can supply quality ducklings at fair price which the private hatcheries may not. While proposing the Kuttanad package, MSSRF (2007)^[13] recommended that improving the capacity of Niranam duck hatchery to increase the supply of ducklings would be helpful to counteract the agrarian crisis of duck based

livelihood of Kuttanad. The performance of private hatcheries too requires immediate intervention. Government must intervene to ensure quality ducklings at reasonable cost from these private hatcheries. Since a majority of farmers depend on private hatcheries for ducklings due to the inability of government hatcheries to cater to the demand.

2.3. New practices to be taken up

Since diseases like duck plague and bird flu are a threat vaccination must be made mandatory along with strict surveillance and monitoring. So much so it becomes imperative that awareness creating campaigns on a war footing need to be undertaken to convince the duck farmers of the importance of vaccination. While proposing the Kuttanad package MSSRF (2007) ^[13] suggested that a mobile unit for regular vaccination and for carrying out awareness programmes will improve duck health management in Kuttanad region.

To overcome the acute scarcity of labourers to be hired and engaged in duck farming certain things need to be done *viz.* forming a labour pool participating those persons willing to be labourers and training them in requisite knowledge and skills as in the case of 'agricultural army' model having been tried elsewhere in Kerala to carry out agricultural operations. This labour pool may be formed and maintained by the duck farmers' unions or an appropriate co-operative society like the proposed APCOS model. Moreover, duck farming must be considered as any other agricultural operation to be included under MNREGA. All these can ensure regular employment and wage income to the labourers. In this context Cheriyan (2004) ^[7] suggested that ensuring better social status and regular income is helpful to address the scarcity of agricultural labourers in Kuttanad.

Entrepreneurship development programmes for youths to take up commercial duck farming or associated ventures providing them with hands-on training and all infrastructure facilities and support services will prove fruitful. Efforts in this line to popularize broiler ducks by integrating them with existing fish farming units have proved beneficial in terms of resource utilization and improved income generation in various regions of Tamil Nadu (Devaki, *et al.*, 2020) ^[8] Nomadic trans-human duck farming which is now becoming extinct need to be revived duly supporting the farmers with enough credit, suitable insurance policies and also compensating for flock loss.

If APCOS model co-operatives are formed of the duck farmers it can effectively address many issues now being confronted by them. It can stop middle-men exploitation and assure a ready and fair market. More importantly it can be a center for all necessary goods and services like feed, medicines, equipments and information support. Kanwat *et al.* (2012) ^[12] reported that the farmers' co-operatives in Arunachal Pradesh acted as an important means of information sharing and labour exchange among the poultry farmers.

Projects to address the present feed scarcity especially during the lean season and the issue of high feeding cost which discourage the duck farmers need to be taken up urgently. Feed mixing units can be established locally and the farmers trained in feed mixing incorporating local feed ingredients. Quality control labs at regional level for testing feed and feed ingredients must be started under government support. Feed quality is an important aspect since the ducks are more prone to contamination especially aflatoxins.

Subsidized duck feed could be provided to duck farmers in line with the calf-feed subsidy scheme in vogue in the state, enrolling registered duck farmers. This project can be undertaken by an agency sponsored by KSPDC or AHD with the organizational support from APCOS model duck farmers co-operatives mooted.

Insurance schemes appropriate to different systems of duck rearing, is a strongly felt need to be accomplished. This is of utmost significance since different systems of duck farming in Kuttanad involve varying practices as well as varying periods and hence the need for coverage is also different. In these circumstances a blanket approach or a common insurance coverage scheme will not suffice. Separate schemes for insuring nomadic flocks, nursery farms and semi-intensive systems and that too for shorter periods usually 3-4 months need to be introduced. Moreover, the norms of insurance coverage especially those regarding presenting the dead birds as proof as and when death occurs, need reform. These norms will make it difficult for farmers to avail the insurance benefits due to the practical difficulties especially leaving the flock behind unattended quite often. Therefore, reorganizing the prevailing insurance schemes to suit the different systems of production as well as duration is the need of the hour. Abraham and Raveendran (2009a) ^[1] suggested that financial support in the form of loans and subsidy and making insurance coverage for duck flocks would be helpful to sustain the Chara and Chembally rearing system in Aroor region of Kuttanad.

Banks must initiate attractive loan schemes, to finance duck farmers whereas loans are adequately subsidized with minimum interest and with sufficient repayment period, with repayment starting at the end of the rearing season. Credit support from banks with a minimum repayment period of six years at four per cent interest and one time subsidy of 25 per cent loan was recommended by MSSRF (2007) ^[13].

Regarding marketing the important practices to be started anew are sale of products through organized market outlets, marketing of value added products and branding and labeling of native products. These practices will improve the income from duck products; help overcome market competition from imported products, exploitation by middlemen and the seasonal fluctuations in demand and supply. Marketing intervention will also be helpful in providing employment opportunities to both men and women self- help groups since they can run selling outlets themselves and even market value added products under the auspices of local panchayaths. Marketing interventions in duck production was also suggested by many previous researchers. For instance, Ezhilvalavan *et al.* (2009) ^[9] suggested popularizing duck products and establishing an organized market system for improvement of duck production system in Tamil Nadu. Likewise, Wibowo (2013) ^[17] suggested development of market, production of value added products, necessary strategy for market penetration along with other factors to improve the layer duck business of West Java. Direct procurement of duck products by the government for a reasonable price will also be useful. For instance, direct procurement of paddy by government has boosted up paddy cultivation in Kuttanad.

The pollution of paddy fields and water bodies of Kuttanad began as an after-effect of constructing Thottappaly spillway and Tanneermukam bund. These structures have

hindered the natural water flow of the region. Thottappally spillway though has prevented flooding of Kuttanad it has affected the natural process of flushing the pollutants out during rainy season. Similarly, the Tanneermukam bund has disrupted the harmony of sea and fresh water since it prevented sea water inundation during the summer season that would have again flushed pollutants out. Among scores of pollutants there is duck farm waste too. Duck farmers have been facing local ill-will in this regard. Hence, safe and scientific waste disposal practices must be introduced.

Converting farm and slaughter waste into bio-fertilizer for use in agriculture need to be propagated at the aegies of LSGs so that waste is dealt with at source itself. In the above circumstance, to facilitate a better control of the situation, regulation through licensing of farms, slaughter houses and the connected selling outlets must be made mandatory. FAO (2010) [10] also reported that a change in the pollution status and its environmental ill effects was observed when strict monitoring and control measures were taken to control the activities in and around water bodies and also to control the waste discharge to the water bodies.

A full-fledged disaster management mechanism with all infrastructures must be in place to work in tandem with stakeholders to contain any calamity for instance, out breaks like duck plague, duck cholera and bird flu. As part of the infrastructure public burial grounds and incinerators must be made available to safely dispose the dead birds during disease outbreaks.

Conclusion

Much wider opportunities like that of integration of traditional farming practices and farm tourism await the duck production system of Kuttanad. However the impact of tourism is perceptible in many ways *viz.* shrinkage of lake area due to construction works especially to augment tourism related infrastructure facilities and water pollution due to chemical contamination besides tourism. These all social and ecological changes are impacting the agrarian blanket of Kuttanad including duck farming. Strategies focusing on scientific, need based and problem specific intervention only can sustain and empower the multifaced development of Kuttanad wetland ecosystem.

References

1. Abraham J, Raveendran R. Sustainable duck rearing system using fresh prawn waste. In: Jalaludheen A, editor. Waterfowl production for food security. Proceedings of IV World Waterfowl Conference; 2009. Kerala Agricultural University, Thrissur, Kerala. p. 346-350.
2. Abraham J, Raveendran R. Studies on Aroor system of duck rearing in Kerala. *Int J Poult Sci.* 2009b;8(8):804-807.
3. Agronomes et Vétérinaires sans Frontières (AVF). Review of free-range duck farming systems in Northern Vietnam and assessment of their implication in the spreading of the Highly Pathogenic (H5N1) strain of Avian Influenza (HPAI). Final report. 2006. FAO, United Nations; 101.
4. Baruah MS, Mokidul Islam M, Suraj Singh K, Debbarm S. Technological interventions for impact assessment on backyard Vanaraja poultry farming in two districts of Arunachal Pradesh, India. *J Krishi Vigyan.* 2024;12(2):414-442.
5. Chang H, Villano R. Technical and socio-economic constraints to duck production in the Philippines: A productivity analysis. *Int J Poult Sci.* 2008;7(10):940-948.
6. Chang H, Dagaas C, de Castro N, Ranola R, Lambio A, Malabayabas ML. An overview of the Philippine duck industry. 47th Annual Conference of the Australian Agricultural and Resource Economics Society. 2003. Fremantle: School of Economics, University of New England; p. 27.
7. Cheriyan O. Changes in the mode of labour due to shift in the land use pattern. Discussion Paper No. 81. In: Nair GPR, Shaji H, editors. Kerala research programme on local level development. Centre for Development Studies, Prasanth Nagar, Ulloor, Thiruvananthapuram; 2004. p. 61.
8. Devaki K, Senthilkumar K, Nisha PR. Performance of Pekin ducks and Desi ducks under integrated farming system at Kancheepuram district in Tamil Nadu. *J Krishi Vigyan.* 2019;8(1):217-220.
9. Ezhilvalavan S, Senthilkumar T, Vengadabady N, Mani K, Edwin SC, Bharathidasan A. Duck production system in Tamil Nadu. In: Jalaludheen A, editor. Waterfowl production for food security. Proceedings of IV World Waterfowl Conference; 2009. Kerala Agricultural University, Thrissur, Kerala. p. 321-330.
10. Food and Agricultural Organization (FAO). Distribution and characteristics of duck-fish farming systems in Eastern China. FAO Smallholder Poultry Production Paper No. 2. Rome: FAO; 2010. p. 28.
11. Gbotosho O, Burt PJA. Environmental and health impacts of poultry manure disposal methods: A case study of Lagelu and Egbeda local government areas in Oyo State, Nigeria. *Int J Agric Sustainability.* 2013;11(1):38-51. Available from: <http://dx.doi.org/10.1080/14735903.2012.700100>.
12. Kanwat MS, Meena P, Suresh Kumar VK, Choudhary R, Bhagawati. Measurement of attitude towards the adoption of backyard poultry farming in Arunachal Pradesh. *J Agric Sci.* 2012;4(3):131-136.
13. M.S. Swaminathan Research Foundation (MSSRF). Measures to mitigate agrarian distress in Alappuzha and Kuttanad wetland ecosystem: A study report. 2007. p. 227.
14. Pervin W, Chowdhury SD, Hasnath MR, Khan MJ, Ali MA, Raha SK. The duck production strategy and profile of duck farmers in the coastal areas of Bangladesh. *Livest Res Rural Dev.* 2013;25(7). Available from: www.lrrd.org [10 Dec 2013].
15. Tamizhkumaran J, Rao SVN, Natchimuthu K. Nomadic duck rearing in and around Puducherry region - An explorative study. *Indian J Poult Sci.* 2013;48(3):377-382.
16. Thakur D, Sharma AK, Chander M, Katoch S. Adoption of scientific backyard poultry rearing practices in hills of Himachal Pradesh. *Indian J Poult Sci.* 2013;48(3):357-361.
17. Wibowo RH. Business analysis of laying ducks SME: Case study in the area of Cirebon, West Java. 2013. Available from: <http://repository.ipb.ac.id/handle/123456789/67065> [26 Dec 2013].