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Advance in Arabica Forest Coffee Management Research in Ethiopia

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Summary
Forest and semi-forest coffee stands contribute to about 40 - 41% of the total production in the country. However, productivity of these stands is very low primarily because of poor management. In line with this, several experiments have been conducted to improve yields of these coffee stands in Ethiopia. Accordingly, it was observed that rejuvenation practices, *viz*. topping, agobiado and eskeletamento increase forest coffee yield by 43.2, 40.4 and 38.0% over clean stumping and 12.5, 8.4 and 4.7% over control (not rejuvenated trees), respectively. Earlier stumping immediately after harvesting tends to promote yield. Coffee trees stumped at 50 cm height had slightly higher yield than the conventional 30 cm stump. Tied ridge gave respective yield advantage of 19.0 and 23.6% over untied ridge and traditional flat land field. Maintaining 3 - 4 bearing heads per tree or stump and adjusting plant population to 4000 - 5000, 5000 - 6000 and 7000 - 8000 trees ha^{-1} had maximized productivity of forest coffee at Tepi, Jima and Metu and Agaro, respectively. On the other hand, forest coffee stands did not respond to mineral fertilizer application and weed management.

Introduction

Forest coffee regenerate spontaneously as an understory bush growing in humid rain forests of west and southwestern parts of Ethiopia. It represents 10% of the total land covered by coffee and it contributes 5 - 6% of the total coffee production in the country (Workafes and Kassu, 2000). Despite its importance in the national economy of the country, its production potential hardly exceeds 200 - 250 kg ha^{-1} clean coffee (Paulos and Demil, 2000). The same thing applies to the semi-forest coffee contributing to about 35% of the bulk of the production (Workafes and Kassu, 2000). Exhaustion due to aging, unregulated tree growth and population density, drought, inadequate or excessive light or shade, and rugged and undulating topography and associated factors, such as soil erosion, are among the major constraints that account for low productivity of forest coffee stands in the country (Anteneh *et al*., 2008).

In order to alleviate the constraints and conserve the genetic resource and improve and sustain productivity of old coffee *in situ*, several crop management research have been carried out in the areas of rejuvenation, soil and moisture conservation, adjustment of population density and bearing heads, soil fertility management and weed control practices. Therefore, out standing research achievements generated so far pertaining to forest coffee management in Ethiopia are reviewed and briefly presented in this paper.

Research Findings

Old coffee rejuvenation

In four, five and seven year's cycle stumping trials, stumped plots gave higher yields than unstumped coffee (Figure 1a, b and c). Similarly, it was observed that yield of old coffee stands increased by 43.2, 40.4 and 38.0, and 12.6, 8.4 and 4.7% using rejuvenation methods, namely topping, agobiado and eskeletamento, as compared to the conventional clean stumping and the control (not rejuvenated) plot, respectively (Figure 2). However, the adoption of the different rejuvenation methods may be influenced by stem nature of varieties (flexible or stiff), spacing between plant (population density), age of coffee trees, economic status of the farm and management system (Yacob *et a*l., 1996; Anteneh *et al*., 2008). Thus, these factors determine the feasible method to be adopted to renew old coffee orchards.

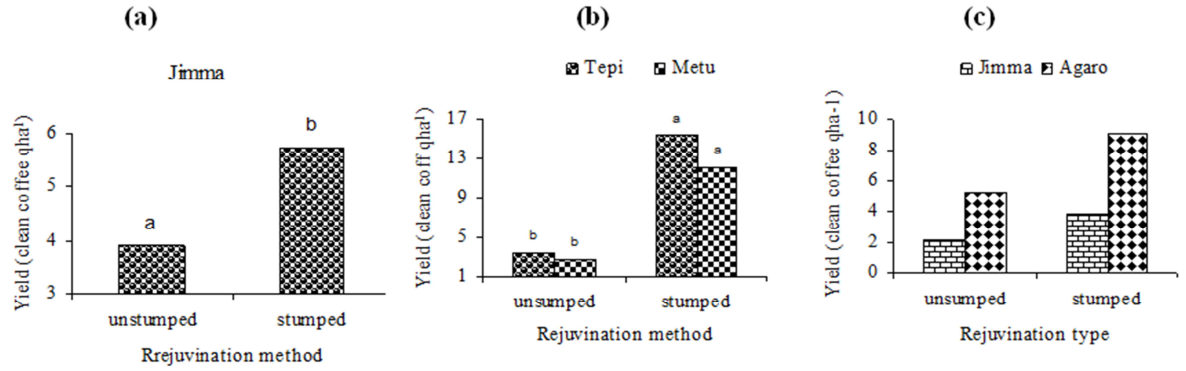

Figure 1. Four (a), five (2) and seven (3) year stumping trial. Bars capped with same letter(s) are not significantly different at P = 0.05 probability level. Yield is given in quintal (q), which is equivalent to 100 kg. *Source: Yacob et al. (1996).*

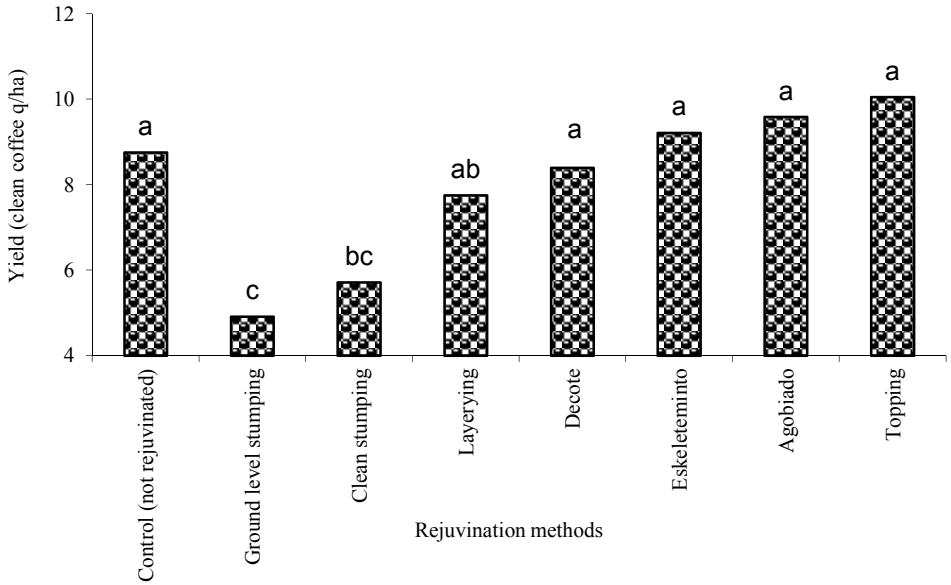

Figure 1. Effect of different rejuvenation methods on yield of forest coffee. Bars capped with same letter(s) are not significantly different at P = 0.05 probability level. Yield is given in quintal (q), which is equivalent to 100 kg. *Source: Anteneh et al. (2008)*

Time and height of stumping

It was observed that earlier stumping and increased stumping height significantly promoted forest coffee yield at different locations (Figure 3a and b). Relatively higher yield response to increasing stumping height could be attributed to the large amount of carbon compounds (photosynthates) accumulated in the stump, nourishing the newly growing suckers and the root system. This could maintain optimum shoot to root ratio and thus, promote productivity of coffee trees.

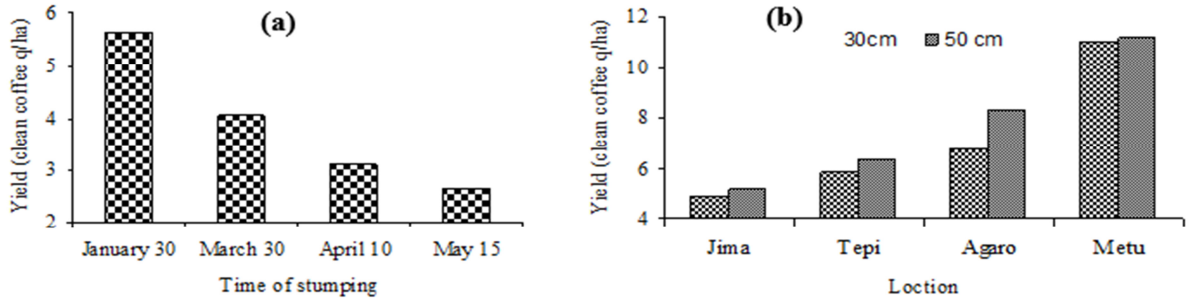

Figure 3. Effect of time (a) and height (b) of stumping on yield of forest coffee. Source: *Anteneh et al. (2007)*

Population density and bearing heads

Higher population density improved forest coffee yield, culminating the highest value at 5000, 6000 and 8000 trees ha^{-1} at Tepi, Jimma, Metu and Agaro, respectively (Figure 4 a, b and c). Besides maintaining optimum population density yield of forest coffee stands linearly increased with increasing number of bearing heads per tree or per stump (Figure 4b). The increase in coffee yield with increasing population density has been attributed to efficient utilization of environmental inputs, *viz*. light, moisture and nutrients, until the biological optimum is attained (Taye *et al*., 2001).

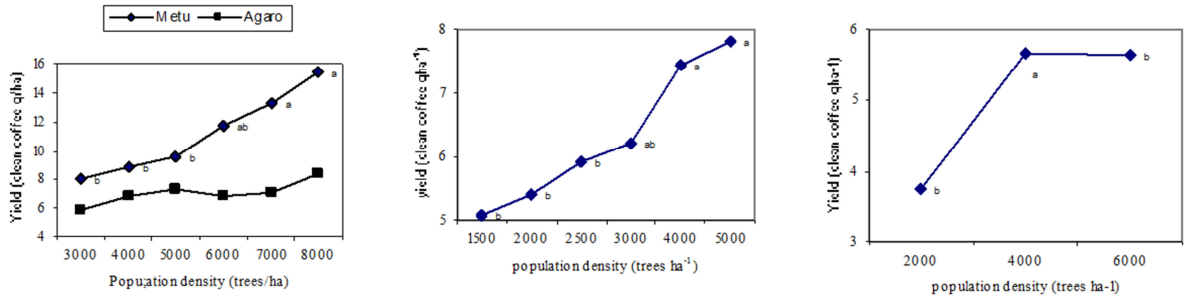

Figure 4. Forest coffee yield (clean coffee q ha^{-1}) as affected by population density at Metu and Agaro (a), Tepi (b) and Jimma (c) (five years mean). Figures followed by the same superscript(s) are not significantly different at P = 0.0. *Source: Anteneh et al. (2008)*

Soil and moisture conservation

Soil and moisture conservation structures, such as ridging tree rows were found to be effective in improving yield of forest coffee stand especially on sloppy lands. With regard to this, tied ridge exhibited 19.0 and 23.6% yield advantage over untied ridge and flat land, respectively (Fig. 4a). Similarly yield advantage observed with closed end ridges for annual crops (Heluf, 2003) and for tree crops like coffee (Yacob *et al.,* 1996).

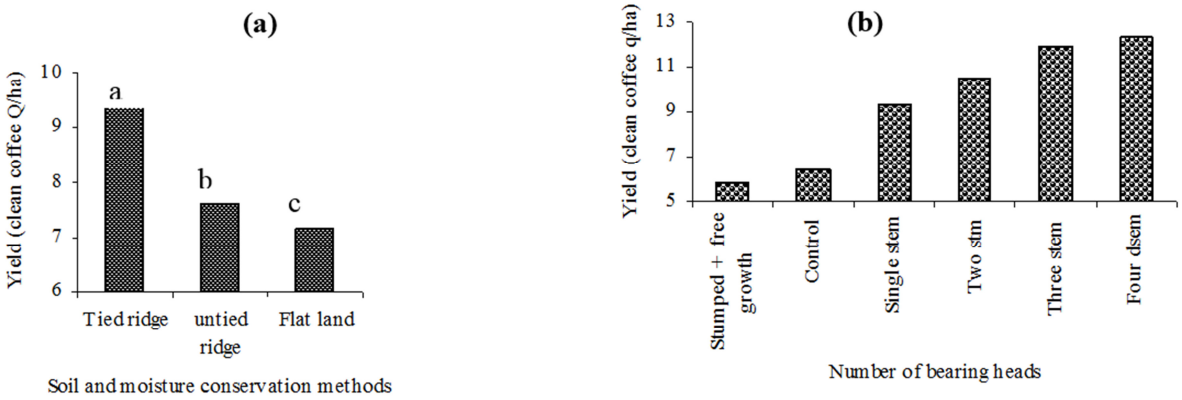

Figure 4. Effect of soil and moisture conservation methods (a) and number of bearing heads (b) on forest coffee yield. Bars capped with same letter(s) are not significantly different at P = 0.05 probability level. *Source: Tesfaye et al. (1998); Anteneh et al. (2006, 2007)*

Mineral fertilizer and weed control

It was observed that forest coffee yield was not significantly affected by application of mineral fertilizer and weed management (Figure 5a and b). This could be associated to high organic matter content of the soil, resulted from mineralization of dense litter fall from the shade trees, and heavy over head shades that mask, depressed or nullified the effect of fertilizer and weed management, respectively, on the performance of coffee tees underneath.

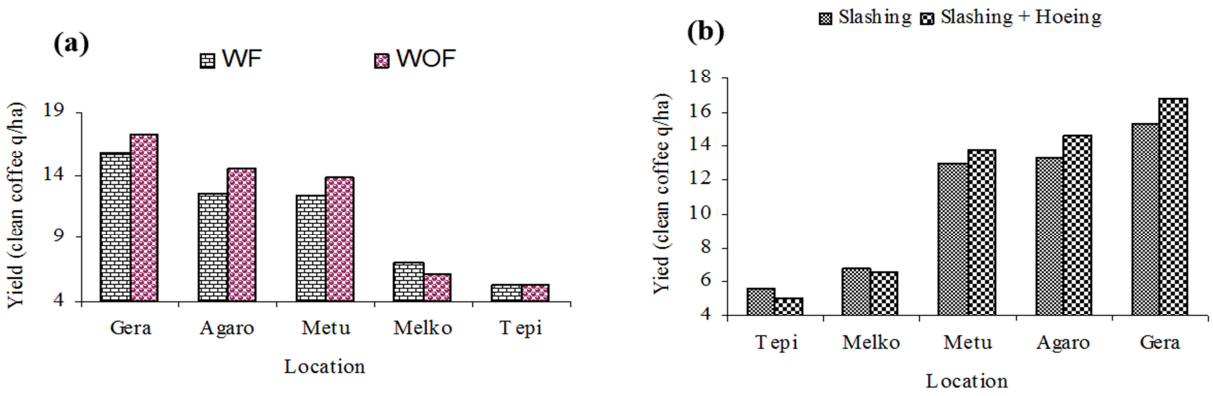

Figure 5. Forest coffee yield as affected by mineral fertilizer application (a) and weed management (b) (four years mean). WF = With recommended rate of fertilizer ($N_{172}P_{77}$ and $N_{150}P_{63}$ kg ha^{-1}), WOF = Without fertilizer. *Source: Anteneh et al. (2008).*

Conclusion and Recommendations

Forest coffee can be successfully rejuvenated and become productive by applying different rejuvenation practices, *viz.* topping, agobiado and eskeletamento, which out yield the conventional stumping at least by two fold. Furthermore, yield of forest coffee stand slightly improved by stumping orthotropic shoots at 50 cm height above the ground as compared the conventional 30 cm stumping height. On the other hand, tied ridge was found to be important components of land management, especially on sloppy land, to sustain and promote forest coffee yield. Maintains coffee trees on a flat land had inferior compared to other land preparation and soil moisture conservation practices (tied and untied ridge).

Application of mineral fertilizer is not recommended for forest coffee production as it promote organic coffee production by subsistence and small-scale forest coffee producers in the country. Yield of old coffee stands increase linearly with increasing number of bearing head per tree or stump by thinning out weak and closely spaced coffee trees and/or by planting new coffee seedlings in open space ranging between 4000 and 8000 trees per ha at different sites.

Gaps and Challenges

- Indigenous farming systems and cropping pattern for each forest area have not been assessed for forest coffee management;
- Lack of training of farmers on improved management practices that promote the productivity of forest coffee stands;.
- Relationships between ecological factors (climate and soil) and coffee yield and quality attributes in the forest coffee production systems have not been assessed.
- The main a biotic and biotic stress associated with coffee production in the montane rain forest of the country have not been identified and documented yet; and
- The impact of different management practices recommended to boast and sustain forest coffee production has not been assessed..

Prospects

Investigation in various aspects of forest coffee management (shade regulation, training and pruning etc.) should continue to generate technologies economically feasible in the country to promote and sustain productivity of old coffee stands.

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