Improving productivity and competitiveness of Kepahiang robusta coffee through innovation and partnership

Y A Dewi*, L Hutahaean and Rubiyo

Indonesian Agency for Agricultural Research and Development, Ministry of Agriculture, Bogor, Jawa barat, Indonesia.

E-mail: *yovi_anggita@yahoo.com

Abstract. Robusta coffee is a very strategic commodity in Kepahiang district, bengkulu province. This paper aims to (i) describe the overview, coffee quality and flavor, the financial feasibility of Kepahiang coffee farming, (ii) formulate technological innovations in increasing productivity, and (iii) formulate efforts to increase competitiveness. The paper was synthesized from literatures related robusta coffee, and it was conducted in 2019. All data were gathered from secondary data using documentation methods and the data from relevant literature were analyzed descriptively. Based on the synthesis, the productivity of Kepahiang robusta coffee is only around 774 kg/ha or still below its production potential. Kepahiang coffee was characterized as small beans with grade 5 and 6 while the total of flavor total was 80.50 - 85.50. Efforts to increase Kepahiang coffee productivity can be done through technological innovations such as the use of high yielding planting material, pest and disease control, pruning technology as well as postharvest and processing improvement. Increasing competitiveness can be done by developing partnerships that are designed through 4 (four) stages, namely phase 0, phase 1, phase 2 and phase 3. Technological innovation and partnership relationships are expected to increase productivity and competitiveness of Kepahiang robusta coffee.

1. Introduction
The area of coffee plantations in indonesia in 1980-2017 around 1.15 million hectares with production reaching 523.83 thousand ground coffee/year. However, for robusta coffee, the growth has decreased [1]. Indonesian coffee also has comparative advantage with its ability to compete at the international market [2,3].

One of the coffee producing regions, especially robusta coffee in indonesia, is bengkulu province. This region is the third largest coffee producer after lampung and south sumatra [4]. Yet, its strategic role has not been matched by the level of productivity and production. In bengkulu province, the coffee productivity is 740.67 kg/ha/year with a declining trend [5]. This productivity is still below its optimal potential average which can reach 2 tons/ha.

Technology implementation is one of the main factors which allegedly affects the fluctuated coffee productivity and production [6]. According to [7], increasing coffee productivity in the Kepahiang area - bengkulu province is constrained by the limited use of high yielding and quality planting materials and the application of fertilization technology resulting productivity less than 1 ton/ha/year. The absence of intensive plant maintenance, pests and diseases, the use of random planting materials, and the old and less productive plants have triggered the low productivity of coffee in bengkulu [8]. Coffee development
in bengkulu is faced three main problems which are low productivity (< 1 ton/ha/year) and low coffee selling value (farmers received 84% of the price paid by the exporter) [8,9].

Several previous studies already discussed about robusta coffee farming from various aspect yet the review about kepahiang robusta coffee is still limited. Thus, it is very important to identify the current status of robusta coffee in Kepahiang and to formulate technological innovation. This paper is focused on describing the existing conditions of coffee farming, providing information about the quality and taste of coffee, identifying an alternative of technological innovations and formulating suggestions to increase competitiveness through partnerships.

2. Materials and methods
The research used the Kepahiang robusta coffee in bengkulu province in 2019 as a case study. All the research data were gathered from secondary data using documentation methods raised from relevant literature. Data were obtained from the indonesian bureau of statistics at the national level and provincial level (bengkulu province), the indonesian ministry of agriculture (directorat general of estate crops), and results of previous research studies. Types of secondary data included cost structure of coffee production released by the indonesian bureau of statistics, revenue analysis of coffee farming from relevant research. Equally, data of physical quality of robusta bean were also compiled to meet the question of research. The data from relevant literature were analyzed descriptively.

3. Results and discussion

3.1. Overview of Kepahiang coffee farming
The coffee production centers in bengkulu are muara kemumu followed by kabawetan, tebat karai, and Kepahiang [10]. The coffee plantation has been cultivated since the dutch colonialization era. This commodity, in 2017, was managed by 62,066 farmers with the number of plants up to 90,704 trees, and the contribution of the total plantation crops was around 20.78%. The total production was recorded at 56,434 tons and dominated by robusta coffee (97.35%). In 2013-2017, Kepahiang was the largest coffee-producing area in bengkulu province with an average production of around 18,419.33 tons/year or contributing 32.66% to total provincial production [11]. This puts Kepahiang as a very main coffee production center, yet the average productivity (747 kg/ha/year) is still below its potential. Robusta coffee is more cultivated because of its better resistance to leaf rust disease, easier maintenance requirements, but the yield is still much higher than arabica coffee [12].

3.2. Beans quality of Kepahiang robusta coffee
The results of the analysis of the physical quality test and taste of coffee samples showed that all samples of coffee beans were free of live insects, free of foul odor and mold and 0% dirt content. However, there were 2 (two) samples of coffee beans that did not meet the indonesian national standard (ins) requirements (table 1). This indicates that the unstandardized and variation of drying or post-harvest process.

| Samples   | Living insects | Foul odor and molds | Water content (%) | Dirt content (%) | Defect value |
|-----------|----------------|---------------------|-------------------|-----------------|--------------|
| 02.19.1.0177 | None          | None                | 12.2              | 0               | 216.6        |
| 02.19.1.0178 | None          | None                | 12.3              | 0               | 105.7        |
| 02.19.1.0179 | None          | None                | 12.9              | 0               | 117.6        |
| 02.19.1.0180 | None          | None                | 13.1              | 0               | 121.8        |
| 02.19.1.0181 | None          | None                | 12.4              | 0               | 99.3         |

As can be seen from table 1, Kepahiang coffee beans were included as small beans and the defect value was 5 and 6 grades. Four samples were included in quality 5 with a defect value of 99.3; 105.7;
117.6; and 121.8, while one sample had quality 6 with a defect value of 216.6. These results also described that the quality of Kepahiang robusta coffee beans still requires improvement due to the high defect. Farmers knowledge and capacity in implementing harvesting and processing management are alleged influencing the low quality of coffee beans.

3.3. Analysis of profits and factors affecting farming profits
Several studies stated that coffee farming was quite profitable. Study on robusta coffee in rejang lebong-bengkulu by [13] mentioned that in one hectare, the total revenue at the private price was around 32.22 million idr with a profit of 19.09 million idr/ha/year whereas r/c 2.45 or for each expenditure idr 1,000 idr, farmers will receive a return of 2,450 idr. [8] conducted a similar study which revealed that robusta coffee farming provided r/c value of the cash cost and total cost of 5.33 and 1.87, respectively (table 2).

Table 2. The overview of revenue analysis of robusta coffee farmings in several regions.

| Study site                      | R/c  | Sources | Annotation                                      |
|---------------------------------|------|---------|-------------------------------------------------|
| Kepahiang district-Bengkulu     | 4.24 | [14]    | Calculated based on mature plants               |
| Rejang district, Bengkulu       | 3.37 & 3.85 | [6]    | 3.37 = traditional; 3.85 = grafting            |
| Rejang district, Bengkulu       | 2.45 | [13]    | Calculated based on private cost                |
| Rejang district, Bengkulu       | 5.33 & 1.87 | [8]   | 5.33 based on cash cost; 1.87 based on total cost |
| Bondowoso district, East Java   | 1.85 | [15]    | Average between narrow and large lands          |
| Okan Komering Ulu Selatan district, South Sumatra | 1.35-1.98 | [16] | The r/c varied depending on plant ages          |

As can be seen in table 2, in rejang lebong, bengkulu, robusta coffee farming using farmers’ technology (existing) were able to provide r/c of 3.37, but it was still the revenue by implementing side grafting technology with r/c of 3.85 or 14.24% higher [6]. In bondowoso, east java showed that robusta coffee from this region resulted r/c of 1.85. The profit level of coffee farmers in okan komering ulu selatan district was varied according to plant age. Coffee plants aged 5-7 produced the highest profit at r/c of 1.98, followed by coffee farmers with plant age <5 years, meanwhile coffee plants over 25 years produced the smallest profit of 1.35 due to the declining productivity [16].

3.4. Productivity increasing through technological innovations
Many technologies to improve robusta coffee productivity improvement technology have been found. However, not all farmers have implemented recommended technologies in their coffee farming. Some technological innovations to overcome the low productivity of coffee at the farm level are described as follows.

3.4.1. High yielding planting materials. The use of planting material from non-high yielding seeds is still commonly applied by farmers even though there are already many high yielding of national robusta coffee clones produced such as bp 42, bp 234, bp 288, bp 409, bp 456, bp 534, bp 936, sa 234 and sa 203 with potential productivity between 800-2,000 kg/ha/year [17]. According to [18], robusta coffee has a fairly varied range of height to grow resulting variation on genotypes. Although it causes the yield and quality distinction, it can be used for propagation. Farmers are actually quite experienced in selecting and developing superior genotypes. However, the criteria used are often very simple so that only meet the requirements for seed size and productivity level yet it is still difficult to compete in the global market.

Likewise, [19] mentioned that the basis for selecting planting materials by most farmers only refers to the high production and large seed sizes. In fact, with technological innovation farmers can receive
better results, for example with plagiotropic shoot grafting techniques [19], side grafting techniques [20] [21], or shoot grafting techniques [18].

The provision of high yielding planting material is also carried out through the development of parent seed garden/entres garden. The varieties developed in Kepahiang as a source of entres were 11 clones namely sintaro 1, sintaro 2, sintaro 3, senhance, bp 308, bp 358, bp 409, bp 535, bp 936, bp 939 and bp 42.

3.4.2. Pests and diseases controlling. Some types of pests frequently found in coffee plants are coffee fruit borer (*hypothenemus hampei* ferr.), red stem borer (*zeuzera* sp.), branch and twig borer (*xylosandrus* spp.) And green lice (*coccus viridis*). The main diseases are caused by fungi (*hemileia vastatrix*, *cercospora coffeicola*, *corticium salmonicolor*) such as leaf rust, leaf spot, fungus, or fallen stems and diseases caused by nematodes. Coffee pod borer (cpb) can be controlled using a proper fertilizing to produce healthy plants and optimal growth, controlling weeds after harvest, routine pruning as well as physical and mechanical control [22]. Main diseases such as leaf rust can be overcome for example by the use of tolerant varieties, fungicides or application of technical culture [23].

3.4.3. Pruning techniques. Branch pruning technique is one of the crucial factors in producing high and stable robusta coffee production. [24] described that improper branch management will reduce the productivity. Branch b1 or branch already produced once, for example, is the branch with the highest yield potential because it can contain 8-14 bunches/branch. This branch is much more productive than the b3 branch (branch already produced three times) which is only able to produce 2-6 bunches.

3.4.4. Post-harvesting and processing technology. Post-harvest coffee technology includes the process of handling coffee produce to produce semi-finished products. Handling of coffee after harvest is continued with fruit sorting, processing, sorting of coffee beans, packaging, and warehousing [25]. Post-harvest of coffee needs to be handled properly according good handling practices (gph) including the accurate application of technology and the facilities and infrastructure. [26] mentioned that post-harvest coffee consists of two activities namely primary and secondary handling.

Kepahiang coffee farmers generally apply dry processing techniques because it is relatively easy and simple with the use of various coffee fruit ingredients and varying degrees of maturity resulting low quality. The recommended processing technique is wet processing since it will produce good quality coffee and high taste. [27] suggested that wet-processed robusta coffee resulted a better taste due to the influence of higher amino acids, fat, ash content and the formation of precursors from the fermentation process.

3.5. Increasing competitiveness through partnerships

The results of the analysis with the policy analysis matrix (pam) showed that bengkulu robusta coffee has competitive and comparative advantages [13], yet it still requires improvement. One of the efforts to increase the competitiveness of Kepahiang coffee is through partnership networks. Partnership patterns in the coffee commodity, have actually been done a lot, but they have not been fully implemented [28]. The developing partnerships in Kepahiang coffee farmers can be carried out through 4 (four) phases using a modified approach by [29].

The coffee commodity partnership concept in Kepahiang involves farmer groups, traders/exporters and mediators as three main actors. The mediator functions as a liaison for the various parties involved in the partnership. The mediator is very important to assess partnership opportunities and to build trust and commitment from the involved parties [30].

The initiation of partnership networks for coffee farmers in Kepahiang begins with phase 0 (figure 1). In this phase, farmers' groups and traders/exporters actually already know their respective roles, however, contact between farmer groups and exporters has not yet been established. This condition causes farmer group members to tend to sell and market their coffee individually. Phase 0 also illustrates the crucial role of a mediator.
The expected next phase is to emerge the building of partnerships (phase 1). In this phase, the partnership between exporters and farmer groups begins to be established, because the mediator plays an active role in facilitating the partnership and providing assistance including increasing knowledge and capacity for farmer groups (figure 2). Phase 1 demonstrates that the role of the mediator is still very large in bridging the other two actors, and then it is expected the decreasing role of the mediator in line with the growth and development of the partnership.

Phase 2 displays that there has been a fairly well-established and good partnership between farmer groups and traders/exporters. This stabilization phase also reduces the role of the mediator. The mediator no longer acts as a facilitator but only as a source of information, consultation and part of the supervision or monitoring activities (figure 3). The last phase is phase 3 through the realization of independence and sustainability of the partnership. The mediator no longer plays the main role and the mediator’s function is consultative (figure 4). In this phase, the absence of intervention from the mediator no longer affects the sustainability of the partnership because the two other actors have interacted and established mutually beneficial relationships. The growth and development of partnerships through these various phases aims to increase the competitiveness of coffee so it can provide equal benefits for both farmer groups and traders/exporters. Increasing the competitiveness of coffee commodities will not only contribute positively to coffee farming actors but also to the regional economy.

4. Conclusions
Robusta coffee farming has long been one of the backbone subs sectors for farmers in Kepahiang. Farming coffee is financially profitable and feasible to develop, so that if it is managed properly, it will contribute positively to increasing regional income and economy. Technical constraints in particular
concern the application of technological innovations especially the use of varieties, fertilization and pruning. Marketing of coffee individually and not using a partnership forum has made the selling value and competitiveness of Kepahiang coffee still low. The recommended technological innovation is started from the use of high yielding planting materials, cultivation, to post-harvest technology and processing. The institutional aspect needs to be built through the development and development of partnerships involving various actors. Thus, it is expected that the competitiveness will continue to improve, not only to be able to compete in the domestic market but also to the export market.

References

[1] Kementerian Pertanian [Ministry of Agriculture] 2018 Laporan Tahunan Kementerian Pertanian Tahun 2017 [Annual Report of The Ministry of Agriculture 2017] jakarta: kementerian pertanian [ministry of agriculture] 461 p available from: http://ppid.pertanian.go.id/

[2] Nalurita S, Asmarantaka R W, Jahroh S 2014 Analisis daya saing dan strategi pengembangan agribisnis kopi di Indonesia [Analysis of competitiveness and development strategies for coffee agribusiness in Indonesia] Jurnal Agrribisnis Indonesia 2(1) pp 63-74

[3] Zuhdi F, Suharno 2015 Analisis daya saing ekspor kopi Indonesia dan Vietnam di pasar asen 5 [Analysis of the competitiveness of Indonesian and Vietnamese coffee exports in the asean market] Habitat 26(3) pp 152-62

[4] Kusmiati A, Windiarti R 2011 Analisis wilayah komoditas kopi di Indonesia [Analysis of coffee commodity areas in Indonesia] Journal of Social and Agriculture Economics 5(2) pp 47-58

[5] Kementerian Pertanian [Ministry of Agriculture] 2019 Laporan Pembangunan Perkebunan 2019 [Annual Plantation Development Report In 2019] Jakarta: Direktorat Jenderal Perkebunan Kementerian Pertanian [Directorate General of Plantation Ministry of Agriculture] 92 p available from: http://ditjenbun.ppid.pertanian.go.id/

[6] Suhendra D, Nurung M, Reswita 2012 Analisis pendapatan usahatani pada kopi tradisional dan kopi sambilub di Desa Lubuk Kembang, Kecamatan Curup Utara, Kabupaten Rejang Lebong [Income analysis of traditional coffee farming and continued coffee in Lubuk Kembang village, Curup Utara district, Rejang Lebong regency] Jurnal Agrisep 11(1) pp 61-68

[7] Yesmawati, Wibawa W 2018 Keunggulan finansial peremajaan tanaman kopi dengan teknik kapak kulai di provinsi bengkulu [The financial advantage of rejuvenating coffee plants with the curry ax technique in bengkulu province] in Indonesia Prosiding Seminar Nasional Agroinovasi Spesifik Lokasi untuk Ketahanan Pangan pada Era Masyarakat Ekonomi Aman (Bogor, Indonesia) Accepted

[8] Listyati D, Sudjarmoko B, Hasibuan A M, Randriani E 2017 Analisis usaha tani dan rantai tata niaga kopi robusta di bengkulu Jurnal Tanaman Industri dan Penyegar 4(3) pp 145-54

[9] Sugianti, S 2010 Analisis pemasaran kopi di kecamatan bermani ulu raya Kabupaten Rejang Lebong [Analysis of coffee marketing in bermani ulu raya sub-district, Rejang Lebong district] Jurnal Agrisep 9(2) pp 130-36

[10] Badan Pusat Statistik Kabupaten Kepahiang [BPS-Statistics of Kabupaten Kepahiang] 2018 Kabupaten Kepahiang Dalam Angka 2018 [Kepahiang Regency In 2018] (Kepahiang, Indonesia: Badan Pusat Statistik Kabupaten Kepahiang) [BPS- Statistics of Kabupaten Kepahiang] P 312 Available from: https://kepahiangkab.bps.go.id/publication/2018

[11] Kementerian Pertanian [Ministry Of Agriculture] 2019 Situs Basis Data Statistik Pertanian [Agriculture Statistics Database Site] (Jakarta: Kementerian Pertanian) [Ministry of Agriculture] Available from: https://aplikasi2.pertanian.go.id/bdsp/

[12] Prastrobo W, Karmawati E, Rubijo, Siswanto, Indrawanto C, Munarso S J 2010 Budidaya dan Pasca Panen Kopi [Cultivation and Post Harvest Coffee] Bogor: Pusat Penelitian dan Pengembangan Perkebunan [Center of Plantation Research and Development]

[13] Murtiningrum F, Asriani P S, Badrudin R 2013 Analisis daya saing usahatani kopi robusta (coffee canephora) di Kabupaten Rejang Lebong [The competitiveness of robusta coffee farming in Rejang Lebong regency] Jurnal Agrisep 13(1) pp 1-14
Bibliografi

[14] Bank Indonesia Bengkulu 2011 Kajian Ekonomi Regional Provinsi Bengkulu Triwulan I/Bengkulu Province Regional Economic Study Quarter I) Bengkulu: Bank Indonesia Bengkulu p 57
[15] Sari E I, Sutiarso E, Hadi S 2018 Analisis keuntungan dan efisiensi penggunaan biaya usahatani kopi rakyat robusta di Kecamatan Sumber Wringin Kabupaten Bondowoso [Analysis of the benefits and efficiency of using the cost of faring robusta coffee in the Sumber Waringin district, Bondowoso regency] Jurnal Agrihést 2(1) pp 61-9
[16] Megayani D 2019 Studi kelayakan usaha tani kopi dan karakteristik rumah tangga usaha tani di Kabupaten Ogan Komering Ulu Selatan [Feasibility study on coffee farming and the characteristics of farming households in Ogan Komering Ulu Selatan district] Mimbar Agribisnis 5(1) pp 104-13
[17] Rubiyo, Martono B, Dani 2013 Perkatan Teknologi Untuk Peningkatan Produksi Dan Mutu Hasil Perkebunan Kopi Rakyat [Assembly Technology to Increase Production and Quality of Community Coffee Plant Products] Bogor: Pusat Penelitian Dan Pengembangan Perkebunan
[18] Dani, Tresniawati C, Randriani E 2013 Seleksi genotype unggul kopi robusta spesifik lokasi [Location specific superior genotype selection for robusta coffee] Buletin Ristri 4(2) pp 139-44
[19] Randriani E, Dani, Tresniawati C, Syafaruddin 2014 Hubungan antar karakter vegetative, komponen hasil, dan daya hasil kopi robusta asal sambung tunas plagiotrop [The relationship between vegetative characters, yield components, and robusta coffee yield from plagiotropic shoot graft] Jurnal Tanaman Industri dan Penyegar 1(2) pp 109-16
[20] Limbongan J 2009 Peremajaan pertanaman kakao dengan klon unggul melalui teknik sambung samping (side-cleft-grafting) [Rejuvenation of cocoa plants with superior clones through side grafting technique (side-cleft-grafting) Agrosaint Uki Toraja 1(2) pp 48-55
[21] Limbongan J 2011 Kesiapan penerapan teknologi sambung samping untuk mendukung program rehabilitasi tanaman kakao [Readiness for the application of side grafting technology to support the cocoa plant rehabilitation program] Jurnal Ltitang Pertanian 30 pp 156-63
[22] Harni R, Samsudin, Amaria W, Indriati G, Soesanthy F, Khaerati, Taufiq E, Hasibuan A M, Hapsari A D 2005 Teknologi Pengendalian Hama Dan Penyakit Tanaman Kopi [Pest and Disease Control Technology for Coffee Plants] Jakarta: Iaard Press
[23] Mahfud M C 2012 Teknologi dan strategi pengendalian penyakit karat daun untuk meningkatkan produksi kopi nasional [Technology and strategies for controlling leaf rust disease to increase national coffee production] Pengembangan Inovasi Pertanian 5(1) pp 44-57
[24] Yuliasmara F 2017 Mengenal pertunasan dan percabangan pada kopi robusta [Get to know germination and branching of robusta coffee] Warta Pusat Penelitian Kopi dan Kakao Indonesia 29(3) pp 22-7
[25] Kementerian Pertanian [Ministry of Agriculture] 2012 Peraturan Menteri Pertanian Republik Indonesia Nomor 5 Tahun 2012 Tentang Pedoman Penanganan Pascapanen Kopi [Regulation of The Minister of Agriculture of The Republic of Indonesia Number 5 of 2012 on Guidelines for Postharvest Handling of Coffee] Jakarta: Kementerian Pertanian
[26] Mayrowani H 2013 Kebijakan penyediaan teknologi pascapanen kopi dan masalah pengembangannya [Postharvest coffee technology provision policies and development issues] Forum Penelitian Agro Ekonomi 31(1) pp 31-49
[27] Towaha J, Aunillah A, Purwanto E H, Supriadi H 2014 Pengaruh elevasi dan pengolahan terhadap kandungan kimia dan citarasa kopi robusta lampung [The effect of elevation and processing on the chemical contents and flavor of lampung robusta coffee] Jurnal Tanaman Industri dan Penyegar 1 pp 57-62
[28] Fadjar U 2006 Kemitraan usaha perkebunan: perubahan struktur yang belum lengkap [Plantation business partnership: incomplete structural changes] Forum Penelitian Agro Ekonomi 24(1) pp 46-60
[29] Wijaya A, Glasbergen P, Mawardi P 2017 The mediated partnership model for sustainable coffee production: experience from Indonesia International Food and Agribusiness Management Review 20 pp 689-708
[30] Hermanto R 2007 Rancangan kelembagaan tani dalam implementasi prima tani di Sumatera Selatan [Farmers institutional design in prime farmer implementation in South Sumatera] Analisis Kebijakan Pertanian 5(2) pp 110-25